Science and Technology

The Army's Science and Technology (S&T) mission is to "foster invention, innovation and demonstration of technologies to enable Future Force capabilities while exploiting opportunities to transition technology-enabled capabilities to the Current Force." The U.S. Army depends on its S&T Program to research, develop, and demonstrate high-payoff technological solutions to hard problems faced by Soldiers in the ever-changing, complex environments across the full spectrum of conflict. In order to prevent, shape, and win future conflicts in an uncertain, complex world, Army S&T delivers timely technology solutions that address the Army's top priority capability gaps, while investing in developing technology solutions that Soldiers will need in the future.

ARMY S&T MISSION

FOSTER INVENTION, INNOVATION AND DEMONSTRATION OF TECHNOLOGIES TO ENABLE FUTURE FORCE CAPABILITIES WHILE EXPLOITING OPPORTUNITIES TO TRANSITION TECHNOLOGY-ENABLED CAPABILITIES TO THE CURRENT FORCE

The Army's S&T Enterprise includes Research, Development, and Engineering Centers (RDECs) and laboratories, depicted in Figure 1, with more than 12,000 scientists and engineers who are committed to ensuring Soldiers have the technological edge in any environment, against any possible adversary. S&T programs and projects also include participation from academia, industry, and other organizations such as University Affiliated Research Centers (UARCs) and Federally Funded Research and Development Centers (FFRDCs). Our vision is to provide technology-enabling capabilities that empower, unburden, and protect our Soldiers and warfighters in an environment of persistent conflict

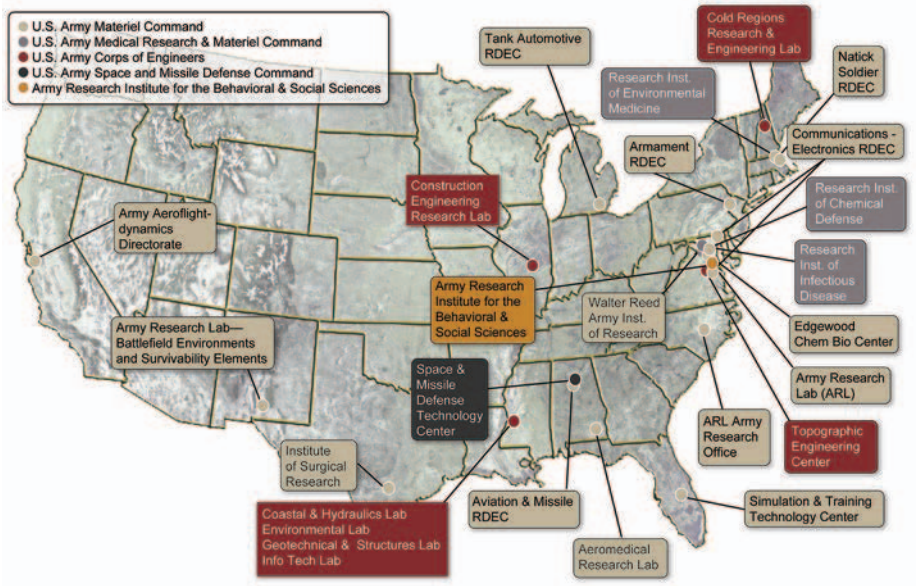

Figure 1: The Army S&T Enterprise

SCIENCE AND TECHNOLOGY TENETS

It is the objective of Army S&T to maintain Army-critical enabling technologies (Army Campaign Plan, 5-6). The Army S&T program balances investments in innovative, game-changing "revolutionary" research with other investments in more "evolutionary" research to advance performance of existing and developing warfighting systems. Underpinning all S&T research is a commitment to strong business practices, which ensures efficient and appropriate investment across the S&T enterprise. The Army's S&T program is guided and directed by Army leadership and is based on the following tenets:

Innovative, Revolutionary S&T

- Create future Army mission capabilities via technical innovation, especially in areas with the greatest potential utility to Soldiers and small units
- Prepare for an uncertain future by researching and developing leap-ahead and disruptive technologies that can be matured and demonstrated to provide advanced capabilities in accordance with identified Army warfighter technology gaps

Advancing Performance of Warfighting Systems

- Provide research and engineering that can rapidly provide solutions for urgent needs in current operations and/or to assist Acquisition Programs to achieve threshold and objective requirements
- Demonstrate advanced technologies and manufacturing methods that will reduce lifecycle costs of future systems and enable more effective, efficient, affordable systems through upgrades

Effective Business Practices

- Invest in areas where Army must invest because no one else will (i.e., take the lead); leverage other service laboratories, Department of Defense (DoD) laboratories, academia, industry, and international partners for everything else
- Maintain critical in-house Army research facilities (in 22 organizations in 5 commands), workforce, and capabilities in areas where the Army must lead in invention and innovation
- Synchronize our S&T programs and major efforts with fiscal processes and Army Force Generation (ARFORGEN) timelines determined by needs of the warfighter
- Develop strong partnerships throughout the Army, especially with the Training & Doctrine Command (TRADOC), Acquisition, and Threat Communities, as well as with the Soldiers in the Active and Reserve Components, so that there is a greater understanding of the value of Army S&T and its endeavors

