**STATEMENT BY**
**MS. MARY J. MILLER**

**DEPUTY ASSISTANT SECRETARY OF THE ARMY**

**FOR RESEARCH AND TECHNOLOGY**

**BEFORE THE**

**EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE**

**OF THE**

**HOUSE ARMED SERVICES COMMITTEE**

**ON**

# THE UNITED STATES ARMY'S SCIENCE AND TECHNOLOGY (S&T) PROGRAM FOR FISCAL YEAR 2016

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**UNITED STATES HOUSE OF REPRESENTATIVES**

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Chairman Wilson, Ranking Member Langevin, and distinguished members of the Subcommittee, thank you for the opportunity to discuss the Army's Science and Technology (S&T) Program for fiscal year (FY) 2016.

> *"Now more than ever, in today's uncertain and dynamic security environment, we must be prepared to meet multiple, wide-ranging requirements across the globe simultaneously while retaining the ability to react to the unknown. The velocity of instability around the world has increased, and the Army is now operating on multiple continents simultaneously in ways unforeseen a year ago. In short, our Army is busy."*[1]
>
> *— Sec John W. McHugh, Gen Raymond T. Odierno*

The Army faces a continued challenge – balancing force structure, operational readiness and modernization in an increasingly complex environment. The Chief of Staff of the Army (CSA) has identified the velocity of instability – the realization that what used to take our enemies months and years to disrupt may now take only days – as a key concern. The Army has developed a new Army Operating Concept (AOC), "Win in a Complex World" to address this new environment. Acknowledging the changing world around us, the AOC envisions the Army of the future as expeditionary, tailorable, scalable and prepared to meet the challenges of an increasingly global environment. The AOC sets the foundation upon which Army leaders can focus our efforts and resources to maintain both strategic and operational flexibility – to prevent conflict, shape the security environment and win wars now and in the future.

The path to get there is the Force 2025 and Beyond (F2025B) initiative – the Army's comprehensive strategy to create the Army of the future and deliver landpower capabilities as a strategic piece of the future Joint Force. F2025B envisions a series of improvements implemented over time to create Army forces that can conduct expeditionary maneuver, operating in multiple regions simultaneously. These forces must routinely operate with the initiative, moving and executing operations more swiftly

[1] The Posture of the United States Army, Senate Committee on Appropriations Subcommittee on Defense, United States Senate, March 11, 2015, pg i

than adversaries can fight or respond. To do this, we need forces that can be scaled and tailored to suit the terrain and enemy, and that our Joint Force can transport in quantities necessary to be decisive. These forces must possess the right combination of mobility, protection and lethality to defeat our adversaries and consolidate gains. Often this combination of capability will be specific to address the threats of the region of operations. The concept of Regionally Aligned Forces (RAF) is one that offers the ability to tailor equipment and Soldier expertise to a specific area of interest/deployment.

The Army S&T Enterprise[2] is postured to address these challenges and capitalize on opportunities by focusing not only on developing more capable and affordable systems, but also on understanding the complexity of the future environment. The timelines for science and technology innovation are long. The F2025B strategy looks at the Army of 2025 as a way point to the future and acknowledges that the needs of this force must be met with technologies that already exist within the S&T realm and are, in many cases, well into advanced development. The "Deep Future" Army (2040+) envisioned will exhibit dramatic new levels of capability, deployability and sustainability, while also being more affordable. The S&T investments the Army is making now will be relied upon to meet the critical requirements of the Army after 2025, many of which cannot be foreseen today.

> *"No one can predict where the next contingency will arise that calls for the use of Army forces. Despite our best efforts, there remains a high likelihood that the United States will once again find itself at war sometime during the next two decades. It is our job to be prepared for it."*
>
> *– 2014 Army Posture Statement*[3]

We are grateful to the members of this Committee for your sustained support of our Soldiers, your support of our laboratories and research, development and engineering centers and your continued commitment to ensure that funding is available to provide our current and future Soldiers with the technology that enables them to defend America's interests and those of our allies around the world.

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[2] The S&T Enterprise refers to ASA(ALT) and the Army S&T Executing Organizations, U.S. Army Materiel Command's Research Development and Engineering Command (RDECOM), U.S. Army Medical Command's Medical Research and Materiel Command (MRMC), U.S. Army Corps of Engineer (USACE) Engineering Research and Development Center (ERDC), U.S. Army Corps of Engineers (USACE), Space and Missile Defense Command/Army Forces Strategic Command (SMDC/ARSTRAT), Space and Missile Defense Command-Technical Center (SMDC-TC), and the Army G1's Army Research Institute for the Behavioral and Social Sciences (ARI).

