

NEWSLETTER

YEAR IN REVIEW 2020

2020 YEAR IN REVIEW

INNOVATING TODAY TO PROTECT OUR FUTURE

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FEATURED



**The Office of Research,
Technology and Laboratories
(RT&L)**



**The Office of Strategic
Technology Protection and
Exploitation (STP&E)**



**The Defense Technical
Information Center (DTIC)**



**Defense Microelectronics
Activity (DMEA)**



Dr. JihFen Lei

Performing the Duties of the Deputy
Under Secretary of Defense for
Research and Engineering

MESSAGE FROM THE DIRECTOR

Dear Readers,

I hope this message finds you in good health and spirits. My name is Dr. JihFen Lei, and I currently serve as the Acting Director of Defense Research and Engineering for Research and Technology (DDR&E(R&T)), under the Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E)).

I am excited to introduce the premiere “Year in Review” for DDR&E(R&T). This publication is intended to showcase our science and technology (S&T) enterprise’s positive impact on innovation and national security in 2020.

The DDR&E(R&T) is responsible for DoD research and technology portfolios, from basic science to advanced technology development. Our organization ensures that the DoD is postured to develop the next generation of disruptive and emerging technologies and enable the rapid delivery of superior capabilities to the Warfighter.

While year 2020 has undoubtedly posed unprecedented challenges around the world, we have been unrelenting in the fight to keep our Nation strong and safe. As you will read in the following pages, our office continues to make great strides in maintaining our technology advantages by implementing National Defense Strategies and our aligned Strategic Goals and Priorities. From developing our defense innovation base here in the U.S. to enhancing security efforts abroad; the S&T Enterprise has proven its resilience in a critical time.

One such example of resiliency amidst the pandemic is the “Newton Award for Transformative Ideas during the COVID-19 Pandemic.” This initiative, led by the Basic Research Office, enabled researchers to continue working on transformative ideas. Our team also worked with our partners in the DoD laboratories and Manufacturing Innovation Institutes (MII) to address various challenges posed by COVID-19, including the development and production of medical supplies during widespread, critical inventory shortages.



New technologies shaping future capabilities to support the future of warfare in the 21st century. (Getty Images)

Another significant development was the establishment of a Biotechnology Community of Interest (Col) to accelerate synchronization, and advancement in synthetic biology and biotechnology—and a ninth MII, the BioIndustrial Manufacturing and Design Ecosystem (BioMADE) nonprofit, orchestrated by the Technology Manufacturing and Industrial Base (TMIB) Office. This institute enables the acceleration of U.S. biotechnology innovation and modernization priorities. These types of partnerships help to make us stronger and enhance our ability to leverage resources for the great-power competition through collaborative efforts.

As we look forward to the new year, I hope to build upon our successes while cultivating an even stronger S&T base for DoD. First and foremost, we must reinforce our core S&T capabilities, such as workforce talent, lab infrastructure, and the technical competencies unique to DoD. They are vital components of future DoD capabilities predicated on technological superiority and addressing emerging technological threats from our adversaries.

Additionally, we must also be cognizant of those who would seek to exploit our progress to our detriment; therefore, our shared efforts with industry partners and academia must be carefully planned and always safeguarded. This will require a pioneering approach towards policy and strategy, as we promote transparency to spur research and innovation while also safeguarding our critical information.

Finally, I expect our organization to harness the DoD

S&T base's full range of technological resources to maximize America's military-technical and strategic advantages. At the same time, we must ensure that OUSD(R&E) is effectively shaping future capabilities to support the future of warfare in the 21st century.

These efforts are vitally important in protecting our Nation, ensuring we are prepared for the ever-changing and increasingly precarious global landscape. I look forward to working together with you all in 2021.

MISSION & VISION

The DDRE(R&T) widens the nation's technological lead by spearheading DoD's research and development portfolio; harnessing the creativity and ingenuity of the national security innovation base; and driving policy to ensure and protect DoD's innovation advantage.

DDRE(R&T) does this by:

- Fostering the health of the Department's entire Science and Technology portfolio
- Accelerating technology advancement by harnessing the full range of DoD's science, technology and innovation base (including academia, small business, and manufacturing industry)
- Advocating for the Department's S&T workforce and laboratory infrastructure
- Governing the Department's Federally Funded Research and Development Centers (FFRDC) and University Affiliated Research Centers (UARC)
- Shaping the Department's critical technology protection policy
- Facilitating coordination, collaboration and joint S&T efforts with internal, interagency, and international partners.

PRIORITIES

DDR&E(R&T) FY2021 PRIORITIES AND GOALS

Priority 1-

Lead the strengthening of DoD-wide S&T competence (workforce, infrastructure, and technical competence) to sustain a capable S&T and innovation base.

Priority 2-

Lead the development of policies, strategies, directives, instructions, legislative proposals, and processes that provide competitive advantages and/or promote innovation.

Priority 3-

Provide technical direction and leadership that identifies technology opportunities, enables joint fight and cross-domain capabilities, and ensures technological superiority.

Priority 4-

Strengthen strategic partnerships and alliances by leveraging the strength of others. Enhance collaboration across the offices within OUSD(R&E), OSD, and Joint Staff for rapid technology transition.

Priority 5-

Develop a strategic communication framework and take actions to enhance recognition of the S&T and innovation ecosystem's value and accomplishments to drive support for DoD's S&T investment.

RESEARCH, TECHNOLOGY & LABORATORIES (RT&L)

**Dr. Douglas C. Blake**

The Acting Deputy Director for Research,
Technology and Laboratories

The Office of Research, Technology and Laboratories (RT&L)

DEPUTY DIRECTOR'S MESSAGE

The Office of RT&L implements the DoD's S&T vision through governance, laboratory infrastructure, and workforce development.

RT&L fosters innovation and scientific and technological dominance across DoD, with our domestic partnerships and international alliances, and through an excellent S&T workforce.

RT&L's mission is to sustain U.S. scientific and technological superiority to enable unquestioned battlefield dominance.

RT&L is organized into three components to execute its mission, each headed by an SES-level director: 1) Science and Technology; 2) Small Business and Technology Partnerships, and 3) Laboratories and Personnel. S&T is further divided into sub-components, each also led by an SES-level director: Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance, Reconnaissance, and Electronic Warfare (C5ISR&EW); Basic Research; Human Systems; and Platforms and Weapons Technologies (PWT).

RT&L works closely with the broader Office of the OUSD(R&E) enterprise to align S&T efforts with the modernization priorities derived from the 2018 National Defense Strategy.

RT&L identifies strategic investment areas and implements the DoD-wide S&T Strategy and Planning Guidance through the Department's 60-plus laboratories across 25 states and D.C. In addition, RT&L provides oversight of S&T workforce and laboratory-infrastructure policies, including those for federally funded research and development centers (FFRDCs) and university-affiliated research centers (UARCs).

RT&L administers a network of laboratories and research institutions that constitutes the enterprise infrastructure. This infrastructure facilitates leading-edge S&T research programs, engagement with other Government agencies, industry, academia, and cooperation with international allies and partners.

Please read more about RT&L 2020 accomplishments in the following pages.

RESEARCH, TECHNOLOGY & LABORATORIES (RT&L)

Small Business and Technology Partnerships (SBTP)

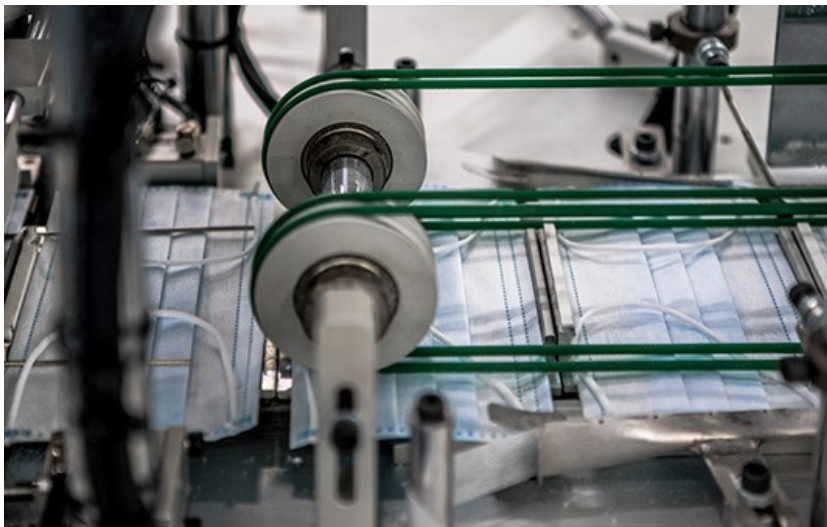
In 2020, the SBTP Office continued to streamline and modernize DoD Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) programs while closing out the Rapid Innovation Fund (RIF).

