Guide to FY2017 Research Funding at the
Department of Defense (DOD)
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Summary and Index

This document provides insights into the various DOD funding agency opportunities for University basic research (6.1) and for some applied research (6.2) efforts, with special attention to changes anticipated in FY2017.   Additional information is available through the USC Mission Agency Program Summary (MAPS) website (see the Resources section).

DOD funds research that is relevant to its mission, predominantly drawing on engineering, computer/information science, and physical sciences. The Department has identified seven cross-cutting Science and Technology (S&T) priorities: Autonomy, Counter Weapons of Mass Destruction, Cyber Sciences, Data-to-Decisions, Electronic Warfare, Engineered Resilient Systems, and Human Systems.

Appendix 2: FY2017 Selected Applied Programs with Significant Change pages 25 - 32

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 program 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. The Department has 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 basic research, 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. On 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 (ISI) and the Institute for Creative Technologies (ICT) 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 Office of the Assistant Secretary of Defense (Research & Engineering) has identified six emerging science research areas: a) novel engineered materials, b) quantum information science, c) cognitive neuroscience, d) nanoscience, e) synthetic biology, and f) understanding human and social behavior (http://www.acq.osd.mil/rd/basic_research/focus_areas/). On occasion (last one in 2012), the DOD Office of Basic Research sponsors workshops in emerging areas of science/engineering that it perceives as important to the DOD; these workshops are meant to guide research investment.

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

Agencies with >$50M 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, 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 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://sslweb.hqda.pentagon.mil/ari/
  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 via CDMRP
- Office Secretary of Defense (OSD): http://www.acq.osd.mil/chieftechnologist/index.html
  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 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 38 to 80.

While peer review is used to differing degrees by the various DOD agencies, the 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. To identify the appropriate program officers, one can use the USC MAPS website keyword search engine, and/or contact Murday. 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. Guides to interacting with the program officers and preparing proposals are in the MAPS web site, Tabs 2-4.

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 and ONR are five 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 $50K/yr (Army) to $250K/yr (DARPA). Submission deadlines vary. For more information, see MAPS DOD Charts 161-166; a listing of prior awardees and their research topics is available from the DC office.

Senior Investigators - National Security Science and Engineering Faculty Fellowship
http://www.acq.osd.mil/rd/basic_research/program_info/nsseff.html
This is a special program to support outstanding faculty in topics-of-interest to DOD; it is competed intermittently as funding allows. An NSSEFF awardee receives ~$600K/yr for five years. Awardees are generally ~20 years post PhD, have impressive credentials, and address a science/engineering basic research topic of interest to DOD. In FY2017 the NSSEF will fund a new class solicitation, organize a DoD I-Corps competition, and conduct a Laboratory University Collaboration Initiative (LUCI). For more information, see MAPS DOD Chart 170; a listing of the prior awardees and their topics is available from the DC office.

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 Technology Alliances (CTA), and Centers of Excellence (CoE)] to single investigator programs [e.g., DARPA/DTRA/CDMRP topic solicitations, and ONR's Basic Research Challenges]. These announcements have specific application due dates.

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 Jul – Sept time frame each year, with white papers due about a month later, and proposals about three months later. 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 single University efforts can be successful. For more information, see MAPS DOD Charts 139-142; 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 160). The Army also has University COE, Collaborative Technology Alliances (CTA), and Collaborative Research Alliances (CRA) that engage Universities (see MAPS DOD Charts 192). 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 184)

Human Social, Cultural, and Behavioral Modeling (HSCB)
MINERVA
http://minerva.dtic.mil/
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 138; it is presently administered by ONR.

Army Research Institute (ARI)
https://sslweb.hqda.pentagon.mil/ari/research.aspx
ARI supports research projects that are designed to expand fundamental knowledge and discover general principles in the behavioral and social sciences, but 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 64.

Medical
Congressionally Directed Medical Research Program (CDMRP)
http://cdmrp.army.mil.
Congress typically adds funds to the DOD budget for support of medical basic research; these total ~$0.5-1B/yr in recent years. Each year the funds are inserted by a congressperson for specific topics for that year only. Those topics are openly competed through the Congressionally Directed Medical Research Program (CDMRP) solicitations. The Army's Medical Research and Materiel Command manages the CDMRP with a contractor (presently SAIC) 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 149-158 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 issued through the CDMRP process. For more information, see MAPS DOD Charts 143-148.

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 Chart 63). DARPA has a Basic Operational Medical Science (6.1) effort (see MAPS DOD Charts 96-98). ONR has a Warfighter Protection and Application Division with interest in selected medical topics (see MAPS DOD Chart 77).

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 <u>strong</u> preference for instrumentation in support of funded DOD research efforts.   For more information, see MAPS DOD Charts 141. ARO also has its own research instrumentation program (see MAPS DOD Chart 57).

Education/Training/Sabbaticals
In addition to funding research itself, there are DOD programs in support of PhD education (the National Defense Science and Engineering Graduate (NDSEG) program - http://ndseg.asee.org/), and Undergraduate/graduate education (the National Defense Education Program (NDEP - http://www.ndep.us/).   Each of the Services also has a STEM education effort, generally focused on K-12, generally focused on K-12.

The DOD research laboratories fund postdoctoral positions through the National Research Council (NRC), the American Society for Engineering Education (ASEE), and the Oak Ridge Associated Universities (ORAU) 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 171-174).

Resources

Defense-wide central resource: defenseinnovationmarketplace.mil

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

Naval S&T Strategic Plan
http://www.onr.navy.mil/About-ONR/science-technology-strategic-plan.aspx

Army Research Laboratory S&T Campaign Plans 2015 -2035
https://www.google.com/search?q=Army+S%26T+Strategic+Plan&ie=utf-8&oe=utf-8#

Air Force Research Laboratory 2014 Strategic Plan
https://www.google.com/search?q=Air+Force+Research+lab+2014+Strat+Plan&ie=utf-8&oe=utf-8#

Mission Agency Program Summary (MAPS)
The DC Office of Research Advancement has created the Federal Mission Agency Program Summary website to:
1. connect PIs with appropriate funding agency programs/program officers
2. assist in development of white papers/charts/elevator speeches

The website (http://web-app.usc.edu/web/ra_maps) can be accessed using one's USC NetID and Password.

