

ARL

open
campus
Strategic Plan



U.S. ARMY
RDECOM



open campus

EXECUTIVE SUMMARY

The U.S. Army of 2040 and beyond will operate in a rapidly changing environment of hitherto unparalleled complexity. U.S. Army leadership has long recognized the need to invest in science and technology (S&T) to empower the discovery and innovation necessary to win future battles. In response, the U.S. Army Research Laboratory (ARL) has implemented a new business model, the “Open Campus” (OC), to pursue leading-edge basic and applied research in truly collaborative fashion by enabling the continuous flow of people and ideas between government, academia, and the private sector. This model creates a 21st Century research culture that is agile and effective and could serve as a model to transform the entire U.S. Defense Laboratory Enterprise into an agile, efficient, and effective laboratory system viewed as a critical element of national security.

ARL’s Open Campus was launched in 2014. The overall Open Campus goal is to expand ARL’s S&T ecosystem by bringing together government laboratories, academic institutions, and the private sector to form a global collaborative network. Open Campus focuses on three major initiatives to create the S&T ecosystem necessary to meet future national security challenges: 1) Modern government workforce management and policies for the 21st Century, 2) Shared facilities between government, academia, and the private sector, and 3) A collaborative S&T ecosystem that encourages an entrepreneurial/innovative culture/environment.

ARL’s Open Campus will develop a diversified national “hub-and-spoke” infrastructure to more effectively partner across the national and international S&T ecosystem. ARL’s OC leverages the expertise, capabilities, and facilities of ARL and its partners, all within the Army’s overarching S&T Campaign Plan. Through the Open Campus framework, ARL scientists and engineers (S&Es) work side-by-side with visiting scientists in ARL’s facilities, and as visiting researchers at collaborators’ institutions. ARL is committed to a goal of having 10 percent – 15 percent of its research staff on rotational assignments outside of the laboratory at partner locations, with at least that number of collaborators actively participating at ARL locations.

The joint value proposition created by Open Campus for partner researchers and institutions includes access to unique ARL facilities, real data sets, and expertise; generation of joint intellectual property; incubation of spinoff companies for the pursuit of S&T innovations; and maturation and rapid transition of intellectual property and technologies to the industrial marketplace. The appointment of ARL S&Es as visiting researchers and professors of practice at universities, or as technologists at cutting edge companies will provide a perspective on complex and challenging defense-relevant problems to the academic and business communities—attracting the next generation of S&Es to careers that support the mission of national security across the S&T ecosystem.

ARL is working aggressively to create the policy framework necessary to support these new avenues of global collaboration. The use of Cooperative Research and Development Agreements (CRADAs) has expanded dramatically with academic, corporate, and small business institutions, and are being established at the system-wide level to protect the intellectual property of all partners while dramatically streamlining the collaboration process.

Policy changes are being made to expand sabbatical opportunities for ARL employees who desire to explore entrepreneurial ventures.

By adopting Open Campus, ARL will attract the best and brightest to address Army research problems, open our campuses for global collaboration, share and leverage specialized facilities, and foster innovation. The result will be an efficient, effective, and agile research institution that is responsive to the national security challenges of the future.

OPEN CAMPUS GOAL and OBJECTIVE

GOAL:

**Create a Transformative
Global Science and
Technology Ecosystem**

OBJECTIVE:

**Link Government, Academia, and
Business to Share the Best and
Brightest People, Ideas, and Facilities**

The vision of the U.S. Army Research Laboratory is to be “the Nation’s premier laboratory for land forces,” with a mission to “discover, innovate, and transition science and technology to ensure dominant strategic land power.”

The ultimate goal of ARL’s Open Campus business model is to create a global science and technology (S&T) ecosystem to foster an agile, efficient, and effective research environment for transformative scientific discovery, innovation, and technology transition in support of national security interests.

The specific objective of Open Campus is to join government laboratories, academic institutions, small businesses, and industry in a global collaborative

network that will engage the “best and brightest” through open campuses, shared modern facilities, and innovative practices.