On October 07, SBTP held the first DoD SBIR/STTR Virtual Symposium, providing an opportunity for more than 1,100 participants from small businesses to interface directly with OUSD(R&E) leadership. The symposium provided small businesses with information and insights about working with the Department to encourage competition and accelerate innovation through SBIR/STTR programs.

SBTP deployed the Defense SBIR/STTR Innovation Portal (DSIP) in December 2019. Since then, the SBIR/STTR programs have seen a significant increase in participation. DSIP facilitated three major broad agency announcements (BAAs), over 25 out-of-cycle BAAs, and over 20 Phase II submissions, resulting in over 17,000 proposals on the portal (representing a 45 percent increase over the legacy system). More than 4,300 contracts were awarded in FY 2020, with a total value of \$2.06 billion.

SBTP also launched the OSD Transitions SBIR/STTR Technologies Pilot Program (OTST), enabling and accelerating the incorporation and transition of SBIR/STTR Phase II technologies into Programs of Record. Since June 2020, the program has funded 24 projects at \$39.4 million total.

Finally, in response to the COVID-19 pandemic, the RIF awarded \$1 million to a Missile Defense Agency SBIR follow-on by eSpin of Chattanooga, Tennessee. This award enabled eSpin to redirect its manufacturing of nanofiber separator technology for lithium batteries to masks and filters, resulting in a production increase from 500 to over 10,000 masks per day and, ultimately, yielding a proven multi-purpose, dual-use technology. During 2020, two additional DoD laboratories became



A nanofiber filter with numerous potential applications, including the production of protective face masks. iStock

Laboratories and Personnel

Science and Technology Reinvention Laboratories (STRLs). The Air Force Joint Warfare Analysis Center (JWAC) and the U.S. Army Space and Missile Defense Command (SMDC) Technical Center successfully published their final Federal Register Notices and have implemented their Demo Personnel systems. Together, they add over 500 employees to the 60,000-strong STRL population.

Also, the Army Research Institute (ARI) was approved for STRL status. Becoming an STRL is a significant milestone, as it enables the laboratories to implement a variety of methods to recruit, retain, and develop the workforce and remain competitive with the technical-commercial marketplace.

Laboratories and Personnel *Continued*



This year, DoD also selected the National Security Agency's (NSA's) Technology Transfer Program (TTP) as the winner of the [2020 George F. Linsteadt Award for Excellence in Technology Transfer](#). This award recognized NSA's newly established process for releasing agency-developed security tools to the open-source community, generating a wealth of commercial applications while simultaneously providing NSA with access to mission-critical open access tools.

On October 05, DoD announced 12 awardees for the [National Defense Education Program \(NDEP\) STEM Awards](#). These distinguished educational and industry partners will receive more than \$31 million over three years to establish or expand STEM education, outreach, and workforce initiatives for students, educators, and veterans at the early childhood through postsecondary levels.

Activities will both support the DoD STEM Strategic Plan and align to the 2018 Federal STEM Strategic Plan. Several of these efforts will include collaboration with the Department's laboratories and military installations across the country.

Initially, on August 01, 2020, the Federal Laboratory Consortium (FLC) National Technology Transfer Awards program, which annually recognizes Federal laboratories and their industry partners for outstanding technology transfer achievements, announced six DoD national award winners across five categories: State and Local Economic Development Award, Impact Award, Technology Transfer Innovation Award, Rookie of the Year Award, and Excellence in Technology Transfer Award (two winners).

Additionally, two outstanding laboratory scientists with Laboratories and Personnel were awarded the "DoD Laboratory Scientist of the Quarter" during 2020 for their exceptional work on behalf of the Department. They are:

Dr. Jonathan P. Vernon, recognized as one of the DoD's leading subject matter experts in the field of materials for mitigating effects of Directed Energy Weapons (DEW). His work enabled the establishment of novel research capabilities and the invention of new Counter DEW survivability options for air, personnel, and space systems. He developed several state-of-the-art laboratory capabilities, enabling both the physics-based assessment of structural component susceptibilities and the design of innovative hardening materials to counter high-energy laser weapons. As a result of his efforts, the first-of-its kind Rapidly Heated Investigation of Materials Laboratory was established; a dormant optical coating infrastructure within AFRL's Materials and Manufacturing Directorate was revitalized; and finally, a Data Science, Artificial Intelligence (AI)/Machine Learning (ML) capability for discovering CDEW applications was developed.

Dr. Igor Linkov, for his research vision and methodology in risk, resilience, and decision science into tools and practices used by DoD and other Federal agencies. Additionally, his scientific tools have been briefed multiple times to the data analytics leads of the White House Coronavirus (COVID-19) Task Force. Dr. Linkov's work significantly impacted 26 research achievements as the lead for the ERDC's Environmental Laboratory Risk and Decision Science Team. As a result of his efforts, critical theoretical foundations for methods of resilience and risk analysis of complex systems were developed; and application of these methods were advanced into a multi-million-dollar portfolio of reimbursable work using cutting-edge science.

Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance, Reconnaissance, and Electronic Warfare (C5ISREW)



Big data and artificial intelligence concept. istock

In July, DoD awarded a \$2.7 billion contract to continue the Carnegie Mellon University Software Engineering Institute (CMU SEI) FFRDC for another five years. This contract will enable advanced work on computer software technology development and cybersecurity. CMU SEI is leading national initiatives to advance the discipline of scalable, robust, secure, human-centered AI engineering and improving security of cloud infrastructure for defense and national security.

The Networking Communications Capability Program's Future Autonomous Battlespace Radio Frequency with Integrated Communications (FABRIC) program reached several milestones in FY 2020. FABRIC is a software-defined ad hoc directional networking capability designed to operate in the most congested and contested tactical environments. The FABRIC team, which includes representatives from several Service labs, FFRDCs, and UARCs, completed a successful de-risking field experiment, tested its networking software on the target architecture, and verified that the modem software runs real-time on the target architecture at FABRIC's highest data rate.

In the Electronic Warfare and Countermeasures Office, the Digital Attack Surface Execution Environment (DASEE) project began transferring the DASEE micro-services containerized code to the U.S. Army Synchronized High Op-Tempo Targeting (SHOT) program, accelerating the SHOT program by over a year.

The U.S./U.K. Autonomy and AI Working Group conducted the Coalition-Assured Autonomous Resupply (CAAR)+ experiment to demonstrate semi-autonomous mixed unmanned aircraft systems (UASs) providing persistent situational awareness for a moving ground convoy. The experiment also further developed AI-based video processing, exploitation, and dissemination (PED) conducted by the UASs and a ground-based tactical high-performance computer, while demonstrating small UAS landing/capture on a moving platform.

The Cyber-Technologies team employed an Air Force Research Laboratory partnership intermediary agreement with the Griffiss Institute to administer the Virtual Institutes for Cyber and Electromagnetic Spectrum Research and Employ (VICEROY) program. VICEROY's goal is to expand the number of Reserve Officers' Training Corps and civilian graduates in cyber and electromagnetic spectrum disciplines while adding rigor to their research, enabling them to contribute effectively to DoD operations and the research and engineering enterprise on day one.

The Sensors/Positioning, Navigation, and Timing (PNT) office led a multi-organizational technology-focused team in the development of the fifth edition of the DoD PNT S&T Roadmap, which projects the development of DoD PNT technologies in the near term (2020-2024), medium-term (2025-2029), and far-term (2030 and beyond). The PNT S&T Roadmap informs Defense Components' S&T investments and guides acquisition communities to facilitate future PNT-dependent systems. The 2020 edition focuses on initiatives to establish an open architecture for integrating DoD PNT sources and to improve modeling and simulation capabilities for operations involving complementary PNT technologies.

Basic Research



Sir Isaac Newton. iStock

At the onset of COVID-19, and in response to the subsequent closure of laboratories and universities throughout the Nation, the Basic Research Office offered a novel funding opportunity known as the [Newton Award for Transformative Ideas](#), named to honor Sir Isaac Newton's scientific achievements in mathematics, optics, and gravitation during London's Great Plague. This award seeks to challenge researchers to develop transformative ideas to resolve challenges, advance frontiers, and set new paradigms in basic research fields of immense potential benefit to DoD and the Nation at large.