MAPS will have the following resources:
1. *Search Tab* for a searchable database of programs/program officers
    One can do keyword searches to locate many of the associated mission agency (DHS, DOD, DOE, DOT, ED, EPA, NASA, NIST, NOAA and USDA) programs and program officers.
2. *Mission Agency Tab* (DHS, DHHS, DOD, DOE, DOJ, DOT, ED, EPA, INTEL, NASA, NIST, NOAA, and USDA)
    Guide to Agency Funding for FYXX
    Agency Research Program Charts
    Agency Planning Documents
    Chart numbers in the "Guides to Funding" reference the Agency Research Program Chart file.
3. *Presentation Tab* for charts from recent USC Center of Excellence in Research workshops
4. *Proposal Tab* for reports / guides on writing proposals
5. *Email Alerts Tab* for URLs at which one can arrange for automatic solicitation updates
6. *Grantee Tab* for URLs at which one can find previous agency/program officer awardees
7. *Visiting DC Tab* for information about DC Office services

Personal Assistance in Locating Funding and Preparing Proposals
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  Tel: 202 824 5863   Email: Murday@usc.edu

Table 1: FY2013 and FY2014 DOD Research Funding ($M) Obligations at Universities/Colleges

	2013		2014	
	Basic	**Applied**	**Basic**	**Applied**
Total for DOD	1862	4093	2094	4732
Total at Universities	974	507	1084	624
Physical Sciences	**202**	**24**	**236**	**33**
Astronomy	0	-		
Chemistry	61	4		
Physics	125	10		
Other	15	10		
Environmental Sciences	**80**	**22**	**88**	**29**
Atmospheric	12	1		
Geological	3	-		
Oceanology	58	19		
Other	7	2		
Mathematics and Computer	**168**	**101**	**179**	**129**
Computer Sciences	57	87		
Mathematics	74	1		
Other	36	14		
Engineering	**321**	**204**	**355**	**247**
Aeronautical	54	18		
Astronautical	4	2		
Chemical	38	24		
Civil	2	5		
Electrical	65	46		
Mechanical	32	4		
Metal/Materials	58	13		
Other	69	92		
Life Sciences	**139**	**131**	**149**	**153**
Agriculture	0	0		
Biological	91	8		
Environmental	3	15		
Medical	38	104		
Other	7	5		
Psychological	**15**	**1**	**17**	**9**
Social Sciences	**23**	**9**	**30**	**8**
Other Sciences	**27**	**14**	**31**	**16**

From NSF "Federal Funds for Research and Development: FY2013-2015" NSF 15-324, July 2015
Because the entries for FY2015 are Budget Request only, they are not reported here.

Basic	2013	Tables 30, 77 and 80-86
Applied Research	2013	Tables 44, 88 and 91-97
Basic	2014	Table 31 and 78
Applied Research	2014	Table 45 and 89

Table 2: Projected DOD Basic Research Funding ($M) for FY2017:
From the President's Budget Request Submitted to Congress.

Discipline / Agency	Army	AF	Navy	DARPA	DTRA	CBDP	DMRDP	OSD
Biology / Life Sciences	9							
Human Systems		20	16					
Biology / Medical			17	58				
Chemistry	13							
Propulsion		34						
Physics	19	60						
Electronics/Photonics	11	40	47	50				
Materials	7	29		66				
Mechanics			53					
Mechanics Structural	7	41						
Mechanics Fluid		31						
Environment								
Ocean			70					
Atmosphere and Space			24					
Environmental Science	2							
Computer, Information Sciences, Mathematics			42	130				
Mathematics	6	27						
Computing Sciences	9							
Information Sciences								
Networks	11	26						
Simulation and Training	2							
Cyber				45				
Air/Ground/Sea Vehicles			52					
Weapons			18					
Counter IED Devices			17					
Science Education Career and Outreach	10	22	46	18				
International Outreach		12						
Transformative / Basic Research Challenge			19	53				
Chemical/Biological Warfare Defense						45		
Weapons of Mass Destruction Defeat					35			
Hi-Energy Laser Multidisciplinary Res Initiative		14						
Multidisciplinary Univ Research Initiatives	53	82	73					
Defense Univ Instrumentation Program	8	15	21					
National Defense S & E Graduate Program and ASSURE		48						
National Defense Educ Program (NDEP)								69
Social / Cultural / Human – MINERVA, HSCB	3							12
National Security S&E Faculty Fellow (NSSEFF)								23
PECASE	5		8					
Basic Operational Medical							6	
Total	175	501	523	420	35	45	6	104

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 AF Research Laboratories.

Since the disciplines in the table are different from most of the agency's program taxonomies, clear assignment of funds by academic taxonomies is not always possible.   The Table 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; 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 15	Estimate* FY16	PBR FY16	PBR FY17	% inc PRB FY17-16
Air Force	Basic Research	539	530	485	500	3
	Defense Res Sciences	382	375	330	341	3
Army	Basic Research	448	469	425	429	1
	Defense Res Sciences	250	279	239	253	5
	ARO (H57)	79	87	87	94	7
	ICT (J08)	7.2	6.1	6.1	6.2	2
Navy	Basic Research	634	672	587	543	-8
	Defense Res Sciences	486	507	452	423	-7
DARPA	Basic Research	293	332	362	333	-9
	Basic Operational Medical Res Science	48	61	50	57	14
DTRA	Basic Research	45	38	38	38	-
CBDP	Basic Research	51	48	51	46	-11
OSD	NDEP	73	58	45	49	8
	MINERVA (0601110D8Z)	9.2	9.4	8.9	9.5	6
DHP	GDF-Basic Operational Med Res Sciences (0601117HP – 371A)	5.8	7.5	7.5	7.4	-1

* The FY15-16 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).