[3] 2014 Army Posture Statement, March 2014, 32.

***Strategic Landscape***

The United States still faces a complex and growing array of security challenges across the globe as described in the 2014 Quadrennial Defense Report:

> *"Future conflicts could range from hybrid contingencies against proxy groups using asymmetric approaches, to a high-end conflict against a state power armed with WMD or technologically advanced anti-access and area-denial (A2/AD) capabilities. Reflecting this diverse range of challenges, the U.S. military will shift focus in terms of what kinds of conflicts it prepares for in the future, moving toward greater emphasis on the full spectrum of possible operations."*[4]

The future Army will be smaller and increasingly Continental United States (CONUS) based, yet must remain capable of conducting the full range of operations on land, including prompt and sustained land combat as part of large, multi-phase joint and multinational operations. The future operational environment is likely to have several characteristics that will have a significant impact on land force operations in the future, including increased momentum of human interaction and events, potential for overmatch, proliferation of weapons of mass destruction, increasing importance of the space and cyberspace domains, and demographics and operations among populations in complex terrains.[5] While the future force will become smaller and leaner, its great strength will lie in its increased agility, flexibility and ability to deploy quickly, while remaining technologically advanced.

While adversaries continue to invest in technology to counter or evade our strengths, resource reductions and insufficient force modernization place at risk our ability to overmatch opponents. To mitigate these risks, the Army must maintain high levels of readiness while also investing in future force modernization.[6] To maintain a decisive advantage over our enemies, the Army emphasizes the integration of advanced technologies with skilled Soldiers and well-trained teams.

You have heard from the Army leadership that decreases in the Army's budget have had a significant impact on modernization and threaten our ability to retain overmatch through the next decade. The fiscal challenge brought on by the Budget Control Act (BCA) continues to strain our ability to balance readiness, modernization and end strength – it puts at significant risk our ability to meet the Army's obligations within the Defense Strategic Guidance and fulfill its national security requirements.

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[4] 2014 Quadrennial Defense Review, March 2014, vii.
[5] TRADOC Pamphlet 525-3-1, *The U.S. Army Operating Concept: Win in a Complex World*, 7 October 2014, 9-10.
[6] FY2016 Budget Request and US Army Strategy, Readiness, and Equipment Modernization Testimony, 26 March 2015.

Despite these great pressures, the Army continues to protect its S&T investments critical to identifying, developing and demonstrating technology options that inform and enable affordable capabilities for the Soldier.[7]

### *A Balanced Approach to Modernization*

It is the Army's responsibility to address both current and emerging threats to ensure every Soldier deployed is equipped to achieve decisive overmatch regardless of the situation. As is often stated, we never want to send our Soldiers into a fair fight. To ensure a balanced modernization strategy, even under these austere fiscal conditions, we created long-term investment road maps across our investment portfolios. I spoke to this activity, our Long-range Investment Requirements Analysis (LIRA), last year as an effort being used within the Army to facilitate more informed program planning and budget decisions. The LIRA has put additional rigor into the development of the Army's budget submission, creating an environment where the communities who invest in all phases of the materiel lifecycle work together to maximize the Army's capabilities over time and strengthen the ties between the S&T community and their Program Executive Office (PEO) and Requirements community partners. This process has formed the basis of a balanced modernization strategy which is being implemented within the Army and addresses five key areas: (1) protect S&T investments in key technologies that will enable next-generation capabilities when resources become available; (2) selectively invest in new capabilities for priority areas; (3) incrementally upgrade existing platforms; (4) reset equipment returning from current contingency operations; and (5) divest select platforms to reduce operations and sustainment costs.

### *The FY16 Budget Request*

Over the next five years, we face a situation where decreases to the Army's overall budget are at odds with the increasingly uncertain and dynamic security environment. The Army has made difficult choices to maintain a minimum force level and operational readiness by slowing Army modernization. As a result, new programs will not be initiated as originally envisioned and the Army's S&T Enterprise will be challenged to better prepare for the programs and capabilities of the future. As part of this balanced modernization strategy, the Army has called upon S&T to focus on maturing technology, reducing program risk, developing prototypes that can be used to better define requirements and conducting experimentation with Soldiers to refine new operational concepts. The S&T community has been challenged to bring forward not only new capabilities, but capabilities that are affordable for the Army of the future.