HISTORICAL BACKGROUND AND THE NEED FOR A NEW BUSINESS MODEL

The concept of the modern defense laboratory was inspired by Thomas Edison’s vision of “a great research laboratory” maintained by the Government. This vision led to the creation of the Naval Research Laboratory in 1923.¹ In 1945, Vannevar Bush’s concepts documented in *Science – The Endless Frontier*, became a model for how the United States would pursue its scientific endeavors.² Bush stressed the necessity for the establishment of a robust and synergistic university, industry and government laboratory research system.³ Over the past 60 years, organizational changes and consolidations have created the National Laboratories structure and a Department of Defense (DoD) research laboratory structure now known as the Defense Laboratory Enterprise (DLE).⁴ The DLE’s overall structure and operation have not changed since their establishment, the only exception being that these organizations have become more insular during the last 60+ years and especially following September 11th. The university and industry research capabilities have evolved over the same period with the changing research and economic environments. For example, research

at large industry laboratories “have shifted from open-ended problem-solving to short-term commercial exploitation” requiring universities and federal laboratories to fill the gaps.⁵ This shift, combined with the rigid and insular nature that has evolved within the DLE, has caused an erosion of the university/industry/government laboratory synergy that is critical to the discovery, innovation, and transition of S&T that is important to national security. In addition, the pace of technological change from 1990 to the present far exceeds the technology pace observed from 1950 through 1990, and is expected to continue to increase in the 21st Century. The increased rigid and insular nature of the DLE must change to meet the evolving technology pace of the future.

Many experts have called attention to trends in U.S. science and technology that are of particular concern for national security, such as the relatively small number of U.S. students in technical disciplines, the growing threat to U.S. leadership in many key science and engineering disciplines and technologies, and the global proliferation of technologies that enable small groups of individuals with malevolent intent to deliver catastrophic effects. These trends and other assessments have led to concerns that the U.S. national security science and technology enterprise is in decline overall, leaving the Nation’s strategic and economic security at risk. In particular, aging infrastructure and cumbersome administrative processes stifle innovation and undermine recruitment and retention of the world’s most talented individuals. Such talent is needed at a time when the international environment demands security systems more technologically advanced and tactically adept than ever before. While the U.S. has relied on technical dominance in the battlespace since World War II, its adversaries have recently narrowed the technology gap. To efficiently and effectively support the development of new capabilities for U.S. national security needs, technological advances are needed to counter the growing competencies of our adversaries in domains such as cyber and quantum information. Transformative advances are required in evolving S&T domains to address ever changing national security concerns.

The overarching goal of ARL’s Open Campus business model is to build a collaborative research environment among U.S. Government laboratories, academia, and business in pursuit of challenging scientific and engineering problems of high Army interest.

In response to this 21st Century environment, ARL initiated a new business model, the “Open Campus”, intended to create a more adaptive, efficient, and effective defense research environment that can be responsive to future national security challenges. An overarching goal of this business model is to develop a collaborative research environment that brings together multiple technical disciplines and globally diverse perspectives to pursue challenging scientific problems of interest to the Army. The formal and informal interactions among scientists, engineers, and business and technology specialists fostered by this environment will lead to new fundamental knowledge, enhance the frequency of scientific and engineering breakthroughs, effectively transition technologies into engineered systems, and help guide strategic science, technology, and acquisition policy. By bringing together researchers from academia, the private sector, and government, ARL is postured to pursue Army-relevant

research with the global S&T community that would be difficult for individual research groups to pursue independently. The joint value proposition created by Open Campus for partner researchers and institutions includes access to specialized facilities and resources, engagement with diverse researchers focused on complex environments and evolving threats, the expansion of academic programs and collaboration spaces at ARL sites, and the establishment of intimate working relationships with regional and global entrepreneurial communities. The Open Campus business model will foster generation of joint intellectual property; incubation of spinoff companies for the pursuit of S&T innovations; and maturation and rapid transition of intellectual property and technologies to the industrial marketplace.

To create the Open Campus ecosystem, ARL is implementing policy and business practice changes that are targeted to: enhance the professional and technical development of its workforce; develop critical research facilities; and create interactions and engagements with public and private sector entities with common technical interests. These changes require strategic investment in and leveraging of human capital, facilities, and technical infrastructure across government, industry, and academia, while increasing public involvement and understanding of defense science technology and exploration.

MANAGING THE 21st CENTURY GOVERNMENT WORKFORCE

The need for diversity of thought is a major driver behind ARL's Open Campus practices, designed to attract the best and the brightest to work on U.S. Army and National Security challenges. Encouraging the interaction of experts from different professional disciplines, organizations, and cultures facilitates opportunities to discover new ways of thinking, and accelerates idea refinement, proof of concept, prototype development, and commercialization of practical systems.