Reports on budget changes might show different percentages than those in table 3. For instance, the AAAS estimate for change to DOD basic research compares the FY17 PBR to the Estimate FY16. In recent years Congress has tended to add funds into the basic research accounts - as can be seen by comparing the PBR FY16 to the Estimate FY16. So the AAAS cited percentages are lower than those shown in Table 3.

Each of the Services has a strategic S&T plan which provides guidance into priorities; these can found at the USC MAPS DOD website. In addition to the funding growth identified in Appendix 1, approximately 20% of the projects in a DOD basic research program are turned over each year. So there are opportunities in many 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 an executive committee comprised of the major departmental S&T organizations. Underpinning that leadership there are 17 communities of Interest (COIs) that encourage multi-agency coordination and collaboration. The COI identify appropriate thrust areas, gaps and opportunities, investment profiles and engagement opportunities.

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:

DOD S&T Funding Agencies managing a 6.1-6.3 investment portfolio
- 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

Other DOD S&T Funding Agencies (w/o basic research)
- Defense Forensics and Biometrics Agency (DFBA)
  http://biometrics.dod.mil/
  Focus: forensics and biometrics activities and operations in support of identity operations
- Defense Logistics Agency (DLA)
  http://www.dla.mil/Pages/default.aspx
  Focus: support the weapon system sustainment program
- Missile Defense Agency (MDA)
  http://www.mda.mil/business/advanced_research.html
  Focus: system to defend against ballistic missile attacks
- Special Operations Command (SOCOM)
  http://www.socom.mil/Sordac/Pages/Default.aspx
  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, especially with the Air Force Research Laboratory, there are some funding opportunities emanating from the Service laboratories/centers/institutes.

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 areas:

- Capable Manpower: Intuitive systems and personnel tools for matching Sailors and Marines to the right jobs and training for mission-essential competencies
- Enterprise and Platform Enablers: Cross-cutting technologies to lower acquisition, operations, and maintenance costs
- Expeditionary Maneuver Warfare: Naval ground forces with special emphasis on regular and irregular warfare
- Force Health Protection: Medical equipment, supplies and procedures to reduce morbidity and mortality when casualties occur
- FORCEnet: C4ISR, networking, navigation, decision support and space technologies that provide an architectural framework for naval warfare in the information age
- Power and Energy: Energy security, efficient power and energy systems, high energy, pulse power
- Sea Basing: Logistics, shipping and at-sea transfer technologies that provide operational independence
- Sea Shield: Missile defense, antisubmarine warfare, mine warfare and fleet/force protection technologies that provide global defensive assurance
- Sea Strike: Weapons, aircraft and expeditionary warfare technologies that provide precise and persistent offensive power

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 205-211.

Defense Advanced Research Projects Agency (DARPA)
http://www.darpa.mil/default.aspx
DARPA invests 6.1-6.3 monies through six offices: Defense Sciences, Biological Technologies, Information Innovation, Microsystems Technology, Strategic Technologies, and Tactical Technologies. 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 proposer day where interested parties can gain more information on the effort, and/or by Requests for Information (RFI) that are used to shape a pending solicitation. For more information, see MAPS DOD Charts 222-228.

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 U.S. 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 229-237.

Defense Forensics and Biometrics Agency (DFBA)
http://biometrics.dod.mil/About/mission.aspx
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). This agency 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 239.

Defense Logistics Agency (DLA)
http://www.dla.mil/SmallBusiness/Pages/default.aspx
The Defense Logistics Agency (DLA) Logistics Research & Development (R&D) Branch is charged with conducting research and development in all areas relevant to the DLA mission and across all DLA supply chains. White papers submitted to DLA may be based on 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 240 - 241.

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 BMDS must have the ability to detect, track, identify and kill ballistic missiles. 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 advanced research. For more information, see MAPS DOD Chart 242.

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 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 243.

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 244 - 246.

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; relative to Universities, most DOD laboratories are far better equipped.   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)
Of the three service laboratories, AFRL issues the largest number of solicitations for extramural research. AFRL also creates University Centers of Excellence in support of specific AFRL interests. For more information, see MAPS DOD charts 181 - 188.

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 189 - 204.

US Army Corps of Engineers Engineering Research and Development Center (ERDC)
http://www.erdc.usace.army.mil/About/MissionandVision.aspx
The U.S. 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. ERDE has a generic solicitation. For more information, see MAPS DOD Chart 205.

Naval Postgraduate School (NPS)
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 81 - 83.

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 248 - 254.

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 255.

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 256.

NNMI

http://www.manufacturing.gov/nnmi.html

The National Network for Manufacturing Innovation (NNMI) consists of linked Institutes for Manufacturing Innovation (IMIs) with common goals, but unique concentrations. In an IMI, industry, academia, and government partners leverage existing resources, collaborate, and co-invest to nurture manufacturing innovation and accelerate commercialization. Typically an IMI has ~$70-100M Federal monies over five years, with a requirement of at least an equivalent amount of matching funds. The IMIs have some limited funds available for University research.

DOD has allocated fiscal resources to begin six IMIs and has requested information that could lead to establishing another two.
FY2013:
    (a) National Additive Manufacturing Innovation Inst (NAMII, now named America Makes)
FY2014:
    (a) Digital Manufacturing and Design Innovation (DMDI)
    (b) Lightweight and Modern Metals Manufacturing Innovation (LM3I, now named Lightweight Innovations for Tomorrow)
FY2015:
    (a) Integrated Photonics
    (b) Flexible Hybrid Electronics.
FY2016:
    (a) Revolutionary Fibers and Textiles
For more information, see MAPS DOD Charts 257 - 258.