Following Newton's footsteps, investigators submitted proposals that aimed to produce novel conceptual frameworks or theory-based approaches, utilizing analytical reasoning, calculations, simulations, and thought experiments. After receiving 548 proposals from 184 unique institutions across 41 states, the Basic Research Office awarded \$50,000 to each of 13 researchers, whose proposed work ranged from the mathematics of complexity to thermonuclear fusion to epigenetic cell memory. In early 2021, these Newton Award winners will present their findings to OUSD(R&E) leadership.

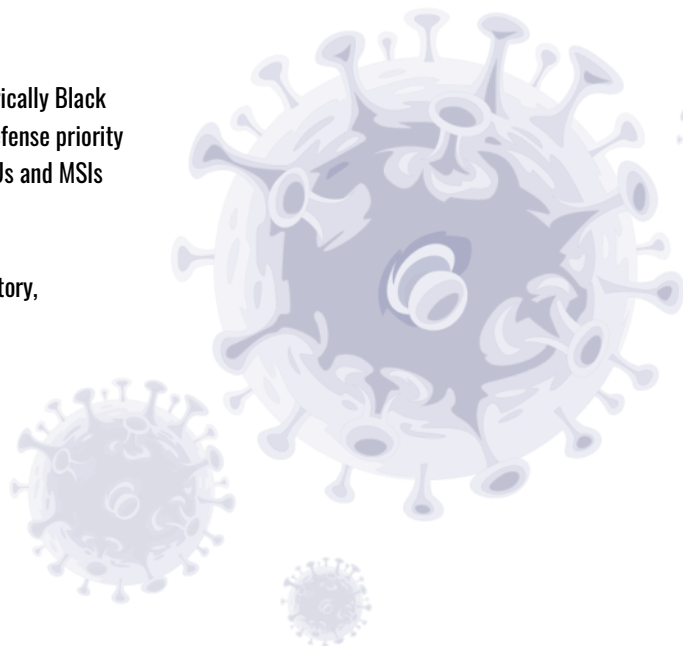
Over the past year, the Basic Research Office re-established the [DoD J-1 Visa Waiver Program](#) within OUSD(R&E), enabling the Department to retain top researchers whose departure would be detrimental to its interests. Without this

waiver, some top researchers conducting Department-funded research are foreign nationals who, under the terms of their J-1 visas, are required to return to their home countries for at least two years upon completion of the exchange visitor program. This requirement forces top talent out of the U.S., making their skills and expertise available to our economic competitors and adversaries. Through the program, the Department requested that the two-year requirement be waived for seven highly talented researchers, thereby ensuring that the U.S. wins the global talent competition.

In education, DoD, through OUSD(R&E), announced awards totaling \$50 million to historically Black colleges and universities and minority-serving institutions (HBCUs/MSIs) to research defense priority areas. A merit competition administered by the Army Research Office selected 31 HBCUs and MSIs for awards totaling \$25.4 million.

A separate [\\$24.5 million merit competition](#), administered by the Army Research Laboratory, selected four HBCUs/MSIs to establish centers of excellence under the DoD HBCU/MSI Research and Education Program. The awardees will conduct research projects in scientific disciplines, including ML, aerospace, quantum science, and fully networked command, control, and communications.

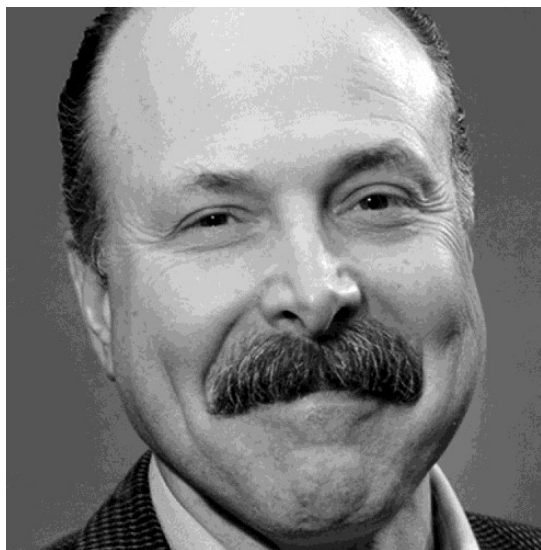
In August, the DoD Grants Office successfully published six regulations that streamline DoD requirements for administering and monitoring Defense financial assistance awards. This effort moves the regulations to title 2 of the Code of Federal Regulations, reducing our grant community's burden by aligning



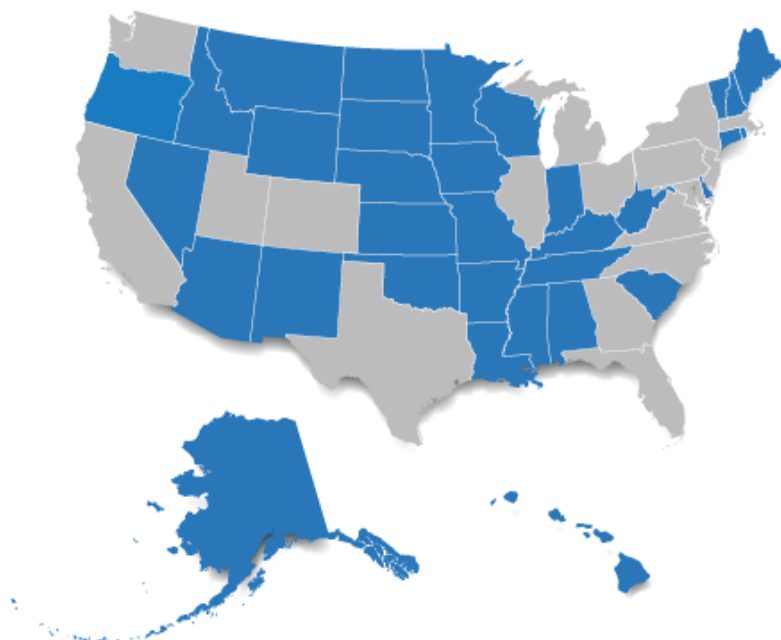
DoD regulations with those of the other Federal agencies. This publication took over two years to complete and represents one of DoD's first fully completed and published policy changes since implementing new Federal regulatory process requirements.

As part of the FY 2019 and FY 2020 defense appropriations bills, Congress tasked the Basic Research Office with managing the [Defense Established Program to Stimulate Competitive Research \(DEPSCoR\)](#). DEPSCoR is a capacity-building program designed to strengthen higher education institutions' research infrastructure in underutilized States/Territories.

Over the past year, the program funded 19 new awards (six from stand-alone DEPSCoR competitions, nine from the Young Investigator Program, three from the Defense University Research Initiative Program, and one Vannevar Bush Faculty Fellowship (VBFF) in 14 different states that have not traditionally received substantial DoD funding enhancing the capabilities of institutions of higher education. This increased the number of university researchers responsive to DoD needs. The program hosted two outreach events at universities and two webinars to introduce researchers from DEPSCoR-eligible states to DoD programs, raise awareness of the basic research enterprise, and encourage increased participation in DoD's initiatives to support national security functions.



David Awschalom named Vannevar Bush Faculty Fellow, March 29, 2017.



In less than a year, [Vannevar Bush Faculty Fellow David Awschalom](#) (class of 2017), professor of molecular engineering at the University of Chicago, forged ahead with research and breakthroughs in the realm of quantum information science that will unquestionably shape the future of quantum technologies. In Professor Awschalom's ambitious determination to accomplish all of the "blue sky" ideas in his VBFF proposal, he led 33 researchers from four different countries in fundamental research successes, resulting in over 40 high-impact publications (including one Nature and five Science articles), as well four patents filed, all in the past year.

In Awshalom's recent Science paper, he and his team brought to light a new class of molecular qubits for sensing and computation. This discovery opens up a new area in synthetic chemistry for quantum information that may help pave the way for next-generation quantum technologies on a large scale. In another breakthrough, Awshalom led his team to develop a new "decoherence" technique that allows quantum states to last 10,000 times longer than the previous record. This monumental discovery could take various quantum technologies from potential to realization and drive progress on numerous DDR&E(R&T) priorities, such as an unhackable internet or extremely powerful computers.



Human Systems

The Human Systems Directorate (HSD) is leading the effort to champion and shape investment in critical, enabling technologies for Warfighter assessment, education, training, and performance; human-machine teaming; human-systems integration; biotechnology; military medicine; and environmental science.

In an initiative to address key challenges and health risks posed by polyfluoroalkyl substances (PFAS), HSD leveraged high-performance computing and ML technologies to develop and validate models to assess the efficacy of pathways for chemical destruction of PFAS-containing materials. HSD made significant progress exploring biological methods for PFAS degradation by isolating microorganisms known to degrade PFAS and mining their genomes to identify potential enzymes and pathways involved in the process. This effort is also developing computational and standardized in vitro/in vivo models for rapid and reliable prediction of human and ecological health risks from PFAS and potential replacements.

