Science & Technology

The Army Science and Technology (S&T) strategy (Figure 1) supports the Army's goal to provide new technologies that enhance and modernize systems in the Current Force and that enable new capabilities in the Future Force. This strategy is effected through a portfolio with three types of investments, each providing different results in distinct timeframes.

Figure 1: Strategy—Develop and mature technology to enable the Future Force while seeking to enhance the Current Force

The three types of S&T investment are far-term, funding basic research for discovery and understanding of phenomena; mid-term, funding applied research component demonstrations within a laboratory environment; and near-term, funding advanced technology development system/sub-subsystem demonstrations in relevant (non-laboratory) environments (Figure 2). The technology demonstrations prove technology-enabled capabilities and concepts and their military utility which, then inform the combat developments process and provide the acquisition community with evidence of the technologies' readiness to satisfy system requirements. This portfolio also supports current overseas contingency operations in the following ways: (1) Soldiers benefit today from technologies that emerged from past S&T investments; (2) we exploit transition opportunities by accelerating mature technologies derived from ongoing S&T efforts; and (3) we leverage the expertise of our scientists and engineers to develop solutions to unforeseen problems encountered during current operations such as the armor applied to Mine-Resistant Ambush Protected (MRAP) combat vehicles for enhanced protection from rocket propelled grenades (RPGs). The entire S&T program is designed to be adaptable and responsive to the needs of the Army.

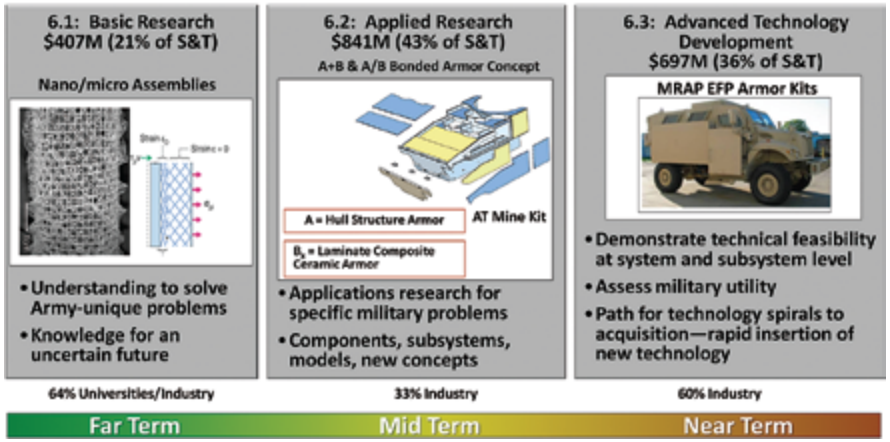

Figure 2: The S&T portfolio consists of three types of investments.

S&T INVESTMENT—FUTURE FORCE TECHNOLOGY AREAS

The diverse S&T portfolio is characterized in terms of Future Force Technology Areas. The investments in these areas are shown at right in a color depiction (Figure 3) that approximates their proportionate dollar value in FY11 by Technology Area.

Within these Technology Areas, the highest priority applied research and advanced technology development efforts are designated by Headquarters Department of the Army (HQDA) as Army Technology Objectives (ATOs). We do not designate ATOs within the basic research area since these investments fund sciences (discovery and understanding), not technology. The Army's Training and Doctrine Command/Army Capabilities Integration Center (TRADOC/ARCIC) represents the warfighter in the S&T ATO development process, and articulates the warfighter's needs to the S&T community through the development, staffing, and coordination of the TRADOC "warfighter outcomes." ATOs are focused efforts that develop specific S&T products designed to address warfighter Outcomes and meet agreed upon metrics. The goal of ATOs is to investigate and mature technologies that provide new or improved capabilities for acquisition programs. This goal requires a close working relationship with acquisition program managers/program executive offices (PM/PEOs) to ensure that the ATO output metrics are defined to be what the acquisition programs needs.

This S&T section of the *U.S. Army Weapon Systems 2011* handbook is organized by Future Force Technology Area. Selected ATOs are described within most of the Technology Areas. The complete portfolio of 89 ATOs is described in the 2010 Army Science and Technology Master Plan (distribution limited to government and current government contractors).