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[7] The Posture of the United States Army, 2015 pg 2

Fortunately, senior Army and Department of Defense (DoD) leadership continue to recognize the importance of S&T efforts for bridging this gap in modernization, and our FY16 budget request holds steady at the level of our FY15 request of $2.3 billion. This includes $425 million in Basic Research (6.1), $880 million in Applied Research (6.2) and $896 million in Advanced Technology Development (6.3). This represents nearly 32 percent of Army Research, Development, Test and Evaluation (RDT&E) funds, and nearly 9.5 percent of overall Army Research, Development and Acquisition (RDA). Additionally, my office manages 6.4 funding for Technology Maturation Initiatives ($41 million in FY16) and 6.7 funding for Manufacturing Technology ($48 million in FY16). These funds allow for prototyping and experimentation in collaboration with our acquisition and requirements communities (6.4) and the development of new manufacturing processes and techniques to increase the affordability of existing and new Army systems.

However, the threat of sequestration continues to hang over all our heads. As Congress debates funding levels within the confines of the Budget Control Act, I urge you to keep in mind that without the fundamental work being done in S&T today, our forces are likely to face a future in which we can no longer claim technological superiority.

### *S&T Strategy*

The Army depends on its S&T program to help prepare for the future, mitigate the possibility of technical surprise and ensure that we are able to remain dominant in any environment. **The Army's S&T mission is to identify, develop and demonstrate technology options that inform and enable effective and affordable capabilities for the Soldier.** In alignment with this mission, the **Army's S&T Vision** is to **provide Soldiers with the technology to Win.** The S&T Enterprise must attract the best and brightest minds to apply their expertise to creatively solve difficult national security challenges and provide the flexibility and agility to respond to the many challenges that the Army will face.

While the Army will become smaller and leaner, it will focus investments and develop concepts and technology to become more lethal, expeditionary, and agile, with greater capability to conduct decentralized, distributed, and integrated operations. The Army will also focus on decisions and priorities regarding current technology to maintain overmatch, while driving critical capability and technology needed for the future.[8]

[8] TRADOC Pamphlet 525-3-1, "The US Army Operating Concept: Win in a Complex World," 7 October 2014, 9-10.

Innovation and technology continue to reshape the strategic environment, multiplying and intensifying the effects that even minor actors are able to achieve. Rapidly advancing technologies in many fields may become critical to military effectiveness; examples include autonomous systems, disruptive energetics, immersive training environments, quantum computing, synthetic biology, alternative power and energy solutions and unprecedented levels of networking capabilities. The Army will continue to develop countermeasures to future threat capabilities and pursue technological opportunities. However, enemies and adversaries will counter U.S. technological advantages through cover, concealment, camouflage, denial, deception, emulation, adaptation or evasion. Finally, understanding how humans apply technology to gain capabilities and train will become as important as the technologies themselves.

The technology playing field is changing. Important technology breakthroughs in many fields are now driven by commercial and international concerns. Our strategy acknowledges the imperative of a global, networked and full-spectrum joint force. It responds to the new fiscal environment and emphasizes new ways of operating and partnering. In a world where all have nearly equal access to open technology, innovation is a critical discriminator in assuring technology superiority.

The Army has identified enduring capability challenges that are necessary to conduct future operations to prevent, shape, and win conflicts, and are used to frame Army modernization. These challenges drive our S&T priorities, including the next generation rotorcraft and ground combat vehicles; modular and open architectures; directed energy weapons; materials research; the human dimension, including cognitive and physical loads, training and medical research; and securing information at the tactical edge. S&T develops these priorities within the context of the LIRA in order to develop a synchronized program that is nested within both the Army and National Military Strategies and balances across the near-, mid-, and far-term investments.

The nature of S&T is such that continuity and stability have great importance. Starting and stopping programs prevents momentum in research and lengthens the timelines for discovery and innovation. While the Army S&T portfolio gains valuable insight from the threat community, this only represents one input to the portfolio and likely describes the most probable future. To have a balanced outlook across all the possible futures requires that the portfolio also address the “possible” and “unthinkable.” The Army’s S&T portfolio is postured to address these possible futures across the eight technology portfolios identified Figure 1.