HSD established the Biotechnology Community of Interest (Col) to accelerate coordination, integration, synchronization, and advancement in DoD application of engineering biology and emerging biotechnologies to next-generation military capabilities. The Biotechnology Col is aligning DoD S&T efforts to create new capabilities for enhancing warfighting systems, materials, and medical technology and for optimizing Warfighter performance by maturing the Department's biotechnology investments; raising awareness of potential biotechnology use in novel application areas; and developing S&T ethics, policy, and guidelines.

The DoD Polar Research Coordination Group and Global Change Research Group advanced the DoD's resiliency to global environments, coordinating approximately \$150 million in Service and OSD S&T investments in environmental change meteorology, oceanography, and Arctic research. DoD leverages these groups to ensure full engagement of both experts and interagency partners in developing the Interagency Arctic Research Policy Committee Arctic Research Plan and the Fifth National Climate Assessment, and the Interagency Council's establishment on Advancing Meteorological Services.

HSD developed a research roadmap for addressing vital S&T gaps in unconventionally acquired brain injury (UBI), marked by a cluster of neurosensory and cognitive symptoms of unknown origin, including oculomotor deficits, headaches, and disrupted executive function such as those experienced by U.S. State Department and Canadian diplomats in Havana, Cuba, during the summer of 2017. The UBI research roadmap focuses on identifying and assessing technologically feasible threat source technologies; characterizing pathological response and etiology; identifying and validating UBI biomarkers; and developing clinical practice guidelines.

HSD published DoD Instruction (DoDI) 3216.02, "Protection of Human Subjects and Adherence to Ethical Standards in DoD-Conducted and -Supported Research," which modernizes policies for the protection of human subjects in DoD research and aligns them with the Federal Common Rule. The revised DoDI 3216.02 better protects research participants, their biospecimens, and data while incorporating new guidance to reduce unnecessary research burdens and delays.



Platforms and Weapons Technologies

The Platforms and Weapons Technologies (PWT) office is leading the effort to champion and shape investment in critical enabling technologies for kinetic and directed energy weapons, operational energy, materials and aerospace technologies research, and both manned and unmanned systems technologies across the domains of air, land, sea, and space.

The Joint Munitions Program successfully demonstrated massive scaling of one of the significant modeling and simulation tools used for design, optimization, and effects prediction of advanced munitions. Lawrence Livermore National Laboratory's Arbitrary Lagrangian-Eulerian 3D (ALE3D) code completed a benchmark blast effects calculation requiring 23 billion computational zones, simulating a physical region of 27 cubic kilometers and for unprecedentedly long scenario time scales, taking maximum advantage of the Nation's supercomputing infrastructure.

Exploring extended-range capability of future munitions, the Joint Enhanced Munitions Technology Program successfully tested a 12-inch-diameter rotating detonation engine (RDE) ramjet, which is serving as a pathfinder for a larger 19-inch tactical RDE scheduled for testing in 2021. The pathfinder hardware allows for risk reduction of two major technical challenges: 1) obtaining sufficient performance with liquid fuels and 2) producing the required thrust for the mission. Testing will continue to determine the various liquid fuels that can provide the extended range needed to meet Warfighter requirements.

The Joint Fuze Technology Program developed a computer code that enables modeling of impact and penetration in high shock environments to determine the effects on fuzing. For a DoD user community of 150-plus experts, the project demonstrated the feasibility of target detection imaging for future high-speed weapons at a fraction of the cost, size, weight, and power compared to current imaging technologies.

The Reliance 21 Space S&T Col represents the space research and development community across DoD. The PWT Space Technologies team developed a comprehensive space S&T strategy that identifies S&T as foundational to the U.S.'s ability to meet increasing challenges and expand its position of advantage in space.

STRATEGIC TECHNOLOGY PROTECTION and EXPLOITATION (STP&E)

**Dr. Robert Irie**

The Deputy Director for Strategic
Technology Protection and
Exploitation (STP&E)

The Office of Strategic Technology Protection and Exploitation (STP&E)

DEPUTY DIRECTOR'S MESSAGE

STP&E ensures the technological superiority of the U.S. military and bolsters DoD modernization initiatives. Despite the challenges that 2020 presented, I am incredibly proud of our STP&E personnel who persevered to achieve our mission. A mission that consists of promoting and protecting U.S. technological advantage and Warfighter dominance by assuring resilient systems, countering illicit technology transfers, and advancing the National Security Innovation Base.

Among our 2020 accomplishments, our Resilient Systems (RS) directorate provided leadership and guidance on program protection and software assurance policy, standards, and practices across the Department and with industry partners. The Maintaining Technology Advantage (MTA) directorate contributed to technology protection by developing S&T guidance for our academic, U.S. Government, and multilateral partners.

These security procedures aim to significantly counter and mitigate adversary attempts to exploit our research and technological advantage and that of our allies. In addition to our efforts to protect our Nation's technological advantage, we also promote emerging technologies and develop an enduring national innovation base through our Technology and Manufacturing Industrial Base (TMIB) directorate. This year, TMIB continued to foster investments in public-private partnerships with the MIIIs, ensuring the research-to-fielding pipeline for critical defense technologies through manufacturing.

We plan to build upon and expand these activities in 2021, aligning with DDR&E(R&T)'s and OUSD (R&E)'s priorities and goals. The RS directorate will continue to transform program protection methods and practices and lead secure cyber resilient engineering standards and methods. Through MTA's work, we will remain vigilant in safeguarding our modernization priorities and technological advantage from those who would maliciously seek to exploit it.

TMIB will focus its resources on identifying gaps in the emerging technology industry, workforce, and infrastructure base, thereby enabling a smooth, rapid transition from research to a fieldable capability for the Department's modernization priorities. Whatever the new year may bring our way, STP&E is ready to meet the challenges and opportunities of 2021 with an unwavering focus on our mission to protect and promote the best technology for our Warfighters.

Technology and Manufacturing Industrial Base (TMIB)

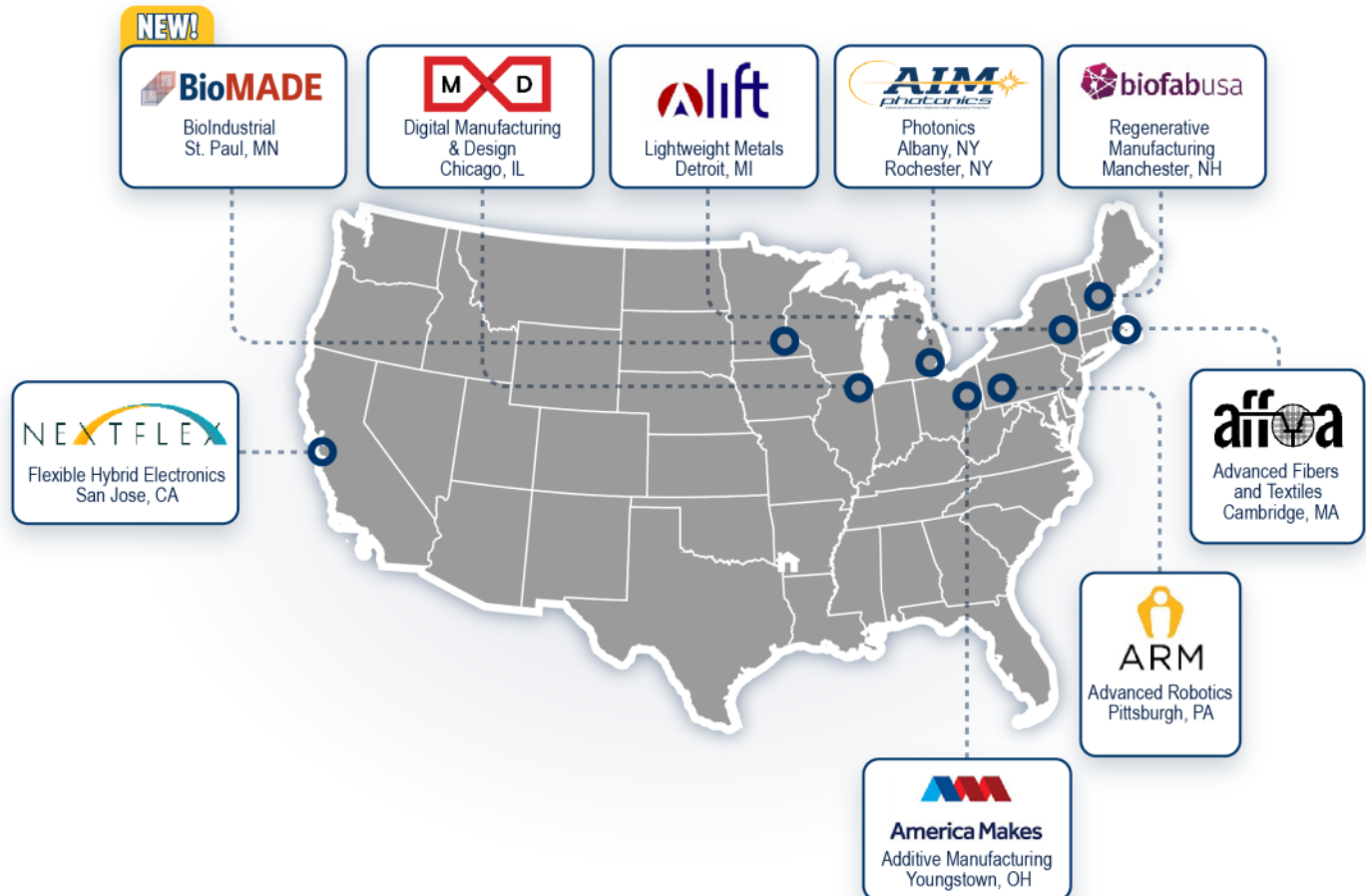
TMIB advances the domestic innovation base to achieve the Department's modernization goals. Among the team's many activities and efforts this year, TMIB established new processes and capabilities to manage Committee on Foreign Investment in the U.S. (CFIUS), and Export Control reviews for OUSD(R&E)'s efforts to protect our national security.