RESOURCING S&T

The Army S&T budget is apportioned within the Research Development Test & Evaluation (RDT&E) appropriation, as follows:

≈20 percent to Basic Research, which seeks to:
- Obtain knowledge for an uncertain future through invention and discovery
- Understand theories and phenomena that may impact Army needs

≈35 percent to Applied Research, which seeks to:
- Conduct research and apply knowledge and understanding to specific Army problems and challenges
- Conceptualize, design, and experiment with components, subsystems, models (discovery and innovation)

≈40 percent to Advanced Technology Development, which seeks to:
- Mature, develop, and integrate technologies at sub-system and system level
- Demonstrate feasibility of technology-enabled capabilities
- Define transition paths to accelerate introduction of technology-enabled capabilities to the warfighter

≈4 percent in Technology Maturation Initiatives which are designed to take selected technologies above Technology Readiness Level 6 (TRL6) in order to facilitate transition, or to conduct competitive prototyping in accordance with the principles of the Weapons Systems Acquisition Reform Act for technologies that have high probability of transitioning to Army Programs of Record (PORs) soon

≈1 percent in Manufacturing Technology, which is focused on advancing the ability of the U.S. industrial base to manufacture affordable key advanced technologies

Army S&T will invest to provide effective, affordable, and supportable solutions for Army needs. For FY 13, the Army has dedicated more than $2 billion to its S&T programs: $444 million in Basic Research, $875 million in Applied Research, $891 million in Technology Development, $25 million in Technology Maturation, and $60 million in Manufacturing Technology.

ARMY S&T IN ACTION

The Army S&T community is organizing its investments into programs which address major investment priorities. Near-term integrated capabilities are developed with Advanced Technology Development and some late stage Applied Research funds to address the aforementioned capability gaps. Today, the Army S&T community is addressing these capability gaps in Technology-Enabled Capability Demonstration (TECD) programs, which either measurably enhance performance and effectiveness of an existing capability, or enable a new and necessary capability for the Soldier. The culminating event for the TECD is an integrated demonstration of the enhanced capability in a relative environment. In early FY12, Army senior leadership approved nine TECD programs.

In addition, several major S&T programs have been developed based on their visibility across the Army and the DoD. Each of these programs is managed with well-defined deliverables and transition commitments.

The major S&T programs and nine TECDs are detailed in the portfolio descriptions included in this section.

S&T PORTFOLIOS – DEFINING THE ARMY'S CAPABILITIES OF TOMORROW

Army S&T investment portfolios support Army modernization goals to develop and field affordable equipment in a rapidly changing technological environment by fostering invention, innovation, maturation, and the demonstration of technologies for the current and future fight. The Army S&T program is organized into investment portfolios that address challenges in six capability areas: four Army-wide areas (Air; Soldier; Ground; Command, Control, Communications, and Intelligence (C3I)) and two areas unique to S&T (Basic Research and Innovation Enablers).

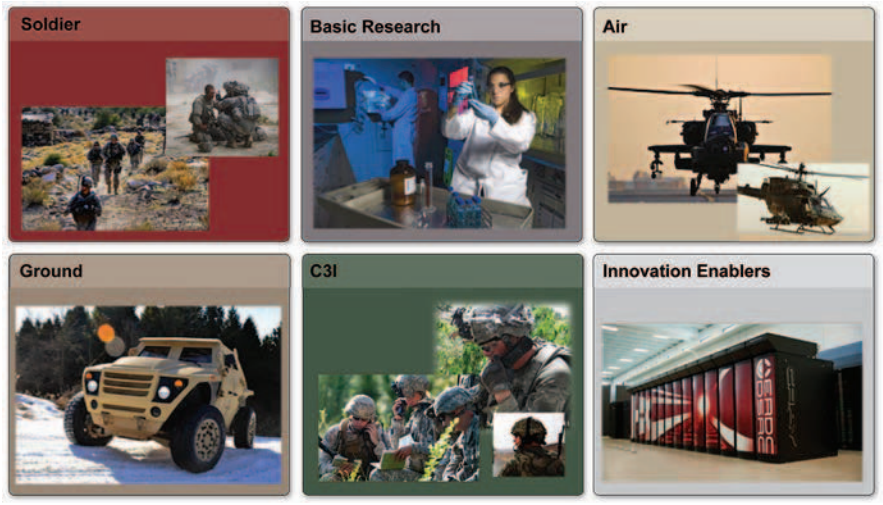

Figure 2: The six Army S&T investment portfolios

SOLDIER S&T PORTFOLIO

The Soldier S&T portfolio researches the science of human performance and matures and demonstrates technologies for the Soldier and squad across a host of supporting sub-portfolios detailed in Figure 3. The efforts of this portfolio are designed to maximize the effectiveness of squad performance as a collective formation.