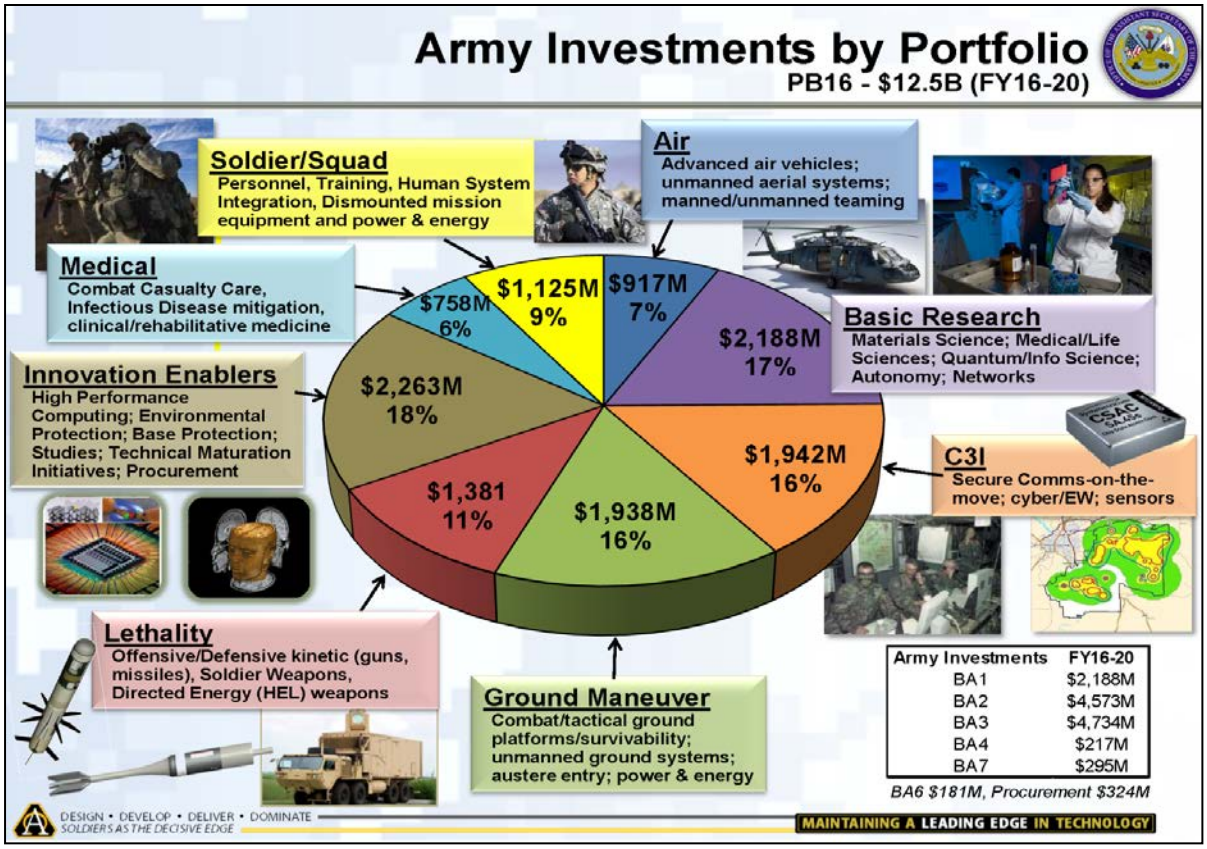


*Figure 1. Army S&T Investments by Portfolio*

The efforts of the S&T Enterprise are managed by portfolio to ensure maximum synergy of efforts and reduce unnecessary duplication. The S&T program is organized into eight investment portfolios that address challenges across six Army-wide capability areas (Soldier/Squad; Air; Ground Maneuver; Command, Control, Communications, and Intelligence (C3I); Lethality; and Medical) and two S&T enabling areas (Basic Research and Innovation Enablers). While we manage by technology portfolio, I will highlight our activities by the various roles we play in ensuring that the U.S. Army remains the dominant landpower in the world.

***S&T Roles within the Army***

Often S&T is looked at with a singular focus - what have we done to develop the next materiel item that can transition into a Program of Record (PoR)? While that remains a critical aspect of our function within the Army, our contributions are much, much broader than that limited perspective. I'd like to take the opportunity to highlight some of these "other" roles - roles which provide critical capabilities for the Army of the future.

The S&T Enterprise is made up of over 11,500 Scientists and Engineers (S&Es) who understand the needs of the Army and the operational environment within which our Soldiers and equipment must operate. This wealth of expertise enables the many ways we support the Army through our S&T investments. Key roles for the S&T Enterprise include:

- **Solve current problems** –Operational Needs Statements (ONS)/Joint Urgent ONS (JUONS);
- **Improve current system capability** – Engineering Change Proposals (ECPs), product improvements;
- **Drive down technical risk** for Programs of Record (PoRs);
- **Inform affordable and achievable requirements**;
- **Investigate new technology/approaches** for potential Army applications;
- **Determine technology/system vulnerabilities** and identify mitigation approaches; and
- **Conduct "technology watch"** functions

I would like to take this opportunity to briefly describe some of our efforts and successes within each of these roles.