Our CFIUS team processed 284 foreign investment cases and coordinated 132 SME reviews. TMIB also established a capability to assess export license requests. The team led 77 export license reviews and multiple export control regulations during the year. TMIB represented OUSD(R&E) in the Joint Industrial Base Working Group and the Industrial Base Council, participating in the selection of Defense Production Act Title III projects funded by the Coronavirus Aid, Relief, and Economic Security Act (CARES) Act to reduce the impact of COVID-19 on the industrial base. This resulted in a \$668 million investment in the Industrial Base, including \$32 million for projects submitted by R&E to support the emergent technologies supply chain.

TMIB initiated seven technology industrial base assessments on behalf of the Principal Directors leading specific modernization priority areas. The assessments' results will support each Principal Director's roadmaps to advance investments, capabilities, and capacities in those modernization areas.

TMIB also led the chartering of the Joint Defense Manufacturing Council (JDMC), which serves as a forum for senior DoD leaders to maximize the value of the Department's manufacturing efforts by providing strategic guidance and identifying cross-cutting manufacturing initiatives.

The Defense Manufacturing Technology (ManTech) Program



The Defense Manufacturing Technology (ManTech) Program

The ManTech Office in OUSD(R&E) anticipates and closes gaps in manufacturing capabilities for affordable, timely, and low risk development, production, and sustainment of defense systems. To that end, DoD sponsors nine MII, which are public-private partnerships that benefit from the largest U.S. investment in manufacturing in decades and are designed to overcome challenges by advancing manufacturing innovation for specific, focused technology area manufacturing ecosystems.

Under the OUSD(R&E) leadership and ManTech Program Office, the Department continues to foster long-term engagements with the MII in support of DoD's modernization priority areas. Already, these Institutes have witnessed progress on a host of priorities around cybersecurity for manufacturing, microelectronics, biotechnology, hypersonics, and autonomy, among other modernization priorities.

Pursuant to these goals, ManTech successfully launched the ninth DoD-sponsored MII in October 2020. The BioIndustrial Manufacturing and Design Ecosystem (BioMADE) MII received \$87 million as part of a seven-year agreement with DoD to advance sustainable and reliable bioindustrial manufacturing technologies.

This year, ManTech also completed a "DoD Manufacturing Innovation Institute Long Term Strategic Plan" that outlines how OSD plans to bolster partnerships with MII to align with DoD equities, establish follow-on agreements with appropriate financial and technical assistance, and integrate MII portfolios meaningfully with the Department's modernization priorities and the needs of DoD's Service and Agencies.

In January 2020, the ManTech-facilitated Joint Additive Manufacturing Working Group, in conjunction with the National Additive Manufacturing MII America Makes, launched the first-ever Joint Additive Manufacturing Model Exchange (JAMMEX). This is a secure web-based system that allows for collaborative sharing of 3D models across DoD to support additive manufacturing. JAMMEX links to various Service-Specific JAMMEX Repositories containing 3D models that allow the Warfighter to search and view the 3D models, edit the models, and download the associated files.

Additionally, America Makes effectively addressed personal protective equipment (PPE) supply chain shortages caused by the coronavirus pandemic by connecting manufacturers with approved PPE designs that manufacturers could download and produce for free. Another MII, Advanced Functional Fabrics of America (AFFOA), was added to the State of Massachusetts' Manufacturing Emergency Response Team (M-ERT) to assist with mobilizing, organizing, and operationalizing critical path work streams necessary for Massachusetts manufacturers to pivot their operations to produce needed materials in response to the COVID-19 pandemic. AFFOA's unique public-private partnership model made them an ideal resource to help rally industry produce the personal protective equipment needed to mitigate the pandemic's spread.

Maintaining Technology Advantage (MTA)

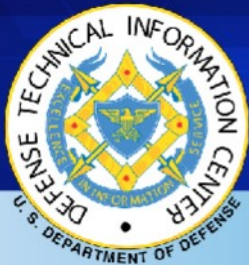
MTA maintains leadership in critical modernization areas. MTA focuses on strengthening cooperation with multilateral partners in 2020, including our "Five Eyes" counterparts Australia, Canada, New Zealand, and the UK, on sharing and enhance security efforts that deterred strategic competitors' activities.

MTA collaborated with the Principal Directors in Directorate of Defense Research and Engineering Modernization (DDR&E(M)) to drive technology protection efforts for the Department's Modernization Priorities. The Directorate also coordinated closely with the Office of the Under Secretary of Defense for Policy and the National Security Council to develop the [National Strategy for Critical and Emerging Technologies](#), released by the White House in October 2020.

Resilient Systems (RS)

RS focuses on fostering assured resilient missions, systems, and components. In 2020, RS advanced policy direction for technology and program protection, software assurance, supply chain risk management, and secure cyber resilient engineering through participation in both DoD and external partnership groups such as the Software Assurance Community of Practice (SwA CoP), Cyber Resilient Weapons Systems Working Group (CRWS WG), and the National Defense Industrial Association Systems Engineering Division (NDIA SE).

The RS directorate also led the Department-wide effort to draft and issue DoDI 5000.83, "[Technology and Program Protection to Maintain Technological Advantage](#)," which establishes policy, assigns responsibilities, and provides procedures for DoD S&T managers and engineers to mitigate risks and protect critical U.S. research, military technologies, and programs.



DTIC

THE DEFENSE TECHNICAL INFORMATION CENTER (DTIC)



Mr. Christopher E. Thomas
Administrator, DTIC

The Defense Technical Information Center (DTIC)

ADMINISTRATOR'S MESSAGE

Throughout 2020, DTIC took key steps and delivered a new capability to users as it strategically refocused from a data repository/provider to an active provider of information, drawing from its knowledge base of 4.6 million records.

By developing an integrated view into the Department's R&D enterprise, DTIC enables users to explore and conduct deep dives, identify trends, and recognize value in the Department's S&T investments. Combining and connecting R&D budget, research projects, and outcomes with user analysis tools, and expanded web analytics, DTIC provides answers to users' questions relevant to their preferences, roles, and interests, and enable discovery and insight into areas that might otherwise go unexplored. Expanded web analytics has taken on additional importance as we work to understand and meet our users' needs in an environment of limited virtual conferences reducing touchpoints to our community.

During 2020, DTIC's mission responsibilities for stewardship of research data expanded as part of Open Science initiatives, and internal DoD research data initiatives, to ensure research data is discoverable and can be employed to validate findings and discover new insights. DTIC advocated for data management plans (DMP) and worked to codify those requirements into DoD Grant and Agreement Regulations (DoDGARS), Defense Federal Acquisition Regulation Supplements (DFARs), and DoD Instructions. In 2021, DTIC will lead coordination with the community to establish data standards and best practices.

For 75 years, DTIC continuously improved how scientists discover and access information relevant to their research. With the ongoing migration to commercial ".GOV clouds," DTIC has unlocked access to 'lease' on-demand advanced search (augmented with ML and AI) and analysis technologies. This adds to DTIC's agility, enabling the adoption of new commercial innovations in search and analytics without delaying long procurement lead times and significant capital investments in both hardware and software.