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

Service		Actual* FY 15	Estimate* FY16	PBR FY16	PBR FY17	% inc PRB FY17-16
Air Force		1090	1240	1217	1260	3
Army		964	1093	880	907	3
Navy		856	966	865	861	-1
DARPA						
	Biomedical	165	115	114	115	1
	Information & Comms	316	341	356	354	-1
	Bio Warfare Defense	42	24	30	21	-37
	Tactical	300	302	315	313	-1
	Materials and BioTech	144	206	220	220	
	Electronics Tech	170	175	175	222	27
DTRA		147	153	155	155	
CBDP		212	202	208	189	-32
OSD	Cyber Security	12	15	15	14	-9
DHP	Applied Biomedical	67	75	58	57	

* The FY15-16 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

Communities of Interest Tier-1 Taxonomy and Descriptions, 18 March 2015
http://www.acq.osd.mil/chieftechnologist/COIs.html

- Advanced Electronics
- Air Platforms
- Autonomy
- Biomedical (ASBREM)
- Command, Control, Comms, Computers, and Intelligence (C4I)
- CounterIED
- CounterWMD
- Cyber
- Electronic Warfare
- Energy & Power Technologies
- Engineered Resilient Systems
- Ground & Sea Platforms
- Human Systems
- Materials & Manufacturing Processes
- Sensors
- Space
- Weapons Technologies

The collection of COIs serve 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.

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.

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

<u>Army</u>
- 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://sslweb.hqda.pentagon.mil/ari/
  Focus: research in behavioral science (6.1 - 6.3)

<u>Air Force</u>
- 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)

<u>Navy and Marine Corps</u>
- 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
Naval Air Warfare Centers (NAWC)
    Weapons   www.navair.navy.mil/nawcwd
    Aircraft   www.navair.navy.mil/NAWCAD
    Training Systems   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   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 175-206.

Appendix 1: FY2017 Basic (6.1) Research Program Significant Changes
$M from 2016 to 2017
Derived from RDDS (R-2) in the President's Budget Submission

AFOSR

Lasers and Optics, Electromagnetics, Communication and Signal Processing   33 to 39
Continue to explore all aspects of producing and receiving electromagnetic and electro-optical signals, as well as their propagation through complex media, including adaptive optics and optical imaging. Continue to investigate aspects of the phenomenology of lasers including high energy lasers, non-linear optics, and ultra-short pulse laser science. Includes the development of sophisticated mathematics and algorithm development for extracting information from complex and/or sparse signals.

Natural Materials and Systems   25 to 29
Continue to investigate multi-disciplinary approaches for studying the ways natural systems accomplish their required tasks. Study how to adapt and mimic existing natural sensory systems and add existing capabilities to these organisms with the intent to gain more precise control over their material production.

Outreach to S&T Workforce   14 to 22
Continue identifying, recruiting, and increasing opportunities for new young investigators to participate in critical Air Force research. Support science, mathematics, and engineering research including Historically Black Colleges and Universities, Hispanic serving institutions, and other minority institutions. Support science activities that encourage elementary/middle/ high school youths to develop an interest in and pursue higher education and employment in the science, mathematics, and engineering (STEM) fields.

Army Research Office (ARO)

Chemical Sciences   10 to 13
Explore the fundamental aspects of oxygen and hydrogen transport gas diffusion electrodes; devise new methods to synthesize infinite coordination polymers, that are a class of materials that possess tailorable properties and high surface areas; evaluate the role of the recently-discovered chemical reaction pathway termed "roaming mechanisms" in the decomposition of energetic molecules such as explosives; and push the current boundaries of mechanical-chemical reactivity by designing and demonstrating new modes for activating molecules called mechanophores, which convert mechanical to chemical energy using pre-defined.

Physics   16 to 19
Characterize and devise methods to control the unique structural, orbital, and magnetic order in a particular structure of oxygen-containing compounds called isovalent oxide superlattices; systematically study and simulate the long-range interaction of quantum defects in materials; utilize recently developed quantum algorithms for quantum chemistry to investigate new algorithms; and develop a comprehensive theoretical framework of photonic metamaterials that control light in ways impossible with any natural material.

Army University and Industry Research Centers

JI7 Vertical Lift Research Center of Excellence   3 to 3
Initiate a new, five year COE program that supports the Future Vertical Lift program and focuses on graduate education and a robust experimental / computational / analytical basic research program in rotorcraft technologies including: aeromechanics, structures, flight dynamics and control, rotorcraft design and concepts, vibration and noise control, propulsion, affordability, safety and survivability, and Naval operations. This currently has a consortia of PSU, UMd and Georgia Tech.

Office of Naval Research

ONR DRS budget lines are flat or decreasing, the following cited "initiates" will depend on program turnover and/or Congressional largesse.

Counter IED Sciences   16.5 to 17.0
- Initiate research efforts to improve stimulated electromagnetic explosive signature collection efficiencies.
- Initiate research efforts to explore compact rapid high selectivity spectroscopic detection in distributed unmanned platforms.

Human Systems   17.1 to 16.1
- Initiate research on social cyber-behavior, information operations and hybrid warfare.
- Initiate research on data visualization, data fusion and novel information streams for understanding novel warfighting problems.
- Initiate research on cognitive maintenance skill acquisition and retention.

Mathematics Computer and Information Sciences   45.6 to 42.2
- Initiate research on dynamic military communications under spectral, spatial and temporal uncertainty.
- Initiate research on broadband channel receiver architectures with interference suppression.
- Initiate research on capacity limits and optimal transmission strategies for heterogeneous networks.
- Initiate research on prioritization, latency, and end-to-end service level guarantees in heterogeneous networks.

Materials/Processes   58.1 to 52.9
- Initiate assessment of materials that incorporate directed energy, ballistic, and blast resistance for structural protection.

Medical/Biology   18.2 to 17.3
- Initiate efforts to study injury mechanisms induced by underwater blast.
- Initiate efforts to study bioderived systems to produce fieldable therapeutics.

Ocean   80.6 to 70.5
- Initiate research efforts to observe, understand and predict coastal land-air-sea interactions and identify needed improvements in operational databases and coupled land-air-sea modeling resolutions, formulations and implementations.