***Solving Current Problems***

As noted before, it is the expertise resident within our Army S&T Enterprise that enables our ability to respond to Warfighter urgent needs in a timely and effective manner. The familiarity of our S&T workforce to the Army operational environment helps them to quickly assess the ability for commercial solutions to meet the need (either with or without modifications) and/or identify developing capability that could address the immediate needs of the Warfighter. A great example of having the right technical expertise to solve an urgent problem is the work that was done by the Army's Edgewood Chemical and Biological Center (ECBC) (within the Army Materiel Command) to respond to an urgent need for the destruction of chemical agents and precursor materials found within Syria. ECBC developed and operated the Field Deployable Hydrolysis System (FDHS) in support of the Organisation for the Prohibition of Chemical Weapons (OPCW) and the United Nations. Working with the Joint Program Executive Office for Chemical and Biological Defense (JPEO-CBD) and in support of the Defense Threat Reduction Agency, ECBC enabled the chemical-biological defense enterprise to rapidly develop the capability needed to destroy 600

metric tons of Syria's declared chemical agent and precursor materials in an atypical operational environment.

From science and technology to advanced engineering, ECBC's proven chemistries, rapid prototyping capabilities and field operational experience were vital to the design and functionality of the FDHS onboard the MV Cape Ray. In less than six months, ECBC transitioned the technology to the JPEO-CBD on a fast-track acquisition process. During that time, ECBC scientists analyzed multiple reagents at varying concentrations and mixing ratios to determine the correct chemistries to achieve at least 99.9 percent destruction of the declared Syrian mustard and a sarin precursor in the sea-based hydrolysis reaction.

More typical responses to ONS/JUONS are a result of the acceleration of capabilities already under development within the DoD. Examples include an effort done in conjunction with Program Executive Office (PEO) Soldier to re-design the Improved Outer Tactical Vest (IOTV) to better fit female Soldiers. The standard issue IOTV was found to restrict movement of female Soldiers while they were getting in and out of vehicles or when they were placing a rifle up to their shoulder for firing. In addition, female Soldiers reported that the hard armor plates, as situated in the standard IOTV, caused abrasions on their hips and cut into their thighs when sitting. The female variant was designed, in response to requests from theater, to fit smaller torsos and is tailored to fit closer to women’s chests. This solution is becoming the standard for female Soldiers. Another ONS response that resulted from the S&T Enterprise is the Video from Unmanned aircraft systems for Interoperability (VUIT-2), which addressed the request from theater for better reconnaissance capability. VUIT-2 is a capability that allows video feed from an unmanned system (in this case the Shadow Unmanned Aerial System (UAS)) to be viewed by the pilot of a manned aircraft (we assess VUIT-2 with both Kiowa and the Apache). This manned/unmanned teaming capability was successfully demonstrated in Afghanistan and is planned for insertion as part of the Apache Block 3 PoR.

## ***Improving Current Capabilities***

The Advanced Affordable Turbine Engine (AATE) program was a 3,000 shaft horsepower engine demonstrator S&T program designed to provide advanced propulsion capability for Army rotorcraft. AATE focused on developing a new centerline, turboshaft engine to support modernization requirements necessary to ensure the Apache and Black Hawk remain operationally effective well into the 21st century. In FY14, AATE transitioned two competing engine designs into a PEO Aviation PoR, the Improved Turbine Engine Program (ITEP), which will provide significantly more

capability and better fuel efficiency, including critically needed operational improvement in hot conditions at high altitudes (6,000 feet/95 degrees).

Another example of S&T improving current capability is the development of an under armor Auxiliary Power Unit (APU) for the Abrams M1 Main Battle Tank. The APU (9kW) provides electrical power for the combat vehicle without depending on the main engine, saving fuel, lowering vehicle maintenance costs, and reducing audible noise. The APU transitioned to PEO Ground Combat Systems as part of the M1A2 SEP V3 Abrams program, (being executed by General Dynamics Land Systems (GDLS)), which is currently in its Engineering and Manufacturing Development phase. It is estimated that the fielding of this APU within the Abrams SEP V3 to approximately 1600 vehicles would save 111,000 gallons of fuel per full battlefield day when calculated across the fleet, according to a 2009 Army Materiel Systems Analysis Activity (AMSAA) study.