In 2020, DTIC continued enhancing activity and partnerships across the research community to add content to DoD's knowledge base - more than 97,000 records, including 38,000 final technical reports, 45,000 summaries of ongoing projects, 2,000 DoD grant awards, 2,000 budget exhibits, 150 international agreements, 6,000 independent research and development summaries, and 4,000 peer-reviewed journal articles. These reports are submitted through

DTIC's submission portal, bulk uploads, digitization efforts, and crawling DoD public websites. DTIC's outreach increased FFRDC final report submissions from 300 in 2019 to nearly 1,700 in 2020, with all FFRDCs submitting.

DTIC engaged Defense Laboratories and Centers with briefings, coordination meetings, and attending symposia events. We implemented a new website crawling service that identified more than 5,000 documents on DoD public websites that were not in the collection. DTIC also prototyped methods to recognize gaps in submissions and is developing dashboards reflecting content submissions by Services and laboratories, accessible to each DoD laboratory and available during engagements between DTIC and laboratory reps.

In addition, more than 197,000 legacy reports were converted from microfiche to searchable PDFs and scanned for personally identifiable information (PII), and 2,900 hard-copy documents were digitized, enabling instant keyword searches via DTIC's R&E Gateway. As we eliminate our legacy collection of microfiche, we will repurpose resources from labor-intensive scanning and curating documents to search, analysis, and data management focus areas discussed above.

Working with our SBIR partners, DTIC employed its thesaurus and developed technology descriptions to scan its entire collection, binning records by both Reliance 21 Col and by the National Defense Strategy modernization priorities. This technology allows the DTIC collection to be re-scanned to add new areas (like 5G) and is quickly adapted for additional categorization.

We operate the DoD Information Analysis Centers (IAC) on behalf of USD(R&E). The IACs offer technical expertise and rapid, low-cost contracting access to proven leaders in DoD R&D. During 2020, the IACs processed record levels of new funding on contracts supporting 800 DoD organizations. DTIC continued the consolidation of IAC management/back-office functions to move more resources to the front line to award and administer task orders. These steps helped to best position resources and support a 50% increase in contract awards in 2020. Through the IAC program, DTIC completes its three mission areas: content; advanced engineering and analysis; and search/discovery and end-user driven analytics.

Last year, DTIC migrated our public tools to the cloud. In 2020 we migrated 48 controlled unclassified (CUI) applications and an associated 25TBs of data to the "IL4 CUI Cloud." This transition enables continued progress for DTIC to meet DoD Chief Information Officer (CIO) and Office of Management and Budget (OMB) mandates to consolidate data centers.

DTIC plays a lead role in NDS IT Reform, as the "pathfinder" organization added to the new Defense Information Systems Agency (DISA) Fourth Estate DoDNet. We are helping to shape the environment for every Fourth Estate Agency. DTIC worked with DISA to define the seams between mission IT and 'common use' IT, including where areas overlap (e.g., common use IT used to support mission activities), establishing service level agreements, and ironing out cost models. DTIC also worked with DISA to improve cloud availability and accessibility.

Please take some time to read about several other highlights from 2020 below. As we move into 2021, DTIC will push the state of the art by reimagining our search capabilities, developing new analytic tools, and improving research data management.

Increasing Submissions to the Collections

One of this year's highlights was DTIC's launch of the Mobile Combatant Command Classified Reading Room (CCMD CRR), which provided industry partners visibility into classified CCMD needs and the opportunity to tailor future presentations on their work for the S&T advisors at Combatant Commands. This was the first time DTIC mobilized the reading room, at the request of INDOPACOM and with agreement from the CCMDs. The CCMD S&T Advisors see this as a highly effective method of sharing their needs and receiving cutting-edge technology solutions from industry.

Enhancing Horizons Analytic Tool

The renamed RBPI application was enhanced this year with grant award information. This enables users to search and filter research, development, test and evaluation (RDT&E) investments by Service or Agency, year, and other keywords. Search results visualize program elements, selected year, previous year, and following year for the President's Budget Request (PBR) and congressional authorizations and appropriations.

Enhancements implemented during 2020 allow users to display where work is actually being performed; by whom; the amount of past, current, and requested funding; the maturity or Technology Readiness Level (TRL) of the work; and alignment to DoD modernization priorities and COI. Visual drill-down displays allow users to refine by year, PBR or Congressional Committee, then budget activity, or by organization. Work continues on data modeling laying the foundation to trace outcomes from funding to operational technology. Compilation and linking these data sources enable decision-makers and analysts to better follow funding from RDT&E efforts to operational capabilities.



User enabled search and filter research, development, test and evaluation (RDT&E) investments by Service or Agency, year, and other key-words. Search results provide a visual overview of the program. iStock.

Coronavirus Research

DTIC developed a public page for information relevant to COVID-19 research, which can be accessed at <https://discover.dtic.mil/coronavirus/>. The page highlights publicly released information from DTIC's collections related to topics including: aerosol viruses; care of patients; coronavirus research; the Defense Production Act; methods of testing, assays, and reagents; pandemic response plans; personal protective masks; Remdesivir; respirators; Chloroquine; vaccines; and ventilators. This page also provides links to official guidance sources on COVID-19, public-private efforts on COVID-19 research, resources from the National Institutes of Health and current DoD efforts.

For controlled unclassified information, DTIC developed a centralized page (https://www.dodtechipedia.mil/dodwiki/x/_4fKJw) on its collaborative tool DoDTechipedia. The page includes information about DoD-funded research; a bibliography on COVID-19-related papers on masks, vaccines, and pandemic plans; information on re-use and decontamination on N-95 masks; a link to a search for reports in DTIC's collection on COVID-19 (November 2019 to the present) as well as links to searches for controlled unclassified materials on respirators and ventilators.

The public page provides a central point to the public for DoD's research efforts regarding COVID-19 and related viruses and infections. The DoDTechipedia page provides a location for DoD to access publicly available and controlled unclassified information concerning DoD's research efforts regarding COVID-19 and related viruses and infections, allowing the researcher quick access to pandemic relevant information. Since March 2020, the COVID page on DTIC's public website has received about 13,600 views; and about 6,000 page views.



Corona virus research. iStock

Technology Scouting and Trip Reports

Technology Scouting and Trip reports are mechanisms for DoD personnel to report on new or developing technologies worldwide. These summaries highlight technologies that are of interest to the Department. Each of the Services hosts a technology scouting office that researches individuals who visit universities, small businesses, conferences, technical interchanges, and other partner countries' events to gather information useful to DoD's capability development.

DTIC worked with the Services to collect and host a central repository of technology scouting reports accessible by researchers Department-wide. These reports are searchable by keyword, country, technical area, date range, or reporting agency.

Research Security

DTIC continues to balance its mission to widely share material in its knowledge base with the responsibility to protect sensitive documents and national security. DTIC successfully tagged documents and records associated with modernization priorities using an SBIR-developed ML tool to assist in evaluating the Department's public collection's sensitivity and aid users with refining search results.

DTIC developed an early prototype application to evaluate the sensitivity of a document based on detailed indicators. The objective is to inform the distributed decision-makers across the DoD R&E community as they select distribution markings for documents. Accurate marking allows the widest dissemination possible for sharing DoD research while protecting national security interests. DTIC will continue development in 2021, and if deemed effective, it will widen the opportunity to evaluate the Services' tool.

Publishing the Peer-reviewed Journal of DoD Research & Engineering (JDR&E)

In 2020, DTIC published three issues of the JDR&E, including a special edition focused on additive manufacturing, commonly known as "3D printing." Issues included controlled unclassified and classified articles recognizing the research work of over 117 DoD authors. In FY20, 52 articles were peer-reviewed by DoD subject matter experts who volunteered their time.

All of the Services and five DoD agencies were represented, covering 12 of the Cols. By giving authorized scientists, researchers, and engineers visibility into controlled defense research, the journal promotes the types of collaboration that results in warfighters' new capabilities.

Establishing New Data Stewardship Efforts

In coordination with the DoD research community, DTIC developed and populated a current DoD research datasets catalog. DTIC also coordinated revision to the DoDGARS, which mandates the creation and submission of Data Management Plans and journal articles from DoD-funded university researchers. DMPs are a first step for managing research data, ensuring that researchers define how they will share research data.

To aid researchers in developing DMPs, we launched a DMP builder. This tool guides users through a series of steps to enter information on the project and returns a DMP in a PDF file, which can later be resubmitted and updated.