Globalization of the science and technology community, and the mobility of the modern workforce within it, have radically changed options for workers in the 21st Century. These options have created challenges in recruiting and retaining employees in scientific and technical fields across the S&T ecosystem. This challenge is intensified by the fact that approximately half of the existing technical workforce will become eligible for retirement by 2020. Office of Personnel Management (OPM) data indicates that employees from the Millennial Generation, born between the early 1980s and early 2000s, make up only about 16 percent of the total U.S. federal workforce. In addition, today's average worker stays with one employer for an average of 5–7 years,

and will hold multiple jobs over the course of their career. Every institution (e.g., academic, industry/small business, non-profit, government) within the global science and technology community faces the same challenge. An example: nearly half of federal employees are nearing retirement eligibility and with a relatively small number of millennials as current

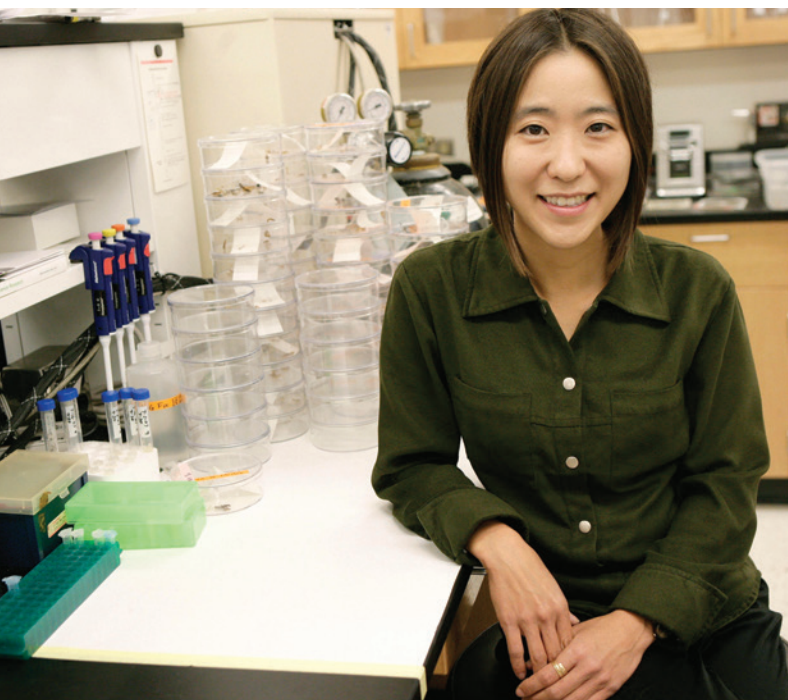
employees, it is imperative that federal agencies recruit and retain future leaders from the millennial generation to fill potential talent and skill gaps.⁶ To do so, engagement tactics must be strengthened and focused to attract and retain the best and brightest. To bolster ARL's internationally recognized workforce of over 3,000 employees, innovative approaches are being implemented within the Open Campus business model to make federal service more attractive by demonstrating that ARL is truly creating an international collaborative environment where researchers can work together on challenging problems by providing wide-ranging professional opportunities, career flexibility, and an entrepreneurial mindset.

ARL's Open Campus is focused on building a science and technology ecosystem that is aligned with the strategic areas of interest of both ARL and the Army. As part of the Open Campus effort there is a focus on developing porosity across the S&T ecosystem so that government, private sector, and academic staff members can easily collaborate and/or transition between organizations. This will enable S&E's to develop careers that address challenging problems across the ecosystem without the loss of core competencies, which are necessary to address our nation's national security challenges. To this end, ARL is committed to a goal of having up to 15 percent of its research staff on rotational assignments outside the laboratory at partner locations or pursuing Army-relevant entrepreneurial opportunities, with at least that number of collaborators actively participating at ARL laboratories.