***Driving Down Technical Risk***

In this time of decreased modernization funds, it is incumbent upon the S&T Enterprise to drive down the technical risks associated with developing new capabilities. As I mentioned last year, the Army has given us a great challenge – we have been asked to better prepare for new PoRs -- to bring forward not only new capabilities, but capabilities that are affordable for the Army of the future. The 3rd Generation Forward Looking InfraRed (FLIR) system is an example of where the S&T Enterprise has done just that. In the development of the 3rd Gen FLIR, S&T proved the viability and benefit of having a dual-band IR system. By combining the LongWave InfraRed (which provides search and track) and the MidWave InfraRed (which enables identification), we created an unprecedented all-weather capability which increased our performance range by 2.3 times that of the current 2nd Gen FLIR systems and extended our identification range beyond that of the detection capability of threat sensors. To ensure that this increase in capability was affordable, we also invested in the manufacturability of both the focal plane array (FPA) and the variable aperture dewar system which allows the system to perform both Wide Area Surveillance and Narrow Field of View ID. This technology transitioned to PEO Intelligence, Electronic Warfare & Sensors (IEW&S) in September 2013 as the Improved FLIR (I-FLIR) program and will help ensure our overmatch capability.

We know that future combat will require technologies that provide dismounted and mounted Soldiers trusted Position, Navigation and Timing (PNT) information, while operating in conditions that impede or deny access to the Global Positioning System (GPS). The S&T Enterprise is driving down the risk in four thrust areas: 1) Pseudolites (pseudo-satellites) that augment or replace military GPS signals by developing a terrestrial/aerial based transmission of a GPS-like signal, enabling signal acquisition/tracking, navigation and timing in degraded or denied environments; 2) a

PNT hub for vehicular applications that develops a robust system to support all PNT needs on the platform and maintain PNT assurance during operations in GPS-denied environments; 3) a PNT hub for dismounted Soldiers systems that has low Size, Weight, And Power (SWAP) and can provide assured PNT signals for all Soldier equipment; and 4) Anti-Jam Antennas that enable GPS signal acquisition and tracking in degraded or denied environments.

These PNT efforts are also part of our 6.4 Technology Maturation Initiatives and have a direct tie into the Assured PNT PoR. By developing these technologies to a relatively high maturity level, we are driving down the risk to the PoR, ensuring that when needed, our troops will be able to operate in a contested environment.

***Informing Affordable and Achievable Requirements***

One of our key current initiatives, the Joint Multi-Role Technology Demonstrator (JMR TD) program, is focused on addressing the Anti-Access/Area Denial (A2/AD) need for rotorcraft with longer range and more efficient combat profiles. The goal of the JMR TD effort is to inform affordable requirements and reduce risk for the Future Vertical Lift planned PoR, the DoD's next potential “clean sheet” design rotorcraft. The overall JMR TD effort will use integrated government/industry platform design teams and exercise agile prototyping approaches. In FY13, AVX Aircraft Company, Bell Helicopter, Karem Aircraft and Sikorksky/Boeing were awarded contracts for Phase 1 (concept design) of the JMR TD. In FY15, Sikorsky/Boeing and Bell Helicopter were selected to complete the design and fabricate and flight test demonstrator aircraft from FY17 to FY19. The Army is considering additional technology efforts with both AVX and Karem Aircraft.

We continue to develop modular and scalable technologies to enable current and future combat vehicles, which includes the Future Fighting Vehicle (FFV). In FY16, you will see the continuation of a focused initiative, done in collaboration with PEO GCS, to develop critical subsystem prototypes to inform the development and requirements of a future Infantry Fighting Vehicle (IFV) replacement program. These subsystem demonstrators focus on mobility (e.g., engine, transmission, suspension); survivability (e.g., ballistic protection, under-body blast mitigation, advanced materials); a medium caliber gun and turret; the Modular Active Protection Systems (APS); and open vehicle power and data architectures that will provide industry with standard interfaces for integrating communications and sensor components into ground vehicles. These activities are also part of our Technology Maturation Initiatives.

We are making a concerted effort to develop common architectures and Radio Frequency convergence (moving C4ISR/Electronic Warfare systems from separate boxes to cards in a common chassis) for a variety of platforms. By moving toward modular, open designs for architectures in this and other areas, we are creating

systems that are easily upgradeable as new threats emerge. We are also making it easier for small, innovative businesses to contribute their technologies.