- Initiate research efforts to model the time-varying shallow-water acoustical environment on HPC resources and to evaluate these models with field data and underwater remote sensing systems.
- Initiate a modeling and autonomous observation study of the Northern Arabian Sea using floats, gliders, and drifters.
- Initiate field experiments to investigate changes in Arctic stratification and circulation and related physical processes in the Beaufort and Chukchi Seas.
- Initiate a multidisciplinary field effort to characterize and understand air-sea-land interactions over the Maritime Continent in the western Pacific and the impact on intra-seasonal variability and extended-range prediction.

Sensors, Electronics and Electronic Warfare   **46.5 to 46.9**
- Initiate research on chalcogenide-based phase-change materials for photonics.
- Initiate research on improved thermal conductivity and contact resistance of germanium telluride for RF switches.
- Initiate research exploiting non equilibrium k-space transport in electronic devices for high efficiency signal generation and information processing.
- Initiate research exploiting avalanche transport phenomena in wide bandgap materials and devices.

Weapons   **18.2 to 18.3**
- Initiate hypersonic aerodynamics, aerothermodynamics and high temperature materials research focused on challenges resulting from unique Navy platform constraints.
- Initiate Dynamical Information Processing for Autonomous Systems.
- Initiate expeditionary basic research efforts in computer science, human-social-cultural interactions and data science related to distributed systems.

DARPA
ES-01 Electronic Sciences
Quantum and Materials Basics   **0 to 10**
Will investigate basic materials and device physics to mature concepts to the point that functioning components could be tested. Promising avenues of research include highly linear 1D and 2D devices and materials that would increase the dynamic range of RF transceivers; coupling of electrical, acoustic, and/or optical fields to significantly reduce the size and improve performance of RF components; and addressing the most outstanding challenges to deploying timing and sensing devices based on modern atomic physics and technology.

TRS-01 Transformative Sciences
Modeling and Forecasting of Social Dynamics   **4 to 10**
Build initial analogical-model-based simulations for social phenomena.
- Develop techniques for testing models for social dynamics using real-world data including historical, current events, and social media and/or other online data.
- Initiate development of a decision support tool for predicting the effectiveness of alternative engagement options.

Engineering Complex Systems   **0 to 7.5**
Pursue new approaches to engineer complex, multi-cellular systems for enhanced capabilities and function. Complex biological materials and systems have unique properties (e.g., controlled porosity

and high strength-to-weight ratios) not only because of the inherent components but also because of how those components are assembled together across length scales. Engineering biology tools and techniques are now at a stage to pursue the organization and function of multi-cellular systems for a new class of improved capabilities.

Decoding Neural Activity   **0 to 6**

Utilize measures of physiological state and neural intention to improve the performance of semi-autonomous and supervised machine learning systems. Through the integration of new techniques from computer science, mathematics, signal processing, and statistics, this effort will investigate new methods for combining physiological and environmental data to decode neural signals and communicate information to computational platforms. Research within this effort will include the generation of novel sensors as well as improved architecture, mathematics, and procedures underlying algorithms and analysis.

Basic Operational Medical Science
Outpacing Infectious Disease   **0 to 10**

Investigate fundamental methods for using biology as a technology to create adaptive therapeutic response mechanisms to outpace viruses and bacteria. New approaches, such as enabling co-evolution and co-transmission of newly developed therapeutics to ultimately outcompete the pathogen, are needed to utilize the power of evolution in vaccine and antibiotic design.

Appendix 2: FY2017 Selected Appl Research (6.2) Program Significant Changes
$M from 2016 to 2017
Derived from RDDS (R-2) in the President's Budget Submission

Air Force
Cyber Technology (PE 622005)
This is a new program element, the funding has been transferred from earlier work in other programs, so it is not truly new money. They are listed here to indicate sharpened AFRL interest.

Malware Detection   **"0" to 4**
Develop deception/malware detection tools for x86-based hardware malware, and expand capability by using file size and instruction frequency to include additional feature sets. The selected feature set will be used in conjunction with existing machine learning algorithms to determine the detection rate and classification accuracy of these algorithms using known malware samples.

Adaptive Cyber Protections   **"0" to 6**
This will investigate the use of evolvable hardware to perform pattern recognition. Demonstrate whether evolvable hardware in conjunction with evolvable mathematical algorithms can achieve advantage over existing pattern recognition algorithms and are applicable to avionics cyber protections.

Cyberspace Dominance Technology (PE 625319)
This is a new program element, the funding has been transferred from earlier work in other programs, so it is not truly new money. Listed here to indicate sharpened AFRL interest.

Cyber Defense Technologies   **"0" to 19**
Initiate demonstration of all system system components, with reduced scale and feature set. Develop validation techniques that assess qualitative effects of mission awareness analytics. Develop a secure foundation for mission models that cross DoD-domains while maintaining robustness, awareness capabilities, and engage assurance technologies. Include live autonomous systems and integrate Stockbridge facility into cyber exercise structure. Address new gaps identified in the initial effort, expand upon results of initial effort, and explore additional capabilities. Continue collaborations with University Center of Excellence in Assured Cloud Computing.

Cyber Offense Technologies   **"0" to 13**
Develop technologies to remain current with new waveforms and signals. Continue SOA mission component development for use in the Air Force Life Cycle Management Center CMP system. Transition components, including Cyber Time and Cyber Mission Planning, for use in the CMP system.

Advanced Architectural Technologies   **"0" to 10**
Develop a runtime environment that can monitor and maintain a trusted and resilient envelope of operation. Initiate fabrication for the prototype neuromorphic processor hardware. Develop a runtime environment that can monitor and maintain a trusted and resilient envelope of operation. Initiate fabrication for the prototype neuromorphic processor hardware.

Survivability Technologies   **"0" to 5**

Integrate basic machine learning functions into defensive cyber operations systems. Research and create prototype for memory isolation and disk introspection. Research processing vulnerabilities between encryption mechanisms.

Cross Domain Technologies   **"0" to 4**

Continue research on cross domain change detection, cross domain machine to machine mediation layer and multiple levels of security mobile secure foundation technologies.

Cyber Technologies for Spectrum Warfare   **"0" to 4**

Continue development of active and passive methods to locate, acquire and process data and signals of interest.