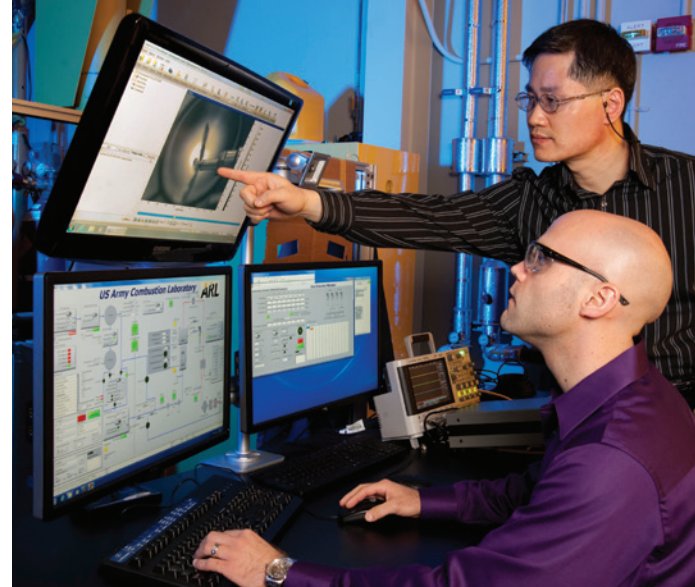
ARL staff is encouraged to pursue entrepreneurial opportunities in high-risk/high-payoff areas of potential strategic value to the U.S. Army through implementation of innovative workplace policies. ARL researchers are encouraged to serve as visiting researchers,

ARL is committed to a goal of having up to 15 percent of its research staff on rotational assignments outside of the laboratory at collaborative partner locations, with at least that number of collaborators actively participating in ARL S&T technical ecosystem.

professors of practice at universities, or as technologists at cutting edge companies conducting joint research in ARL laboratories and the laboratories of their ecosystem partners. Open Campus relationships forged with academic partners expand opportunities for both faculty and ARL researchers providing insight into the complex boundary conditions of defense-relevant problems. These partnerships can contribute to each academic institution's curriculum and breadth, and provide unique insights into



challenging defense problems that would be difficult to obtain otherwise. Collaborations between ARL and academia will help shape the future national security workforce, provide exciting employment pathways for highly trained graduates of science, technology, engineering, and mathematics (STEM) academic programs, and help academic institutions build programs and attract new faculty by offering established linkages to the U.S. Defense network.



In a similar vein, ARL and industry/small business staff exchanges with leading technology companies will help shape technology maturation timelines to the industrial marketplace and will provide ARL and partner researchers with a view of the state-of-the-art in many critical fields, as well as provide insight into emerging government and industry practices regarding technology development. These exchanges will encourage and provide incubation opportunities, empowering and leveraging the novel approaches of these entrepreneurs through access to infrastructure and unique engagement/partnership opportunities between scientists and engineers.

To facilitate the goal of increased mobility and engagement in the expanding Open Campus S&T ecosystem, ARL continues to review and update its policies and uses several mechanisms to empower collaboration. ARL encourages potential partner organization to do the same to help develop the workforce porosity across the S&T ecosystem.