***New and Game Changing Technologies***

We continue to develop solid state High Energy Lasers (HEL) to provide paradigm-shifting, low-cost defeat of rockets, artillery, mortars, unmanned aircraft systems and cruise missiles. We have demonstrated defeat of mortars and unmanned aircraft using an off-the-shelf 10kW laser integrated on a tactical platform and are continuing the development of technology to enable demonstration of tactical 50kW- and 100kW-class laser platforms. The Army has made great strides with these technologies and is well positioned to insert this capability into the Indirect Fire Protection Capability (IFPC) PoR around 2024. Additionally, this fall, we are bringing together industry for a HEL “rodeo.” This is a chance for industry to show us their state-of-the-art capabilities beyond what they have developed for the Army or other Services, in a demonstration at White Sands Missile Range. Based on the outcome, there may be opportunities to provide some limited operational capabilities against specific threats in even sooner.

In our Basic Research portfolio we are pursuing a number of potentially game-changing technologies. Our "Materials on Demand and By Design" research will provide the capability to select and create material properties and responses, essentially building new materials from the atom up. This effort requires intensive computational capability and the research to establish (and validate) a model that accurately reflects the material properties across the various domains from the atom to the continuum. The result is a materials-by-design capability for ballistic protection, energetic materials and electronic materials, built using a multiscale approach heavily leveraging computational materials science.

***Identifying and Mitigating System Vulnerabilities***

New theaters present new challenges – we will face future operations against technically savvy opponents who will challenge our military superiority. In FY14, building from the success of our Deployable Force Protection efforts, we began a new effort that aims to identify and understand potential vulnerabilities early in the materiel development lifecycle. This effort looks at vulnerabilities in both individual technologies and systems, providing timely feedback to technology and materiel developers in order to increase awareness of potential risks (in context of future scenarios and threats) and to identify opportunities for technology and/or employment improvements. These efforts have the potential for significant cost savings, as vulnerabilities are mitigated before system designs are finalized and/or systems are fielded. A key aspect of this initiative is red teaming, challenging the systems with an emulated enemy – one who can use innovative and adaptive methods to disrupt the planned capability. This has proven to

be an effective method to tease out inadvertent seams that result from the introduction of new technologies and systems into operational use.

One way we are accomplishing this is through our Adaptive Red Teaming activities, in which we provide technologists and systems developers with realistic and challenging multi-day experiments to employ and assess their solutions prior to acquisition. These collaborative, non-punitive experiments take emerging systems and prototypes out of the lab and into "messy" environments, incorporating varied operational and increasingly complex scenarios against capable adversaries, as well as experienced warfighters and security forces that provide real-time user feedback on design and performance. In these settings, technology solutions are examined from multiple perspectives – including systems integration, logistics, training and adaptability risks – in order to expose potential employment vulnerabilities and identify needed improvements early on.

***Understanding the Global Technology Environment***

Understanding the current and projected threat environment is essential as we develop future capabilities. As part of Better Buying Power 3.0, we are establishing tighter linkages between the intelligence, acquisition and requirements communities. To this end, we are engaging the National Ground Intelligence Center, the Army G2 and the Office of Technical Intelligence at OSD to remain aware of projected future threats and identify areas of interest for future assessment.

To foster greater innovation within the S&T enterprise, we have undertaken a new effort in technology wargaming. This is focused on identifying concepts and conducting technology-based assessments about what S&T will look like in the deep future (the 2030-2040 timeframe) and how this will affect both the Army and our adversaries. We are taking a multipronged approach that includes crowd-sourced brainstorming from Government, industry and academia, virtual workshops with Government subject matter experts, and red teaming of potential technology concepts. At the heart of this initiative lies a commitment to solid analysis and a focus on bringing fresh ideas from a wide community, including innovative thinkers who haven't traditionally been a part of the S&T planning process.

Our red teaming/vulnerability analysis activities and our technology wargaming are fostering closer ties between S&T and the intelligence community, a partnership that is increasingly important as we look beyond the recent wartime period into a more complex and unknown future.

***The S&T Enterprise Workforce and Outreach Initiatives***

The Army relies on its laboratories and centers (collectively referred to as “labs”) to foster innovation; development and demonstrate new technologies; assess competing technology options; and help transition its basic research investments as they mature. Only with the support of a world-class cadre of Government civilian scientists and engineers – approximately 11,700 – complemented by a military and contracted workforce, in combination with an infrastructure that supports their work, can the labs fully support the needs of the Army. Scientists and engineers in the Army labs also provide scientific and engineering expertise to the Program Managers and Program Executive Offices. In recent military operations in Iraq and Afghanistan, the Army’s labs have been a source of rapid technology transition of solutions to meet operational needs. Most recently, the military’s response to the Ebola crisis has highlighted the importance of a strong, agile lab system. Ebola Virus Disease (EVD) research and development efforts executed at United States Army Medical Research and Materiel Command (USAMRMC) have contributed to the development of investigational EVD therapeutics, vaccines and diagnostic assays. In addition, USAMRMC overseas laboratories are providing technical support to their host nations' laboratory preparedness and EVD response planning efforts.