Figure 3: The Soldier S&T Portfolio and its six sub-portfolios

Technology-Enabled Capability Programs within the Solider portfolio include:

- Force Protection – Soldier and Small Unit which will develop and demonstrate technologies that increase protective gear performance while reducing weight and volume—protection from weapon threats, blast, fire, insect-borne diseases, weather conditions, and chemical/biological threats by FY16.
- Medical Assessment and Treatment which will develop and demonstrate capability to assess, diagnose, treat, and rehabilitate Soldiers who have been exposed to ballistic and blast events or other insults by FY16.
- Individual Training to Tactical Tasks which will develop and demonstrate self-training mechanisms that can monitor and track Soldier learning needs, assess and diagnose problems, and guide Soldiers through training events, provide effective performance feedback, select appropriate instructional strategies, anticipate and seek out information and learning content tailored to the learner's needs, and provide other assistance as needed by FY17.
- Overburdened – Physical Burden which will demonstrate technologies that reduce the weight and volume of items that individual Soldiers in a small unit must physically carry to accomplish their missions, while maintaining or increasing the ability of the unit to perform tasks, whether dismounted or in vehicles, by FY16.
- Sustainability/Logistics – Basing which will develop technologies to reduce supply demands, and reduce waste at small bases to sustain the small unit for the duration of the mission at lower cost and lower risk without adversely impacting primary mission accomplishment by FY17.

Major Efforts

The Soldier Portfolio also includes the following major efforts:

A major program within the Soldier Survivability sub-portfolio is the Warrior Injury Assessment Manikin (WIAMan) Medical Research Program (Figure 4). WIAMan provides medical program management for the effort to develop an improved blast manikin test device for the Live Fire Test and Evaluation (LFTE) Program. This program seeks to provide an enhanced capability to measure and predict combat vehicle occupant injuries during underbody blast events. The project will evaluate skeletal injuries to occupants during vehicle underbody blast events, which will be used with the medically validated set of skeletal injury criteria and the improved blast test manikin to improve LFTE evaluation capability, vehicle design, and soldier survivability.

Figure 4: The WIAMan program

The Military Infectious Diseases Research Program (MIDRP) manages research for the DoD on infectious diseases with a focus on protecting the warfighter by developing vaccines, drugs, diagnostics, and vector control. The U.S. military has been notably successful in this undertaking; since World War I, deaths from naturally occurring infections have not exceeded deaths due to combat injury in wartime. MIDRP's role is of continuing importance because diseases such as malaria, dengue fever, diarrhea, and leishmaniasis continue to have an adverse impact on military operations and the health of service members. MIDRP has supported HIV vaccine research and development since 1985 as HIV remains a significant threat to service members deployed overseas and is a major source of regional instability in areas of U.S. force protection. The MIDRP HIV research program is heavily engaged with efforts of other U.S. government agencies. The National Institute of Allergy and Infectious Disease (NIAID)is a major partner of MIDRP-supported HIV vaccine development activities. MIDRP also develops preventive medicine products to reduce insect and vector-borne disease transmission, such as improved repellents suitable for the military operational environment, bed nets and other products that enhance medical officers' ability to minimize disease threats in the field. DEET is a successful example. This repellent was developed in collaboration with the U.S. Department of Agriculture (USDA), introduced to the public in the 1950s, and has become by far the most common insect repellent used throughout the world today.

The are several Combat Casualty Care efforts related to Traumatic Brain Injury (TBI). The Combat Casualty Care Research Program Neurotrauma research portfolio is organized as a continuum of care model that includes eight phases: Basic Science/Epidemiology, Prevention/Education/Training, Head Impact/Blast, Screening, Assessment, Treatment, Recovery, and Return to Duty. The portfolio includes 472 projects, with 347 of these projects including a mild TBI component and 354 of these projects including a moderate to severe TBI component. Although we have improved diagnostic and treatment guidelines and therapies, recent research indicates that TBI and especially repeated mild exposures may lead to chronic neurodegeneration, mild cognitive impairments, mood disorders, and chronic traumatic encephalopathy. Combat Casualty Care also conducts research in rehabilitative medicine to enhance the ability to diagnose, stabilize, and accelerate wound healing and repair for casualties.

GROUND S&T PORTFOLIO

As depicted in Figure 5, the Ground S&T Portfolio includes technologies across four sub-portfolios that address survivability, weapon systems, active and passive protection systems for ground vehicles, manned and unmanned ground platforms and mobility systems, countermine/counter-IED efforts, and deployable small base protection.