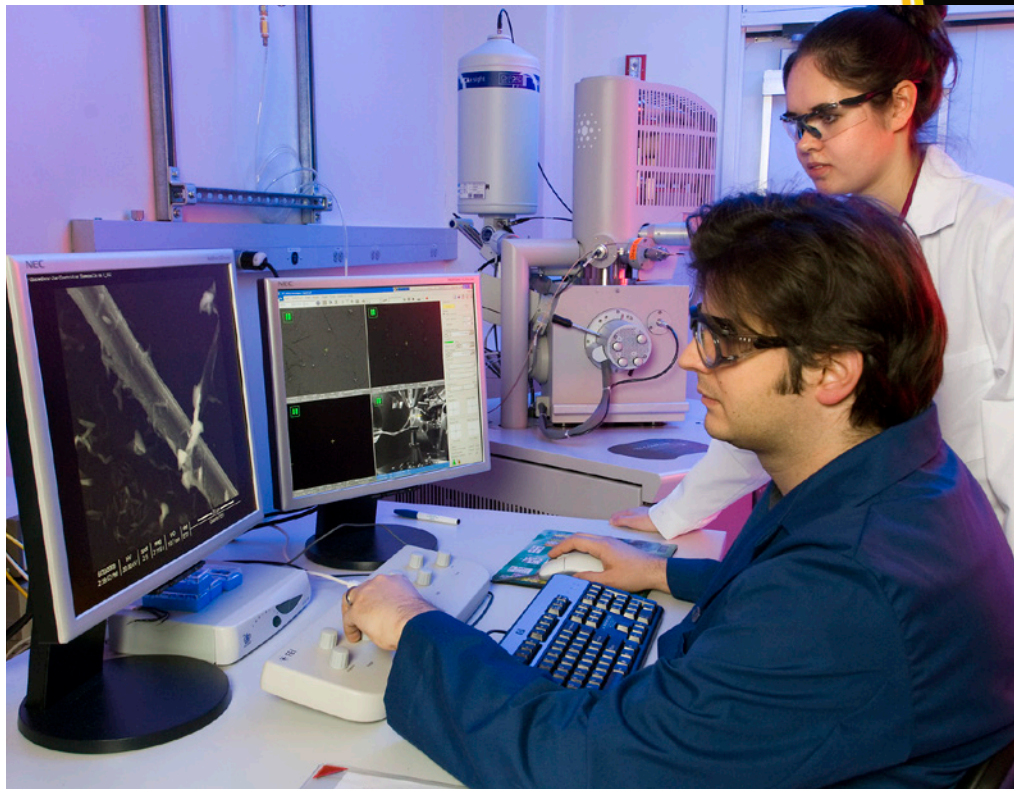
One of the many advantages of the Open Campus model is the career path flexibility for ARL staff. ARL researchers are encouraged to serve at their collaborators' locations as Professors of Practice, Adjunct Professors, or Visiting Researchers while funded by ARL. Short-term visits (i.e., from days to weeks) to a collaborator's location are encouraged for ARL researchers conducting specific experiments, or learning or imparting new skills, as part of a collaborative research project that is aligned with ARL's mission. Longer term appointments (i.e., over 30 days) to a collaborator's location are accommodated as temporary assignments or sabbaticals. The policies to enable sabbatical assignments have been improved under Open Campus, providing ARL's employees that have completed a minimum of three (vs. five) years of service to apply for sabbatical leave once every five (vs. seven) years, for a term of 3–12 months.

Intergovernmental Personnel Act (IPA) Assignments are a mechanism that enables the temporary assignment of personnel between the Federal Government and state and local governments, institutions of higher education, Indian tribal governments, and other eligible organizations. IPA Assignments are limited to two years, with the option to extend for an additional two years. The list of certified "other organizations" includes representatives of state or local governments, associations of state or local public officials, non-profits or Federally Funded Research and Development Centers, hospitals, schools, research institutes and scientific societies. IPA assignments also allow civilian employees of Federal

agencies to serve with eligible non-Federal organizations for a limited period without loss of employee rights and benefits. Federal employees are required to return to Federal service for a time equal to the length of the IPA assignment or be responsible for reimbursing all expenses, except for salary and benefits, associated with the IPA. Cost-sharing agreements, which are negotiated by the participating organizations for each IPA, are based on the extent to which each organization will benefit from the assignment. Since individuals on IPA assignment are deemed employees of the U.S. Government, there are no restrictions on the positions that they can fill. For example, they can make financial decisions and have unfettered access to information.

International opportunities for technical exchanges exist via the Engineer Scientist Exchange Program (ESEP). The ESEP is a professional development program that promotes international cooperation in military research, development, test and evaluation (RDT&E) through the exchange of U.S. Military and/or U.S. Government civilian scientists and engineers. The ESEP provides onsite working assignments for foreign personnel in U.S. Defense (government) establishments, and for U.S. personnel in 17 foreign defense (government and contractor) establishments. The work assignments provide ESEP personnel work experience and knowledge of the organization and management of that defense establishment by performing duties under the direction of a host supervisor. ESEPs are typically assigned for one year, although shorter assignments of several months may be authorized on occasion. ESEPs may also be extended past the initial one year assignment at the discretion of Office of the Deputy Assistant Secretary for Defense Exports and Cooperation (DASA [DE&C]), and are subject to the availability of funding. The international partner pays all costs associated with the placement of international ESEP participants in the U.S. (pay and allowances, travel to and from host country, movement of dependents and household effects, etc.). The only exception is for travel, per diem, and Temporary Duty (TDY) costs done at the request of the host country in performance of assigned ESEP position duties.