Critical to the development of the agile workforce is the ability to recruit new employees, the ability to develop existing employees, and the ability to retain these same employees. Recruiting, developing, and retaining the best science and engineering talent into the Army laboratories is becoming increasingly challenging because of the pay freeze instituted in 2010; conference restrictions implemented in 2012; furloughs related to sequestration in 2013; and the retirement eligibility for greater than 25% of the workforce. Despite these challenges, the labs continue to have an exceptional workforce. The authorities Congress has provided, such as the flexibility to enhance recruiting through direct hire mechanisms, allow the lab directors the management flexibility to shape their workforce and remain competitive with the private sector.

Last year, I described a new concept developed by the Army Research Laboratory (ARL), the Open Campus Initiative, meant to enhance innovation by leveraging the substantial intellectual resources represented by the global academic scientific research community, including industry and small business. Open Campus collaborations are anticipated to empower groundbreaking advances in fundamental science and technology research areas of mutual and strategic interest to the Army. In collaborations cultivated within the Open Campus business model, a value proposition exists for both ARL and the collaborator without a required exchange of funds and where collaborators and institutions are typically financially responsible for their arrangements. Since the introduction of the Open Campus, the ARL has initiated over

60 agreements with small businesses, industry, and academia. More than 200 researchers have come into and out of the laboratory to conduct side-by-side research in the critical S&T areas, including Human Sciences, Information Sciences, Computational Sciences, Sciences for Lethality and Protection, Maneuver, Materials Research, and Assessment and Analysis. An Open House held on December 9th and 10th, 2014, attracted over 500 college/university faculty and graduate students, science entrepreneurs, small business, contractors with enhanced-use lease aspirations, and other large industry participants. The majority of the external guests were from academia (65%), industry and small business (30%), with representation from 25 countries and 37 different states. An additional 572 remote participants joined via streaming. The interest level of high-quality leads is anticipated to result in 200 new collaborations by summer 2015.

In order to sustain the S&T Enterprise for the future, we need to develop the next generation of scientists and engineers. The Army has unique capabilities to assist in addressing the Science, Technology, Engineering and Math challenge. The Army provides access to its research facilities and STEM professionals through its Army Educational Outreach Program (AEOP). AEOP is supported through a cooperative agreement that brings together our Government, industry, and academic partners to provide students access to our laboratories and research centers for STEM enrichment activities, provide one-on-one mentorship opportunities through apprentice programs and reward student achievements in research through competitions, all while introducing students to the world of DoD research.

***Conclusion***

As the Army S&T program continues to identify and harvest technologies suitable for transition to our force, we aim to remain ever vigilant of potential and emerging threats. We are implementing a strategic approach to modernization that includes an awareness of existing and potential gaps; an understanding of emerging threats; knowledge of state-of-the-art commercial, academic, and government research; as well as a clear understanding of competing needs for limited resources. Army S&T will sharpen its research efforts to focus upon those core capabilities it needs to sustain while identifying promising or disruptive technologies able to change the existing paradigms of understanding. Ultimately, the focus remains upon Soldiers; Army S&T consistently seeks new avenues to increase the Soldier's capability and ensure their technological superiority today, tomorrow, and decades from now. The Army S&T mission is not complete until the right technologies provide superior, yet affordable, overmatch capability for our Soldiers.

*"Innovation is the result of critical and creative thinking and the conversion of new ideas into valued outcomes. Innovation drives the development of new tools or methods that permit Army forces to anticipate future demands, stay ahead of determined enemies, and accomplish the mission."*

*-- Army Operating Concept – Win in a Complex World, 31 October 2014*

All of the efforts described above would of course be impossible without the continued support of our partners in Congress. I would again like to thank the subcommittee for your long-standing support of the incredibly important work of the Army S&T Enterprise. I am extremely proud to represent the men and women who have dedicated their lives to provide our Soldiers with the capabilities to operate in any environment and situation. As we continue to navigate this difficult budget environment, I look forward to working with you to ensure the U.S. Army remains history's preeminent ground force. Thank you. I would be pleased to answer any questions you have.