Army Research Laboratory and Centers

H80 Survivability and Lethality Technology (executed by ARL)

Swarming Weapons Technologies   **0 to 4.7**

Develop new modeling and simulation capabilities to capture complex flight physics, such as non-linear flow phenomena, flight body dynamics for complex shape bodies, and rapid, extreme maneuvers; and develop novel nonlinear Guidance, Navigation, and Control (GNC) capabilities to enable cooperative control and extreme maneuverability.

H94 Electronics and Electronic Devices (Executed by ARL and CERDEC)

Energy Efficient Electronics   **0 to 5**

Measure and characterize performance of heterogeneous materials integrated into radio frequency front-end components (e.g., amplifiers, filters, and switches); design and simulate performance of realistic waveforms on ultra-low power field programmable gate arrays (FPGA) and accelerator cores; develop an analog integrated circuit characterization capability; explore extramural prospects for low-power RF transceiver design techniques using leading node (analog) device technologies; and characterize passive voltage amplification with MEMS (Micro-Electro-Mechanical System) piezo-transformers and multi-layer copper air-core designs, efficient power management of isotopic power sources, and improved coupling in wireless transmission.

Precision Measurement Technology for Contested Environments   **0 to 2.5**

Design and fabricate a MEMS quad mass gyroscope (QMG) to improve MEMS gyro performance to less than 1 degree per hour bias instability; design and fabricate a vacuum packaging solution for a MEMS QMG that will achieve an in-package pressure a million times less than atmospheric pressure; investigate and analyze OEOs and laser frequency comb architectures and the direct synchronization of an atomic cell signal to an OEO in order to create an ultra-stable local oscillator source that could increase the period of desired accuracy of military geolocation systems that require GPS synchronization from less than 1 minute to more than 1 hour; identify and develop techniques to suppress noise induced in a transmission media, such as freespace, air, or optical fiber, by transmission of frequency signals via lasers to maintain frequency stability ten times better than GPS; and explore more compact anti-jam GPS and body-worn, textile-integrated antenna designs to support future pseudolite and dismounted Soldier navigation.

Anti-Tamper (AT) Technology Development   **0 to 4.1**
Will begin development of AT tools and techniques for commercial microelectronics, architecture-level AT technologies, threat based sensors, and secure processor Intellectual Property (IP).

H95 Night vision and Electo-Optic Technology (Executed by CERDEC/NVESD)
Computational Imaging   **0 to 5.2**
Will conduct a trade study focused of optics, sensors and processing focused on day/night helmet mounted 3D imagers; research and validate computational algorithms centered on high speed hemispherical threat detection and localization sensors and optics; explore applications of new optics concepts for multispectral weapon and handheld surveillance devices

H92 Communications Technology   (Executed by CERDEC)
Communications Security   **0 to 3.9**
 Will design an advanced processing technique to reduce interference in SATCOM waveforms; design a means to monitor spectrum for wideband SATCOM and design and document situational awareness parameters, protection through diversity and interference mitigation for Army tactical SATCOM Networks; perform a detailed study to analyze wideband SATCOM interference suppression for both enterprise applications utilizing digital IF and tactical multi-frequency, time division multiple access waveform applications.

855 Topographical, Image Intel and Space   (Executed by ERDC)
    GeoIntelligence - Geospatial Data Generation and Decision Support   **0 to 4.9**
    Will complete development of a new algorithm suite to enable rapid processing and searching of high volume multi-modal spatiotemporal datasets for revealing and illuminating relevant embedded relationships, spatiotemporal threads, and discoverable meaningful patterns associated with human geography (e.g., actors, places, events, and time); research new terrain analytics and tactical decision aids supporting Warfighter tactical operations in 3D dense urban terrain environments by providing hazard identification and mitigation, remote feature classification, and 3D terrain analysis techniques; and develop rapid tools for characterization of hazardous urban terrain effects, the detection and identification of urban and peri-urban feature classes using remotely sensed data, and input layers for geospatial analytics enabling multi-source, urban-relevant data enterprise integration.

    GeoIntelligence - Terrestrial Remote Sensing and Data Visualization   **0 to 4.5**
    Will conduct research on terrain feature extraction important to mission planning to provide the terrain and image analyst access to surface roughness, vegetation density, characterization of built-up areas, and near ground obstacles; investigate laser detection and ranging (LADAR) sensors for base force protection through physical mounting integration, mast stabilization optimization, and software techniques enabling anomaly detection, change assessment, and sensor cueing capabilities.

    Human Geography - Spatial Reasoning, Analysis, and Visualization   **0 to 2.0**
    Will research and design a framework to investigate the impacts of environmental stressors (e.g. water security) on populations and military operations.

Map-Based Planning Services   **0 to 3.7**
Will develop approaches to enable Army planners at multiple echelons and at distributed locations to exploit a common geospatial framework within the planner enclave for concurrent planning; and investigate migration of planners' tools and services to a web based capability

T42 Terrestrial Science Applied Research   (Executed by ERDC)
GeoIntelligence - Terrestrial Phenom Characterization for Geospatial Appl   **0 to 1.7**
Will research web-based three-dimensional (3D) visualization of tactical decision aids to enhance point cloud analytics in bandwidth limited environments and mobile applications; investigate utility of LiDAR and terrain based 3D products through new algorithms and processes to access and reuse level zero (raw) data collections preserving sensor calibration and error meta-data.

869 Warfighter Health Protection and Performance Stnds (Executed by WRAIR, ARI)
Concussion/Mild Traumatic Brain Injury (mTBI) Interventions   **0 to 2.4**
Will determine incidence and risk factors for spinal injury and evaluate the military vehicle occupant environment. Will develop provisional spinal injury criteria and assessment methods for occupant protection. Will determine the severity and duration of neurobehavioral and neuropathological (behavioral traits and structure of the brain) disruptions resulting from re-exposure to blast and/or impact-induced head injuries with intervals between insults ranging from 1 to 72 hours and compared to single head insults. Will determine if a traumatic underwater stressor or intermittent electric shock can infer heightened vulnerability to mTBI by comparison of the magnitude and duration of functional impairments resulting from blast mTBI alone using a small animal model

Biomarkers of Exposure and Environmental Biomonitoring   **0 to 3.9**
Will continue collecting data from human volunteers on the middle ear's response to impulsive sounds; will begin evaluating the complex interaction between auditory and vestibular protective systems. Will determine threshold blast overpressure and impulse exposure leading to cellular level ocular injury and refine scaling laws to be able to relate experiments conducted in small animal models to exposure conditions in humans.