Figure 5: The Ground Portfolio vision and sub-portfolios

Major Efforts

The Ground Portfolio is developing protection from underbody blast threats. In the past we designed vehicles with little consideration for accommodating Soldiers—focusing more on mission capabilities. Today we are beginning to explore ways to design vehicles around Soldiers.

Technology-Enabled Capability Programs within the Ground S&T portfolio include:

- The Occupant Centric TECD program, which provides the mechanism to develop, design, demonstrate, and document an occupant-centered Army ground vehicle design that improves vehicle and Soldier survivability by mitigating Soldier injury due to underbody IED and mine blasts, vehicle rollover, and vehicle crash events. This design philosophy considers the Soldier first, integrates occupant protection technologies, and builds the vehicle to surround and support Soldiers and their mission. To this end, Army S&T is developing an occupant-centric survivability concept design demonstrator, as well as platform-specific demonstrators with unique occupant protection technologies tailored to the platform design constraints. We are also publishing standards for occupant-centric design guidelines, test procedures, and safety specifications as well as improving Modeling and simulation capabilities and toolsets.

  We have developed tools and methods which have led to system-level evaluations through modeling and simulation resulting in improved Live Fire Test and Evaluation, faster delivery of technologies to theater/customers, and necessary characterizations of threats, systems and environment. We continue to look at a full range of technologies to address underbody blast events, from modeling and simulation and physiological studies to seats, restraints and energy-absorbing materials. This TECD will complete in FY15.

- Force Protection – Basing which will demonstrate an ability to construct and protect a 300-person combat outpost (COP) or patrol base (PB) in 30 days with integrated sensing and defense capabilities. Additional payoffs expected from this TECD include increased Soldier availability for mission tasks vice set-up and security tasks; force protection levels comparable to larger forward operating bases; decreased combat outpost tear-down time to less than four days and up to a fifty percent increase in reusable materials. This TECD will complete in FY17.

Figure 6: Occupant-Centric TECD

Within the Survivability Sub-Portfolio:
Another major effort is Deployable Force Protection (DFP), which is exploring technologies to improve survivability of small patrol bases and forward operating bases. In 2012, this S&T Program developed designs and methods to quickly establish mortar pits and provide overhead cover using modular systems that incorporate blast and ballistic protection. Members of the DFP team worked with troops on design and employment options. The 82nd Airborne Division will deploy in 2012 with a number of modular protective mortar pit and overhead cover systems; these will be used in an operational assessment in theater. Use of these systems will save of dozens of hours typically spent establishing mortar pits and protection and will increase the associated level of protection for Soldiers.

The Extended Area Protection & Survivability (EAPS) program addresses range, coverage, and performance limitations in protection against rocket, artillery, and mortar (RAM) attacks. The EAPS program encompasses high-risk, robust performance missile and gun technology developments required to provide a capability for 360-degree protection against asymmetric, multiple-threat, simultaneous RAM attacks. The Aviation & Missile Research, Development, and Engineering Center manages the development of two EAPS missile-technology programs; one, a miniature hit-to-kill interceptor with a semi-active radio frequency seeker; the other, a command-guided interceptor with a forward-firing warhead. The EAPS gun-technology program, managed by the Armaments Research, Development, and Engineering Center, manages the development of a command-guided, course-correcting 50mm artillery-round and a rapid-fire auto cannon. In 2011, the U.S. Army received approval to acquire a robust next-generation counter-RAM system to replace what has been fielded, the Indirect Fire Protection Capability Increment 2-Intercept program. The program strategy is to leverage the EAPS technology if the output from the recommendations of the Analysis of Alternatives is to pursue development of either a gun or missile solution based on the EAPS designs. A program Milestone A decision is anticipated in 2013.

AIR PORTFOLIO

The Air Portfolio includes technologies for manned and unmanned systems; air-delivered lethality; and air-platform safety, survivability and protection. These and other efforts are depicted in Figure 7.