To engage the spirit of inventors and entrepreneurs within the Open Campus ecosystem and expand the small business economy, ARL is championing entrepreneurial leave opportunities under the ARL Separation Program. This program enables ARL civilian employees to seek entrepreneurial endeavors independently or with collaborators, and promotes their mobility from government service to the private sector with the option to receive





priority consideration to re-enter the ARL workforce. This program expands technological skillsets with changing technological trends, enhances innovation, and promotes the flow of talent between the federal government and private sector. ARL employees are encouraged to start up and operate their own business and expand their knowledge base to meet the needs of the Laboratory.

SHARED MODERN FACILITIES

ARL recognizes the mutual benefit of leveraging expertise, facilities, and capabilities on an international scale in an economically constrained environment. Through the Open Campus framework, ARL scientists and engineers conduct research side-by-side with visiting scientists in ARL's facilities, and as visiting researchers at collaborators' institutions.

The goal of opening ARL's campuses is to facilitate side-by-side collaboration with the national and international S&T community in the pursuit of Army-relevant fundamental research.

ARL has focused on building a capability for international research partners to freely perform research in ARL's facilities, adopting a phased approach to facilitate the engagement of the global science and technology community, build research networks, and jointly leverage specialized facilities and infrastructure. ARL is partnering with local, state, and regional economic development organizations to incubate small business start-up companies that are

selected in partnership with government and private agencies, and working with Partnership Intermediaries to enhance Research and Development (R&D) partnerships between ARL, academia, industry, other government agencies, and entrepreneurs.

COLLABORATIVE S&T ECOSYSTEM AND ENTREPRENEURIAL CULTURE

ARL's Open Campus is focused on building a science and technology ecosystem that is aligned with the strategic areas of interest of both ARL and the U.S. Army. To facilitate the goal of increased collaboration and engagement in the expanding Open Campus S&T ecosystem, ARL continues to review and update its policies and uses several mechanisms to empower collaboration through shared modern facilities. ARL's Open Campus will develop a diversified national "hub-and-spoke" infrastructure to more effectively partner across the national and international S&T ecosystem. ARL's OC leverages the expertise, capabilities, and facilities of ARL and its partners; and ARL encourages potential partner organization to do the same to develop the ability to effectively and efficiently leverage state-of-the-art facilities and infrastructure.

The leveraging of state-of-the-art facilities and infrastructure provides an effective solution to the ever increasing complexity and cost of scientific research for ARL and its collaborators. As part of the Open Campus business model, ARL is opening its specialized laboratory facilities to the global academic community, industry, small businesses, and other government laboratories through collaboration

with ARL's research staff. Designated portions of ARL's facilities are being opened to enable free movement of academic and industrial partners working with ARL researchers on basic and applied research. Wired and wireless commercial networks have been installed to enable visiting researchers to link their personal computer equipment to their home networks as they engage in collaborative research with ARL partners. ARL's laboratories, testing facilities, and ranges offer many one-of-a-kind facilities around the nation. ARL's primary laboratory locations include the Adelphi Laboratory Center (MD), Aberdeen Proving Ground (MD), Orlando



(FL), and White Sands Missile Range (NM). ARL's facilities are described in the "Facilities" segment of ARL's Open Campus website: www.arl.army.mil/opencampus/. Alignment of collaborative opportunities that use these facilities and active collaboration opportunities are regularly updated in the "Collaboration Opportunities" segment of the Open Campus website.

ARL is establishing Research Centers in strategic, enduring S&T areas such as but not limited to 1) Center for Research in Extreme Batteries (CREB), 2) Center for Semiconductor Materials and Device Modeling (CSDM), 3) Atmospheric Sciences Center, 4) Network Science Research Center, 5) Intelligent Systems Research Center, 6) Center for Adaptive Soldier Technologies (CAST), and 6) Expeditionary Manufacturing Science Center. The centers will be established across the S&T ecosystem as a consortium of Open Campus partner organizations leveraging expertise, facilities, and capabilities on an international scale to bring together consortia to address challenging research problems critical to the U.S. Army and National Security. The Centers are at various stages of development, and are attracting national and global research partnerships. Examples include joint research efforts being pursued in ARL's state-of-the-art 15,000 ft² class 10/100 specialty electronics clean room, and in ARL's high performance computing facilities that are dedicated to Open Campus collaborative research projects.