Millennium Cohort Research   **0 to 5.3**
Assess the long-term impact of sexual assault experiences among military men and women. Assess the long-term health outcomes among individuals with a history of traumatic brain injury. Examine the Performance Triad components (sleep, diet, and exercise) and association with health outcomes. Will investigate the long-term effects of military service on the risk and prevalence of cardiopulmonary (link between the cardiovascular and respiratory systems) and metabolic diseases (anomalies in the way the body processes food sources to generate energy) and continue work to identify populations with greater likelihood of utilizing Department of Veterans Affairs (VA) health services.

Office of Naval Research
Advanced Energetics   **5.4 to 5.3**
- Initiate electric on/off propulsion system studies for advanced solid and liquid rocket compositions
- Initiate process research and development of Dihydroxylammonium Dinitramino Azoxy

Furazan
- Initiate process research and development of Ammonium-3,4,5,-trinitropyrazolate

Surface Ship and Submarine Hull Mechanical and Electrical   **73.9 to 80.9**
- Initiate Explosion Resistant Coatings effort with TTCP countries.
- Initiate development of testing methodologies to validate computational codes and constitutive models for glassy materials.
- Initiate activities in understanding platform modification for greater access in polar environments.
- Initiate research and development of modular, reconfigurable, integrated multi-modal stand-off detection and neutralization of explosive hazard (IED & Mines) system

Electromagnetic Systems Applied Research
Solid State Electronics   **9.9 to 12.9**
- Initiate development of highly linear source electric field engineered HEMT devices.
- Initiate development of ultra-efficient nitrogen-polar mm-wave transistors.
- Initiate Electromagnetic Applied Research initiative.
- Initiate high output impedance RF amplifier development for photonically-enabled STAR architectures.
- Initiate development of high RF impedance electro-optic modulators for photonically-enabled STAR architectures.

Future Naval Capabilities (FNC) Applied Research - new projects
ForceNet
EC: FNT-FY17-01 Communications And Interoperability For Integrated
- Initiate Communications as a Service - Develop distributed optimization algorithms and Quality of Service protocols for heterogeneous data link networks.
- Initiate Mission-Based Networking for DDS - Develop forward error correction and directional networking algorithms.

EC: FNT-FY17-02 Submarine Simultaneous Transmit And Receive
- Develop a submarine broadband antenna enabling simultaneous transmit and receive capability.

EC: FNT-FY17-04 Resilient Hull/Infrastructure Mechanical & Electrical Security
- Initiate SCAMM - Develop software algorithms that protect naval Hull, Mechanical and Electrical (HM&E) systems against cyber threats.
- Initiate SCRAM - Develop information shaping cyber capabilities for tactical platforms.

Power and Energy
EC: P&E-FY17-02 Torpedo Advanced Propulsion System
- Initiate safety analyses and system modeling concepts for each technology identified in the Analysis of Alternatives.

Sea Shield
EC: SHD-FY17-02 Autonomous Unmanned Surface Vehicles For Mine Warfare
- Initiate Autonomous Situational Awareness and Hazard Avoidance System for USVs

- Develop perception and route-planning autonomous control for Unmanned Surface Vehicles (USVs).
- Initiate High Temperature Superconducting Magnetic Influence Sweep Payload for USVs
- Develop superconducting technology for the mine influence sweep payload on Unmanned Surface Vehicles (USVs).
- Initiate Underway Refueling and Data Transfer for USVs and RMMVs
- Develop technology for underway refueling of Unmanned Surface Vehicles and Remote Multi-Mission Vehicles (RMMVs) and conduct data transfer from an RMMV.

EC: SHD-FY17-05 Deep Reliable Acoustic Path Exploitation System
- Develop algorithms for undersea communications, health monitoring, and contact separation and correlation.

Sea Strike
EC: STK-FY17-04 ALPO
- Begin the concept and technology development phase to establish the initial feasibility of the proposed solution for an advance signal processing system.

Defense Advanced Research Projects Agency
BT-01 / Biomedical Technology
Enhanced Monitoring of Health and Disease   **0 to 14**
Leverage advanced data collection methods and capabilities to predict changes in health and spread of infectious disease from the individual to the population scale. Research in this thrust will investigate new methods for the collection and detection of multiplexed biological markers as well as the analysis, correlation, and ultimate integration of vast personalized data into the clinical care information technology infrastructure. Additionally, this thrust will develop new approaches to integrate multi-source data streams to create effective predictive models of disease outbreak and spread.

IT-02 / High Productivity, High-Performance Responsive Architectures
tactical CONtext EXtraction (CONEX)   **0 to 6**
Enriching a primary data stream with contextual information (i.e., the circumstances or facts such as who, what, and where that surround a particular event) can be accomplished by fusing data from multiple sensors. For this task, modern systems rely heavily on man-made reference signals, such as Global Positioning Systems, and preprogrammed algorithms with limited adaptability. The tactical CONtext EXtraction program will develop compact sensors and adaptive processors for extracting contextual information from resource-constrained environments. CONEX sensors will collect information from the landscape and natural sources, such as the relative position of stars, to supplement inertial measurement systems and other sensor feeds in GPS-denied areas. CONEX processors will contain embedded real-time learning algorithms that operate over multiple timescales. These adaptive methods efficiently capture complex spatial and temporal structure in noisy, ambiguous data streams that are beyond the analysis capabilities of state-of-the-art signal/image processing systems.

Removing Barriers to Hardware   **0 to 6**
Develop methods to facilitate hardware innovation for defense applications. The objective is to establish relationships with commercial companies to gain access to proven processes, to explore

the possibilities of open source hardware, and to develop an aftermarket customization strategy to economically adapt commercial chips to specific military needs.