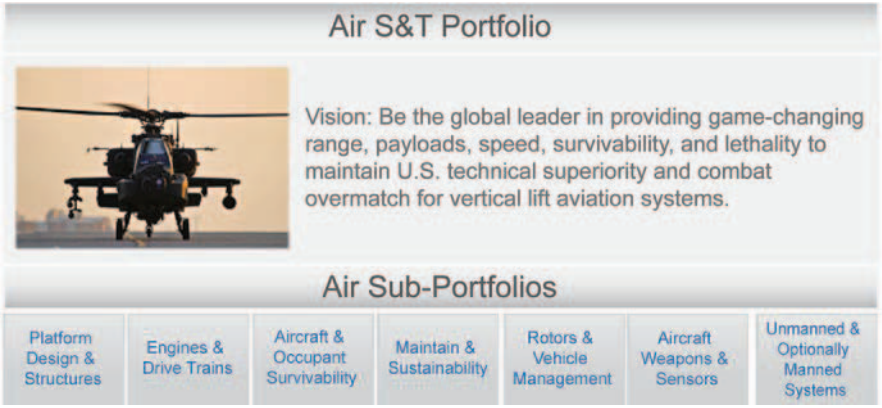

Figure 7: The Air Portfolio and its 7 sub-portfolios

Major Efforts

The major effort within the Air Portfolio, and shown in Figure 8, is the Joint Multi-Role (JMR) Technology Demonstration program, a key facilitator of Future Vertical Lift (FVL). In FY11, the Army, Navy, and NASA agreed to use a common toolset and database and are collaboratively sharing in the definition of a model performance specification for FVL medium, an aircraft intended to replace our Blackhawk/Seahawk and Apache fleets. Three different configurations of representative FVL aircraft have been designed as concepts by the government: a conventional helicopter, a large-wing slowed rotor compound, and a tilt rotor. Seven design excursions have been investigated, fully exploring the size and environmental characteristics of interest, including shipboard operations. In FY13, the design and fabrication phase of two flight demonstrators will begin with flight testing scheduled to begin in FY17.

Figure 8: Future Vertical Lift/Joint Multi-Role Program

While many of our rotorcraft research efforts are focused on the development of technologies for transition to new platforms in 2025 and beyond, Army S&T is also investing to keep the current fleet effective. One recent transition success has been the Advanced Affordable Turbine Engine (AATE), a 3000-shaft horsepower engine with 25% greater fuel efficiency and 35% reduced lifecycle costs. In FY12, AATE transitioned to Program Manager (PM) - Utility for Engineering and Manufacturing Development under the Improved Turbine Engine Program, which will re-engine our Blackhawk and Apache fleet.

COMMAND, CONTROL, COMMUNICATIONS & INTELLIGENCE (C3I) PORTFOLIO

The C3I Portfolio, detailed in Figure 9, includes technologies for ground, air, and Soldier communications devices and networks, air and space sensors, intelligence, electronic warfare (EW), cyber and network payloads, and mission command. The key to successful operations in an increasingly complex battle space is secure, seamless, and timely communications across all echelons, from headquarters to the Soldier. As such, the C3I portfolio aims to provide Soldiers at the tactical edge with trusted and responsive sensors, communications, and information adaptable in dynamic, austere environments to support battlefield operations and non-kinetic warfare.

Figure 9: C3I Portfolio and sub-portfolios

Major Efforts

A major effort in the C3I portfolio combines enhanced mission command capabilities for the Soldier and small unit with improved actionable intelligence that is pertinent to the squad's mission using mobile networks to connect the squad to higher echelons. The Mission Command and Actionable Intelligence TECDs will reduce tactical surprise and achieve overmatch at the squad level by providing the intelligence and mission command (MC) tools to the tactical edge that allow leaders to synchronize action, seize the initiative, and maintain situational awareness. These TECDs will complete in FY15.

Within the Sensors sub-portfolio a major effort is the Infrared (IR) Revitalization program, an innovative effort to help maintain Department of Defense proficiency in IR sensors. The program is focused on developing new semiconductor materials for higher temperature focal plane arrays and advanced digital read out integrated circuits for the next generation of sensors.

Within the Mission Command sub-portfolio, Army S&T is providing solutions to improve command and control, situational awareness, and dynamic communications, while maintaining appropriate military security not found in commercial devices. In order to exploit the full range of capabilities that smart devices offer the Soldier, we need an adaptive network in an on-the-move (OTM) environment; handheld devices that provide Soldiers with the necessary decision and communications capabilities with an intuitive interface; and appropriate security protection against potential cyber threats on the battlefield.

Army mobile network research efforts are increasing network efficiency and reliability, increasing OTM connectivity and bandwidth use, and allowing for reliable message delivery in difficult communications environments. Our mission command efforts are aimed at providing Soldiers and small units with the kinds of data-driven decision tools once available only to higher echelons. As our defense strategy moves to a smaller, more agile force, it is critical that small units and individual Soldiers have access to accurate and relevant situation awareness information including geospatial and meteorological data, combat identification and battle space awareness, as well as full-spectrum decision support tools.

Within the intelligence/electronic warfare sub-portfolio, Army research is focusing on identifying, locating, neutralizing, and protecting against electronic threats on the battlefield while coordinating EW and cyber capabilities while maintaining interoperability between EW transmissions and Blue Force communications.

The most useful tools are worthless if they are not properly secured. Security must address capabilities such as approved encryption for Secret and below, identity management, security policy management, exploitable applications, bi-directional cross-domain data transfer (Secret to UNCLAS) and security for computing, network and wireless infrastructure. Army S&T efforts in this area include authentication of approved applications and preventing the installation of rogue applications, providing Secret voice and data connections across disparate technologies including handheld devices, and developing a mutual authentication mechanism between users, handheld devices, and the network core.