DMEA

DEFENSE MICROELECTRONICS ACTIVITY (DMEA)



Mr. Douglas Casanova
Acting Director, DMEA

Defense Microelectronics Activity (DMEA)

DIRECTOR'S MESSAGE

For over 20 years, DMEA has developed essential technology products and services and delivered them to DoD Agencies, the Military Services, and their partners to ensure continued weapon system readiness and operational effectiveness.

In 2020, DMEA met the Department's needs by maintaining the microelectronics laboratory's critical capabilities, executing hundreds of microelectronics-focused technology development projects and research activities, and ensuring continued access to mainstream microelectronics manufacturers and integrators across the country.

As the microelectronics ecosystem evolved in 2020, so did the DMEA laboratory. We have established, enhanced, and expanded critical partnerships with industry and academia. For example, DMEA leveraged the private sector and domestic universities to explore emerging technologies in the areas of machine vision and high-performance radio frequency devices. DMEA also expanded our cadre of trusted suppliers. Our goal is to ensure the continued availability of a wide range of microelectronics products and services with the quality, security, and confidentiality DoD programs need. New security and assurance methods and techniques developed under the DoD microelectronics roadmap are broadly implemented.

Please take a few moments to review some of the highlights from the past year and learn more about DMEA at <https://www.dmea.osd.mil/>.

Printed Circuit Board Assembly and Micro Circuit Assembly

DMEA's organic Advanced Package Design and Simulation capability is currently on-line. This capability utilizes Cadence SiP and Sigrity signal integrity analysis tools. With this technology, the DMEA Packaging, Assembly, and Substrate Lab are developing and qualifying process flows for the design and simulation (electrical power and signal integrity) of wire-bond, flip-chip, 2.5D/3D packages, and heterogeneous assembly structures. These process flows and technology further enable DMEA to support the mitigation of DMSMS and obsolescence issues while also supporting the DoD vision for trusted advanced packaging and assembly access.

Technology Support Program

The ability to rapidly increase Warfighter capabilities and provide solutions to microelectronics-related reliability, maintainability, and supportability issues is paramount to maintaining the U.S. military's tactical advantage. The DMEA Advanced Technology Support Program-IV (ATSP-IV), a fifth-generation multiple award contract vehicle backed by 30 years of experience, provides that advantage. With a contract ceiling of \$17.47 billion, ATSP-IV is unique in the speed at which it provides advanced technology avenues to upgrade existing systems and get effective new capabilities to the Warfighter.

Roughly 15% of the 2020 ATSP workload was based on either a Joint Urgent Operational Need (JUON) or a Joint Emergent Operational Need.

Program highlights for 2020 include the technical program management of 275 task orders worth \$4.5 billion and the development and award of the technical requirements of 64 new task orders worth \$705 million. The key to the continued success of ATSP is a motivated and well-trained DMEA engineering and contracting workforce with standardized work processes and a well-crafted ATSP contracting vehicle. Continuing this success into 2021, DMEA is developing technical requirements for 42 new tasks worth \$431 million.

Counter–Rocket, Artillery, and Mortar Program

The C-RAM system of systems is composed of sensors, warning systems, command, and control systems, and, in many cases, effectors that combine to protect the Warfighter against incoming rocket, artillery, and mortar fire. Using radar and the command-and-control system from the canceled Future Combat System program, DMEA worked together with the Army C-RAM office through the ATSP-IV accelerated acquisition process to rapidly develop and deliver life-saving technologies to forward operating bases supporting overseas contingency operations.

Successfully fielding a system of systems capable of detecting and targeting incoming rounds was a technological achievement capping years of development, integration, test, and employment, resulting in the urgent deployment of a system that provided over 7,000 warnings and more than 400 confirmed intercepts. Initially focused on reducing susceptibility to high and low angles of attack in response to three separate U.S. Central Command JUONs, the ATSP-IV efforts incrementally migrated to the specific radar solution employed today. Currently, DMEA manages 26 C-RAM tasks, distributed between the Sense and Warn and Counter Unmanned Aircraft Systems.

DMEA has been instrumental in the rapid design, development, and production of a number of life-saving systems which have provided thousands of warnings and enabled hundreds of intercepts of hostile indirect fires launched against our forces... We continue to enjoy the expertise DMEA can provide in our mission to provide our Warfighters with confidence in our ability to warn and protect exposed personnel.

— Brian Anderson, Acting Director for C-RAM

646 Devices and Systems Delivered to Warfighters Supporting Combatant Commands

DMEA designed and delivered 646 custom microelectronics devices and systems to our Warfighter clients, supporting all Combatant Commands (CCMDs). Deliveries supported the CH-53E Sea Stallion helicopter, Columbia-class submarine, UH-60 Blackhawk helicopter, Special Operations devices (Globalstar repeaters), and the Air Force Air Combat Command. The 646 delivered units spanned all classification levels. These devices have helped ensure success in some of the most critical and sensitive operations.

Demand and Capacity Grow for the DoD Trusted Integrated Circuit Supplier Program

DMEA provides access to leading-edge trusted microelectronics foundry services for the typically low-volume needs of the U.S. Government. The Trusted Access Program Office (TAPO) facilitates and administers the contracts and agreements with industry to provide U.S. Government users with access to commercial integrated circuit manufacturing flows for complex digital and mixed-signal system-on-chip application-specific integrated circuits (ASICs). DMEA continues to operate as the only DoD program to aggregate orders and provide access to state-of-the-art manufacturing of trusted ASICs at GLOBALFOUNDRIES facilities in the U.S.

The program has expanded the industrial base available to DoD by working with suppliers who have never dealt with the U.S. Government before. The Trusted Supplier Accreditation Program works with these entities to ensure that all of the Government's requirements for trusted processing of materials are met before contract award. There are 81 accredited trusted suppliers representing 19 semiconductor fabrication partners offering 21 semiconductor processes and 190 related accredited services encompassing the ASIC supply chain.

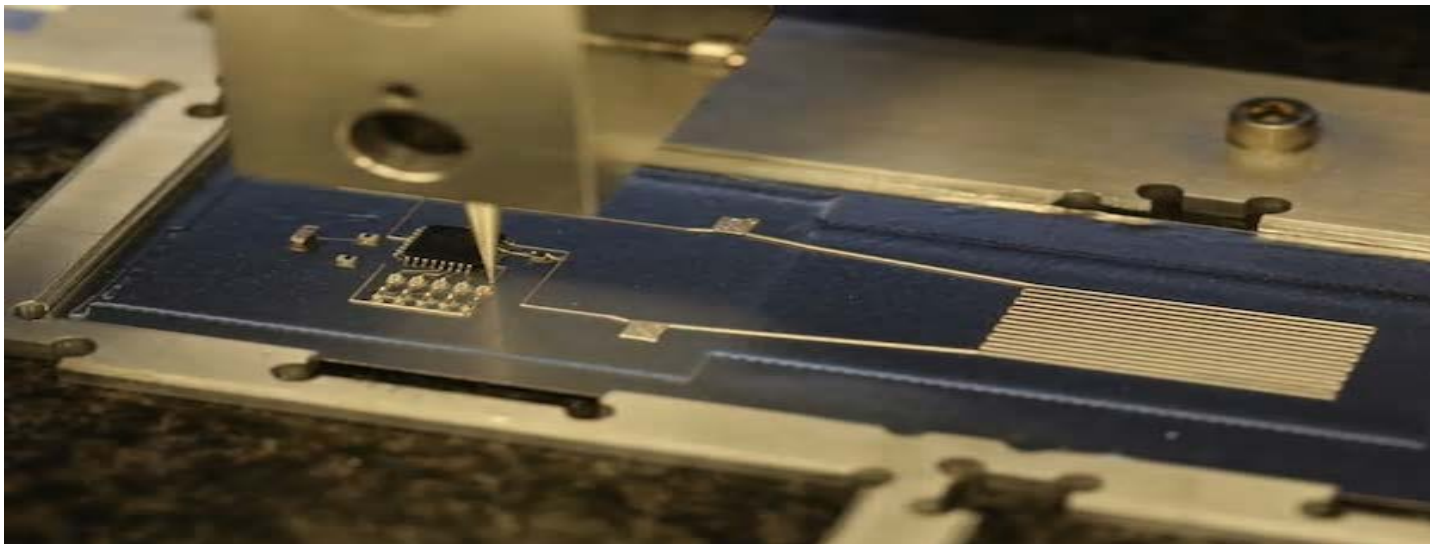
Accredited services include ASIC design, design aggregation, photolithographic mask data parsing, mask manufacturing, semiconductor fabrication, fabrication post-processing, packaging, and test. DMEA works with all accredited suppliers to keep the cost of meeting the security requirements for trust as low as possible. As new methods for assured microelectronics evolve, DMEA will ensure uninterrupted access and work with trusted suppliers to adopt the new techniques.