IT-03 / INFORMATION ASSURANCE AND SURVIAVBILITY
System Security Integrated Through Hardware and software (SSITH)   **0 to 8**
Better protect DoD systems by exploring innovative approaches that combine hardware and software to provide enhanced system security. By exploring integrated hardware/software solutions, SSITH will combine the efficiency and robustness of hardware with the flexibility and adaptability of software to provide security solutions that are resistant to attack and adaptive to new attack approaches.

IT-04 / Language Technology
Understanding Machine Intelligence   **0 to 10**
This program was previously funded in PE 0602702E, Project TT-13. Formulate approaches for AI systems to explain their behavior and clarify the basis for and reliability of outputs.
- Develop automated drill-down techniques that provide users with logic/data that drives AI system outputs/behaviors.
- Develop a mathematically rigorous virtual stability theory for AI-enabled logic systems analogous to the (conventional) stability theory developed for dynamical systems.
- Propose a general technology for building systems with the ability to understand, explain, and modify their behavior.

TT-04 / Advanced Land Systems Technology
Counter Unmanned Air Systems and Force Protection   **0 to 9**
Examine advanced detection, tracking, and system defeat capabilities to counter emerging threats posed against U.S. military forces. Key research will include an analysis of system threat phenomenologies where non-state and state actors seek to leverage asymmetries by employing small unmanned systems and other threats to include rocket propelled grenades, anti-tank munitions, and indirect fires. Central research and development will factor in analysis of advanced sensor integration, detection, and weapons engagement capabilities within operationally relevant environments (urban, tactical, and strategic domains).

TT-07 / Aeronautics Technology
21st Century Propellants   **0 to 5**
Examine new classes of solid propellants capable of affording solid fueled rockets the ability to perform in a greater range of operating scenarios. Successful propellant systems for this program must demonstrate a controlled burn rate, restart capability, termination control, improved safety, and a dramatically improved shelf life (>15 years). The program will also address critical issues of safer manufacturing (improved operational handling, transportability issues, and improved environmental impact).

TT-13 / Network Centric Enabling Technology
Science of Human and Computer Teaming   **0 to 15**
Develop and demonstrate data-driven approaches for the formation and training of teams comprised of humans and computers. Computer scientists are looking at ways in which humans may team with computers to achieve superior levels of performance. The program will identify individual characteristics predictive of performance of mixed human-computer teams; develop techniques for measuring these characteristics in military personnel; demonstrate the capability to select, assign roles, and train human-computer teams with performance superior to that of human-

only teams formed and trained using current methods; and develop an understanding of how to structure human-computer teams for superior performance on military missions such as cyber defense and intelligence analysis.

MBT-02 / Biologically Based Materials And Devices
Enhancing Neuroplasticity   **0 to 14**

The Enhancing Neuroplasticity program will explore and develop stimulation methods and non-invasive devices to promote synaptic plasticity that is expected to impact higher cognitive functions.

ELT-01 Electronics Technology
Limits of Thermal Sensors (LOTS)   **0 to 9**

The long wave infrared (LWIR) is the most commonly used spectral band for thermal imagery, and current systems must choose between high performance cryogenically cooled focal plane arrays, and uncooled microbolometers. Microbolometers offer a significant reduction in size, weight, and cost (SWaP-C), at the expense of reduced sensitivity and slower response time. The objective of the LOTS program is to demonstrate a detector technology that breaks this traditional trade space by providing the same benefits in SWaP-C as current microbolometers while approaching the sensitivity of a cryogenically cooled sensor.

Connect.Everything   **0 to 9**

Research efforts will focus on leveraging commercial industry investment in future wireless technology to develop communication modules that operate within the various unlicensed radio frequency (RF) and millimeter wave (mm-wave) frequency bands. The program will extend current state of art Multiple-Input Multiple-Output techniques toward future applications which require gigahertz bandwidth, low latency, low power, and high power efficiency to support seamless connectivity between users, sensors, payloads, and platforms across that spectrum.

Chemical Biological Defense Program
CB2 / Chemical Biological Defense Applied Research
Biosurveillance   **3 - 8**

Develop technologies (e.g., event-based surveillance and historical baselines; predictive models of plant and/or animal disease; uncertainty quantification) to intelligently fuse ubiquitous sensing capabilities (wearables, field deployed diagnostics and autonomous environmental sensing vehicles). Data fusion technologies were developed in FY16 under BA2 TM2/Diagnostics; readjustment in FY17 more appropriately aligns these activities as biosurveillance efforts.

TM2 / Techbase Medical Defense Applied Research
Viral/Bacterial/Toxins Vaccines   **10 - 15**

Develop a non-reactogenic Coxiella (Q-fever) vaccine and a humanized mouse model for aerosolized Q-fever. Evaluate prototypic three-component vaccines against WEVEE viruses in small animal models with down-selected adjuvants. Initiate immune correlate studies with a three-component vaccine against WEVEE viruses in small animal models. Evaluate immunogenicity and efficacy of nanoparticle adjuvants with the VEEV DNA vaccine and the trivalent (WEVEE) vaccine in mice. Initiate research to assess MCM capabilities and strategies to defend against emerging and genetically engineered bioweapon threat agents

Appendix 3: Abbreviated illustration of a Program Officer Datasheet

Dr. David M. Stepp
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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.
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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

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)
ARL	Army Research Laboratories
ARO	Army Research Office
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
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
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
ECBC	Edgewood Chemical and Biological Center
EM	Electromagnetic
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)
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
ISR	Intelligence, Surveillance and Reconnaissance
LM3I	Modern Metals Manufacturing Innovation (an IMI)
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 Medi
NPGS	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)
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
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

<u>General</u>

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
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
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
ED	Department of Education
EPA	Environmental Protection Agency
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)
HBCU/MI	Historically Black Colleges/Universities and Minority Institutions
HTM	Hierarchical Temporal Memory
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
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
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
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