Beyond the specific security efforts for mobile battlefield communications, the C3I portfolio also directs our broader cyber security S&T efforts. Our work in a resilient cyber security framework will provide a more secure foundation for participants, including cyber devices and software, to work together in near real time to anticipate and prevent cyber attacks, limit the spread of attacks across participating devices, minimize the consequences of attacks, and recover systems and networks to trusted states.

INNOVATION ENABLERS PORTFOLIO

The Innovation Enablers Portfolio includes technology development associated with environmental quality and installations, in the areas of sustainable ranges and lands, pollution prevention, military materials in the environment, and adaptive and resilient installations. This portfolio also includes the Department of Defense High Performing Computer (HPC) Modernization efforts and is detailed in Figure 10.

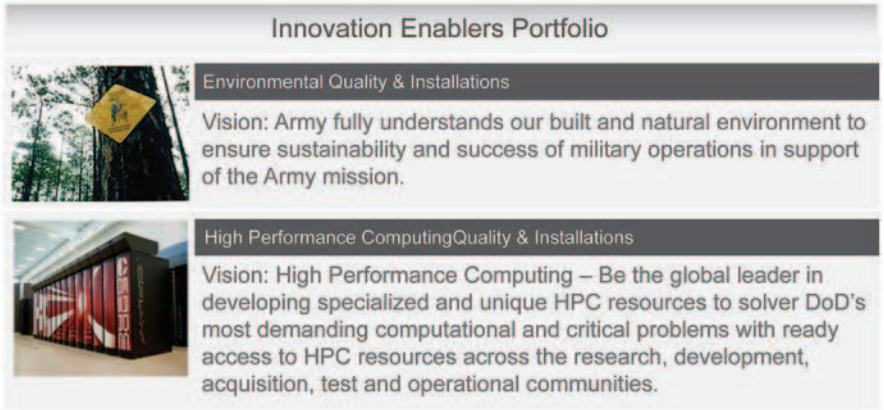

Figure 10: The Innovation Enablers Portfolio and its 2 sub-portfolios

The High Performance Computing Modernization Program (HPCMP) devolved from the Office of the Secretary of Defense to the Army in FY12. This program supports research and development in Army, Navy, Air Force, Marine Corps, and DoD agencies, by enabling advanced computational capabilities as a solution of first resort to explore and evaluate new theories. The HPCMP, shown in Figure 11, provides the hardware, software, and expertise to solve the complex problems faced by the RDT&E community and also reduces the time and cost of acquiring weapons systems and platforms through advanced computing, simulations, and calculations in support of military operations.

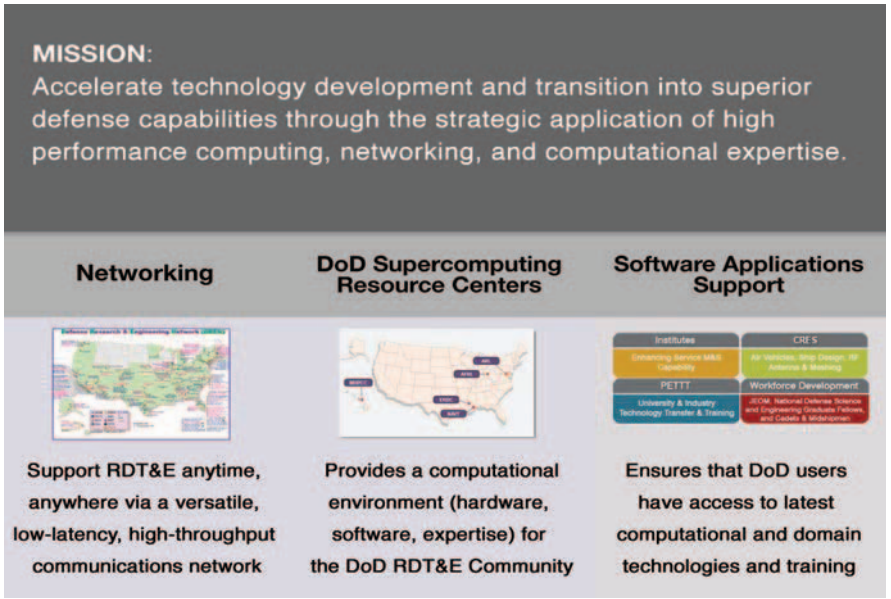

Figure 11: The High Performance Computing Modernization Program

BASIC RESEARCH PORTFOLIO

Underpinning all Army S&T efforts is a strong basic research program. Figure 12 details the vision and sub-portfolios of the Basic Research portfolio. Investments in Basic Research are critical to acquiring new knowledge in areas that hold great promise in advancing new and technically challenging Army capabilities and concepts—concepts that will enable revolutionary advances and paradigm-shifting future operational capabilities. Long-term exploration efforts look to discover or invent new technologies and capabilities relevant to the Army mission—we explore with a purpose. Our long-term disruptive technology investments are researching technologies that will change the rules of the playing field for our Soldiers. Long-term enabling research looks for innovative ways to move the inventions and discoveries into components and subcomponents and technologies that our labs and research partners can exploit. By doing this we enable future S&T applied research, advanced tech development, and capabilities. Taken together, this basic research provides the solid foundation for Army S&T.