Access to State-of-the-Art Microelectronics

As DoD's only microelectronics engineering center to conduct trust accreditations, DMEA assists in developing the quantifiably assured manufacturing model in support of the Department's zero-trust initiative for the procurement of microelectronics.

Significant developments in 2020 included DMEA TAPO support to DoD and other agencies at each new technology node through the development of base intellectual property (IP). This IP is used in the design and development of ASICs, margined to extended military temperature operation of -55 to +125 degrees Celsius. The next generation of foundational base IP focuses on GLOBALFOUNDRIES 12LP+ (12nm) technology.

DMEA TAPO provided access to seven dedicated 12nm and eight dedicated 45nm multi-project wafer (MPW) fabrication runs for DoD and other agencies for research and prototype development, supporting programs requiring high levels of trust in their supply chains. The MPW runs enable the aggregation of multiple projects onto a single fabrication activity, distributing costs and efficiently fabricating prototypes before full production.



Air Force Research Lab, Harvard researchers invent new method of hybrid 3-D printing for flexible electronics. DVIDS

Gallium Nitride Technology Development Kickoff in Support of Leading-Edge Domestic 5G and Beyond

In March 2020, DoD provided an update on the Department's top tech priorities signaling an increased focus on microelectronics and 5G. Gallium Nitride (GaN)-based microelectronics, for instance, will be an enabling technology.

DMEA supported these efforts by commencing a multiple-phase effort to introduce GaN on silicon (Si) at a high-volume semiconductor production facility. DMEA worked with industry to develop a 200mm GaN process technology that targets 5G, millimeter-wave infrastructure, and client premises equipment (CPE), smartphone antenna tuners, and switches in 4G Cat 16+, 5G, and 6G handsets, aerospace, and defense radar applications, and electronic warfare applications.

DMEA is teaming with a coalition of U.S. Government partners consisting of the Air Force Research Laboratory (AFRL), Missile Defense Agency, Army Research Laboratory (ARL), Naval Surface Warfare Center—Crane Division, and other members of the Advanced Electronics Community of Interest. The effort's primary intent is to have DMEA's industry partner implement a GaN process technology compatible with a traditional 200mm complementary metal-oxide-semiconductor (CMOS) facility targeting an underlying 130nm CMOS process technology.

DMEA Caps off 20 Years of Academic Engagement with Sacramento State University through Novel Research and the Development of a Senior Project Program

2020 marked the twentieth anniversary of the DMEA - Sacramento State Education Partnership Agreement (EPA). As codified in 10 U.S.C. § 2194, the director of each defense laboratory is authorized "to enter into one or more education partnership agreements with educational institutions in the U.S. to encourage and enhance study in scientific disciplines at all levels of education."

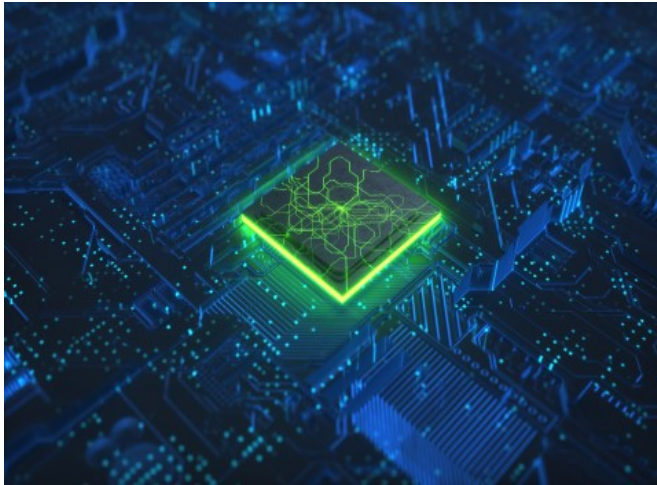
This year DMEA participated in Sacramento State's second annual research symposium, titled "Discussion, Discovery, and Dissemination." The event featured 63 research posters presented by faculty of the colleges across ten departments. Research topics ranged from deep learning and neural networks to low-temperature properties of 3D materials to squishy physics. Also on display was the Peer-Assisted Learning (PAL) Program. Based on 20 years of national research on learning, the PAL model helps students adjust to the rigorous expectations of foundational courses required for degrees in math, science, and engineering.

More significantly, DMEA materially sponsored a master thesis team project to design and fabricate a novel low-power microelectronics device. The device, which is used in the digitization of electronic signals, has potential biomedical applications. The Senior Project Support Program, for which DMEA provides microelectronics-based concept topics for senior project teams to consider, also saw significant development.

Selected topics are supported to successful completion by DMEA through mentorship and the supply of project kitting material. Complete program rollout is expected to occur in 2021, coinciding with the expanded EPA's execution with Sacramento State that will welcome the College of Natural Sciences and Mathematics' inaugural participation alongside the College of Engineering and Computer Science.

Sacramento State is recognized as the fourth most diverse university in the U.S. and is certified by the Department of Education as a Hispanic-, Asian American-, Native American-, and Pacific Islander-serving institution. The campus is also considered a minority-serving institution. The university has a robust programmatic and support system for underrepresented students and places particular emphasis on groups who traditionally are involved in the science and engineering professions in disproportionately low numbers.

DMEA Caps off 20 Years of Academic Engagement with Sacramento State University through Novel Research and the Development of a Senior Project Program, Cont...



Radiation-hardened microelectronics, necessary for long-duration spacecraft . iStock

To operate successfully across the globe, U.S. military forces depend on the continuous availability of space-based systems like telecommunications and observational satellites that must operate reliably, often for decades, in a harsh environment of temperature extremes and ionizing radiation in the form of energetic atomic particles traveling, in some cases, at the speed of light. The most vulnerable components of these space-deployed assets are the microelectronics subsystems upon which the entire system and mission architecture are built. Over time, these microelectronics will succumb to the environment, resulting in overall system degradation and, in due course, failure.

To address this concern, engineers at DMEA invented a system that investigates the susceptibility of microelectronics devices to the combined harmful effects

resulting from simultaneous exposure to ionizing radiation and elevated temperatures found in space. To simulate the combined-effects stresses encountered in the space environment, the devices undergo accelerated reliability

testing at high temperatures and electrical stress while simultaneously irradiated for up to 30 hours. During this time, periodic in situ electrical measurements are taken to observe device degradation. From the collected data, device operating lifetimes can be predicted for a given set of operating conditions.

The U.S. Patent issued a patent to the project engineers for their work on the “System and Method for Simultaneous Testing of Radiation, Environmental, and Electrical Reliability of Multiple Semiconductor Electrical Devices.” Through this combined-effects testing, the inventors were able to demonstrate that ionizing radiation has a complex effect on device reliability and that, in the space environment context, ionizing radiation worsened device performance under operationally relevant conditions.

A significant benefit is that it allows for devices to be simultaneously stressed and tested, whereas the current standard employs a time-consuming stress-then-test methodology that poses a risk to devices because of the additional handling required. Another benefit is that the patent ensures U.S. Government programs and other federal test labs can utilize this invention.

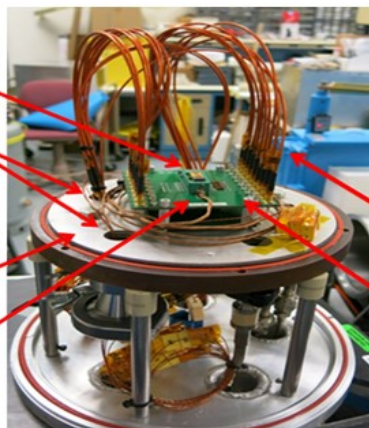
The DMEA Science and Engineering Gamma Irradiation Test (SEGIT) facility was essential to the success of this invention. The SEGIT performs total ionizing dose testing for Government, university, and commercial partners. It includes two large-format irradiators, one designed for high-dose-rate testing and the other optimized for enhanced low-dose-rate sensitivity research.

Device Under Test Package

Vacuum tight
cable feed-through

Temperature controlled
by flowing hot nitrogen
gas through the
baseplate

Thermocouple at socket



Kapton-coated coaxial
signal cables
- Vacuum safe
- Radiation safe
- High signal fidelity

Custom Circuit Board

SEGIT Dewar Temperature System module instrumental in the combined-effects testing. (Source: DMEA)

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