ARL's Open Campus approach is a "research multiplier," designed to maintain and expand a strong collaborative network of researchers while providing opportunities to develop new research directions of common interest.

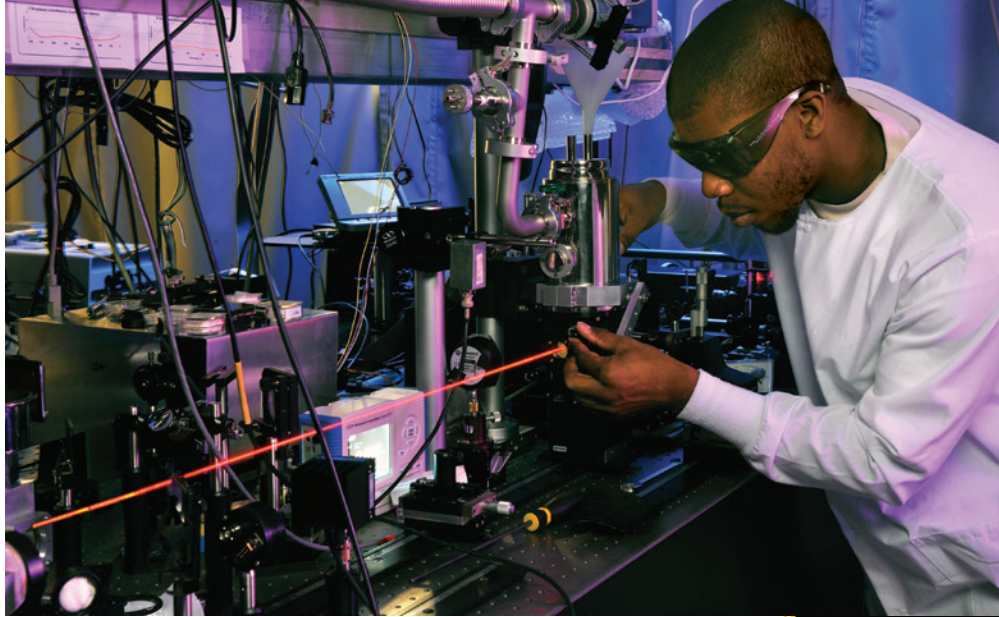


ARL has started to physically expand its global presence by establishing new ARL satellite campuses to enable access to regional human resources and broader outreach to building international relationships. An example is the ARL West campus in Playa Vista, CA, where staff members are recruited from Southern California to work on challenging U.S. Army programs in ARL laboratory space and to develop strategic partners throughout academic and private sector partners in California.

The Open Campus initiative is also using Enhanced Use Lease (EUL) authority to offer opportunities for public-private partnerships with a vision toward building research park environments on U.S. Army bases where ARL resides. These environments will enable a broader range of collaboration, development of co-located academic consortia to provide graduate education opportunities to ARL staff and residents of the broader local community, and help strengthen the international S&T network.

COLLABORATION TOOLS

The primary mechanisms used to establish Open Campus collaborative partnerships are Educational Partnership Agreements (EPAs) and Cooperative Research and Development Agreements (CRADAs). As detailed in the following, other mechanisms are also used for specialized circumstances.



EPAs are established between ARL and academic institutions to encourage and enhance joint education and research opportunities with academia in science, technology, engineering and mathematics (STEM) disciplines relevant to ARL science and technology programs. Under EPAs, visiting students and professors, including those with international citizenship, can access ARL's research facilities and collaborate with subject matter experts in their fields of interest. Benefits to educational institutions include access to ARL's specialized research facilities, receipt of ARL's excess laboratory equipment, and opportunities for research experiences on ARL's projects, enhancing students' interest in STEM disciplines through collaboration and internships. EPAs provide a mechanism for ARL researchers to serve as adjunct faculty, collaborating with educational institutions and helping to develop and implement cooperative education programs for undergraduate and graduate education.