Figure 12: The Basic Research Portfolio and its 5 sub-portfolios

Major Efforts

The following is a brief summary of select areas of investment noted above, the synergy among them, and some of the capabilities they may provide by sub-portfolio.

Within the Human Centric sub-portfolio:

Immersive Technology—the path to virtual reality training

The evolving threat environment continues to put increasing demands on the diversity and effectiveness of Soldier skills. To meet these demands, superior training tools and methods are needed. Virtual worlds can provide this capability; however, we are currently at primitive stages in their realization. With advances in computational processing and steady progress in understanding the brain's "software" comes the possibility of creating highly realistic virtual training environments inhabited by humanlike avatars. Such environments will create a paradigm shift in the way we provide training, while achieving low-cost, safe, low-environmental impact, highly variable simulation environments for the future training of our Soldiers.

Neuroscience—Understanding how the human brain works

Fundamental to the conduct of military operations is superior Soldier performance. Understanding how the human brain works—determining the brain's "software"—is the key to developing these capabilities. When embedded in a wide range of military platforms, this "software" will provide superior training methods and human system interfaces that will be tuned to an individual's characteristics, thereby resulting in superior Soldier performance. Research in this area will also dramatically advance our ability to prevent and treat those suffering from various types of battlefield brain injury.

Within the Information Centric sub-portfolio:

Network Science—managing complex military operations with greater speed and precision

Networks tie together the following: highly distributed sensor systems for reconnaissance and surveillance, information for decision-making, Soldiers, and the execution of fast distributed precision fires. Better-functioning networks advance our ability to conduct complex military operations with greater speed and precision. However, we know relatively little about network science and are

not yet realizing the potential that networks can provide on current and future battlefields. We are implementing a new multidisciplinary approach that combines communications, information, and the social/human component of networks. This approach changes the way we think about optimizing the use of networks. Advances in network science will allow us to predict and optimize network performance before we build them through the creation of wholly new design tools.

Within the Material Centric sub-portfolio:
Materials Modeling research develops fundamental scientific principles to develop underpinning, cross-cutting, and transferable physics-based modeling capabilities. Research focuses on two-way multi-scale modeling for predicting performance and designing materials. We also investigate analytical and theoretical analyses to effectively define the interface physics across length scales. In addition we aim to advance experimental capabilities for verification and validation of multi-scale physics, and modeling and strategies for the synthesis of high loading rate tolerant materials. The intent is to provide the Army with next generation multi-functional materials for ballistic and electronic applications, for light-weight vehicle and facility protection, and for energy storage and electronic devices, and to provide new materials to address the extreme challenges associated with understanding and modeling materials subject to Army operational environments. This research supports the development of computational tools, software, and new methods for material characterization to speed the process of discovery and development of advanced materials and make it less expensive and more predictable.

Biotechnology—leveraging four billion years of evolution
The increasing importance of and demands for wide-area persistent surveillance create significant challenges for sensor systems, real-time processing of vast amounts of data, the real-time interpretation of information for decision-making and power and energy requirements to support such demanding systems. Through four billion years of evolution, biological systems have engineered solutions to some of these challenges. We seek to leverage research in these areas to improve the performance of our Soldiers. Major investments in this area through reverse engineering will lead to totally new sensing systems, new ways to rapidly process data into information, the development of novel sense and response systems, and biologically inspired power and energy solutions.

Nanotechnology—dramatically changing our ability to manufacture new material by design
The last century was dominated by advances in the physical sciences through the discovery of the atom, its structure, and the laws that govern its behavior. This century will be dominated by the complex world of nanoscience, whose mysteries will be unraveled by our understanding of systems of atoms and molecules. Nanotechnology is the manipulation of matter on a near-atomic scale to produce new structures, materials, and devices. Nanotechnology research makes it possible to explore the emerging biotech field and dramatically change our ability to create new materials by design. This technology has the ability to transform many industries in discovering and creating new materials with properties that will revolutionize military technology and make Soldiers less vulnerable to the enemy and to environmental threats. Research in nanoscale technologies is growing rapidly worldwide. By 2015, the National Science Foundation estimates that nanotechnology will have a one trillion dollar impact on the global economy and employ two million workers, one million of whom may be in the United States.

Within the Platform centric sub-portfolio:
Autonomous Systems—extending the operational effectiveness of Soldiers through robotic systems
A major military objective is to totally frustrate and defeat our adversaries across a wide spectrum of conflicts while dramatically increasing the survivability of our Soldiers by keeping them out of harm's way. Autonomous systems of extraordinary capability can fulfill this objective; however, they must be completely safe and secure while operating in highly complex operational environments. Achieving such levels of capability will require significant investments in highly sophisticated sense, response, and processing systems to approach the capabilities of biological systems; major advances in artificial intelligence; the development of intelligent agents approaching human performance levels; and advances in machine learning, swarming, and actuation and control.