CRADAs provide an easy way to establish a collaboration with ARL. CRADAs are formal agreements between one or more federal laboratories and one or more non-federal parties (e.g., small business, industry, or academic institution) under which the government and the non-federal party jointly provides personnel, facilities, equipment or other resources to conduct specific research or development efforts that are consistent with the mission of the laboratory. The CRADA outlines intellectual property protection for all parties. Under a CRADA, ARL may receive financial contributions, but funds may not be sent to the partner. CRADAs are appropriate when ideas, staff, materials and equipment are to be shared over a period of time for the purpose of collaboration and/or if an invention may result. Joint work statements (JWS) are developed by the collaborating principal investigators that outline each collaborator's contributions, and describe the research to be performed. CRADAs are ideally developed at the institutional level (e.g., between ARL and an entire university or corporate system) to enable the development of multiple JWS within the system.

International armaments cooperation programs have the potential to significantly improve interoperability for coalition warfare, leverage other program resources, and obtain the most advanced, state-of-the-art technology from the global technology and industrial base. ARL recognizes that armaments cooperation programs offer unique opportunities for promoting U.S. security and technology advancement. To meet these objectives, ARL has collaborated with traditional foreign allies and reached out to new foreign partners. ARL is the proponent for dozens of Data Exchange Annexes (DEAs), Project Agreements (PAs), and

Memorandums of Understanding (MOUs) with foreign military R&D partners that are used to augment current R&D efforts and future military platforms. ARL will also explore the use of International CRADAs as a novel way to engage with foreign universities.

Patent License Agreements (PLAs) are another engagement opportunity where an agreement by ARL permits a licensee to practice patented invention in return for valuable consideration. Under Open Campus, ARL takes an aggressive approach to actively market government generated intellectual property with small business and industry. ARL will collaborate with partners under a CRADA to advance the current state-of-the-art technology under the PLA and look to transfer these capabilities to the Soldier or to the commercial sector. These activities will affect the regional industrial base by creating jobs and generating revenue for all parties involved.

Personnel exchanges with both domestic and foreign partners may be facilitated by a number of existing mechanisms to include CRADAs, EPAs, and other cooperative mechanisms previously mentioned. These exchanges may last a few weeks to a few years, depending on the level of effort required. The ARL STEM Program and Army Education Outreach Program (AEOP) also supports the next generation of scientists and engineers by providing exposure to our facilities and technical staff during meaningful technical engagements. These outreach programs help to build the pipeline for the future technical U.S. workforce.

Collaborations with other U.S. federal laboratories will be facilitated through a memorandum of agreement or an MOU. These formal documents will shape the technical arrangements between federal laboratories and facilitate the exchange of technology, personnel, funds, and facilities.

SUMMARY

ARL's Open Campus business model is building the framework for a global science and technology ecosystem that will foster an agile, efficient, and effective research environment supporting the continuous flow of people and ideas to ensure transformative scientific discovery, innovation, and technology transition beneficial to national security.

ARL is expanding the use of existing policies and advocating new policies to open the doors to employee and visiting researcher exchanges within a globally distributed "hub-and-spoke" model. ARL is establishing specialized Research Centers that are attracting industrial and academic partners and investment focused on Defense-related research. A variety of tailored collaborative agreements protect the intellectual property of all parties, ensuring the confident pursuit of joint research. The entrepreneurial environment created by the Open Campus business practices encourages discovery through intellectual collaboration and fluid motion of researchers, innovation through sabbaticals and start-up companies, and transition through growth in patent licensing and technology transfer.



Open Campus practices are enabling ARL to become one of the best places to work by empowering work-life balance, enabling expansive cutting-edge research, expanding the number and diversity—intellectual, regional, cultural, gender, and age – of staff, and expanding science and technology capabilities through leveraged infrastructure investment.

ARL's Open Campus is transforming the national security research culture, and will have a profound positive impact by accelerating the pace of innovation to provide increased capabilities for the Warfighter.

ENDNOTES

¹ *History of the Naval Research Laboratory*. <http://www.nrl.navy.mil/about-nrl/history/>. 2013. [date of access]

² *Unlocking Our Future: Toward a New National Science Policy*. U.S. House of Representative Committee on Science. 1998.

³ Bush, Vannevar. *Science – The Endless Frontier, A Report to the President*. July 1945.

⁴ *Defense Laboratory Enterprise*. <http://www.acq.osd.mil/rd/laboratories/>. 2013. [date of access]

⁵ *Transformation and Opportunity: The Future of the U.S. Research Enterprise*. President's Council of Advisors on Science and Technology (PCAST). November 2012.

⁶ [Federal workforce trends in 2015: Finding and keeping the right talent is top priority]