Quantum Effects—overcoming the limitations of Moore's Law
Increasing demand for information to support decision making on the battlefield requires advanced sensor systems to collect relevant data, as well as the means to process it into actionable forms. Major advancements in processing power are required to cope with the demand to process ever-larger amounts of data.

Investments in this area will exploit the massive parallelism of the quantum world to create computers that will dwarf the capabilities of the most powerful computers today, making them look like pocket calculators. The development of such computational systems will enable the embedding of high-performance computing in all military platforms, including the Soldier's uniform.

In 2012, Army S&T developed a process similar to TECDs to define a set of priorities for Basic Research and identify challenge statements against which programs can be proposed and approved. Moving forward, Army S&T will continue to refine these statements and develop long-term basic research programs and investments to meet these challenges for the Army of the future.

TECHNOLOGY TRANSITION – A KEY METRIC OF PERFORMANCE

Neither a technology nor a collection of technologies are useful unless accepted by someone and provided to the warfighter. A concept or technology can be matured and demonstrated to a Technology Readiness Level (TRL) 6 with S&T funds (Budget Activity 2 or 3). Products or deliverables of Army S&T programs can be knowledge products; experimental data on performance; hardware (devices, components, sub-systems, or prototype systems) or software; specifications, or concepts.

There are many ways that transition from S&T can happen.

- Transition can be to an Army Program of Record (POR) managed by a Program Executive Office (PEO). It is best practice to have a Technology Transition Agreement (TTA) between the S&T program and the PEO that specifies the S&T products or deliverables. A TTA is negotiated at the beginning of the S&T program and revisited every year to ensure that the effort remains on track and in alignment with the modernization strategy of the Army.
- Transition can be to a field element through a PEO or rapid fielding initiative—usually in cases of retrofits or solutions to problems with equipment identified in the field.
- Transitions can be through Joint Capability Technology Demonstrations (JCTDs), which provide capability demonstrations to combatant commanders along with leave-behind assets.
- Transitions can be to field units through the response to Operational Needs Statements (ONS) or Joint Urgent Operational Needs (JUONS).

- Transitions can be to an Army organization such as TRADOC, ATEC, a member of the Army S&T enterprise, the G-1, another DoD entity, or industry. These transitions are typically in the form of "knowledge products" that inform requirements such as analysis of alternatives; inform acquisition, such as a proof of concept or information to enable a milestone decision or a technology data package. These knowledge products can take the form of TTP or even science and engineering support for follow-on development, demonstration, experimentation, and assessments. Finally, these knowledge products can include standards, certification, accreditation, or test methods that will enable subsequent fielding of capabilities to the Army.

Many times transition of S&T is indirect because the research and technology maturation funded by S&T and executed by industry or university partners often becomes the technology solution provided years later to the government in response to competitive solicitations for systems.

The Army technology transition strategy is to address the principal causes of the chasm between S&T and acquisition. Army S&T will seek to improve:

- Systems integration: People performing on both sides of Budget Activity 3/ Budget Activity 4 or Budget Activity 3/Manufacturing Technology hand-off must have knowledge of the target system and understand system interfaces of target system/platform; we will strive to hire, retain, and utilize more systems engineers in S&T.
- Collaboration: We will seek to improve partnerships and maintain a more collaborative environment among all entities (S&T laboratories and centers, industry, PEOs/PMs, TRADOC).
- Accountability: S&T will strive to improve its program planning and execution—stressing accountability for the cost, schedule, and performance of technology products and solutions in all our efforts.
- Matching technology maturation and insertion cycle times: S&T will, where appropriate, use prototyping to facilitate timely insertion of rapidly developing technologies into PORs within constraints imposed by deliberate requirements, budgeting and acquisition processes.
- Time horizon balance: We will seek to revitalize "advanced concepting" and wargaming activities to provide game-changing concepts to inform requirements development and guide the maturation and transition of innovative technologies in the mid- to long-term.

SUMMARY

The Army Science and Technology (S&T) investments support Army modernization goals to develop and field affordable equipment in a rapidly changing technological environment by fostering invention, innovation, maturation, and demonstration of technologies for the current and future fight. As we continue to diligently identify and harvest technologies suitable for transition to our force, we aim to remain ever vigilant of potential and emerging threats. We will sharpen our research efforts to focus upon those core capabilities we will need to sustain for the future and also identify promising "leap-ahead" technologies able to change the existing paradigms of understanding. Ultimately, our focus remains upon Soldiers; we consistently seek new avenues to increase their capability and ensure their technological superiority—today, tomorrow and decades from now.