Figure 3: The Future Force technology area color bands shown on the left are approximately proportional to the financial investment within the Army's requested FY11 S&T budget. The specific technologies funded in these investment areas are aligned to the ten Comprehensive Warfighter Outcomes (CWO). The ten CWOs are the consolidation of TRADOC's Tier I warfighter outcomes. The warfighter outcomes articulate the warfighter capability needs.

Short descriptions of Future Force Technology Areas:

- **Force Protection** technologies enable Soldiers and platforms to avoid detection, acquisition, hit, penetration, and kill. These technologies include advanced armor, countermine, and counter improvised explosive devices (IEDs) detection and neutralization, and counter rocket, artillery, and mortars (CRAM) aircraft survivability and active protection systems.
- **Intelligence, Surveillance, and Reconnaissance (ISR)** technologies enable persistent and integrated situational awareness and understanding to provide actionable intelligence that is specific to the needs of the Soldier across the range of military operations.
- **Command, Control, Communications, and Computers (C4)** technologies provide capabilities for superior decision-making, including intelligent network decision agents and antennas to link Soldiers and leaders into a seamless battlefield network.

- **Lethality** technologies enhance the ability of Soldiers and platforms to provide overmatch against threat capabilities and include nonlethal technologies enabling tailorable lethality options.
- **Medical** technologies are developed to protect Soldiers by diagnosing and rendering initial treatment to combat casualties, preventing and treating infectious diseases, enhancing clinical care and rehabilitative medicine, while saving lives. They include technologies to enhance Soldier performance in extremely challenging environments imposed by physical and psychological demands on the battlefield, as well as extremes in topography and climate.
- **Unmanned Systems** technologies enhance the effectiveness of unmanned air and ground systems through improved perception, cooperative behaviors, and increased autonomy.
- **Soldier Systems** technologies provide materiel solutions that protect, network, sustain, and equip Soldiers, and non-materiel solutions that enhance human performance. Together these solutions enable Soldiers to adapt and dominate against any threat.
- **Logistics** technologies enhance strategic response and reduce logistics demand. Focus is on technologies that increase efficiency of systems or subsystems or sustainment processes that enable production of consumables closer to the point of use, that conserve or reduce demand for consumables (such as fuel and water), and that enhance the nation's assurance of sufficient energy for Army missions.
- **Military Engineering and Environment** technologies enhance deployability and sustainability. These technologies also enable sustainment of training and testing range activities.
- **Advanced Simulation** technologies provide increasingly realistic training and mission rehearsal environments to support battlefield operations, system acquisition, and requirements development.
- **Rotorcraft** technologies enhance the performance and effectiveness of current and future rotorcraft while seeking to reduce operational and sustainment costs.
- **Basic Research** investments seek to develop new understanding to enable revolutionary advances or paradigm shifts in future operational capabilities.

FORCE PROTECTION

Kinetic Energy Active Protection System

The Kinetic Energy Active Protection System ATO will demonstrate the capability to defeat tank-fired kinetic energy rounds. This program develops warhead and interceptor designs and conducts robust component and interceptor testing.

Figure 4: Kinetic Energy Active Protection System

Threat and Minefield Detection Payload for Shadow Tactical Unmanned Aerial Vehicle

The Tactical Unmanned Aerial Vehicle (TUAV) ATO matures and demonstrates a payload incorporating multi/hyper-spectral imaging sensors, adaptive spectral detection, and change detection algorithms. The TUAV payload demonstrates real-time detection of roadside threats, threat deployment activity, and minefields at realistic mission altitudes. It also provides an advanced reconnaissance, surveillance, and target acquisition capability for detection of difficult targets.

Advanced Aircraft Survivability

The Advanced Aircraft Survivability (AAS) ATO develops and demonstrates an integrated, multi-spectral (ultra violet [UV], infrared [IR], acoustic), and distributed aperture aircraft survivability solution to simultaneously detect, identify, and cue integrated counter-measures against currently operational and emerging hostile fire and Man Portable Air Defense (MANPAD) technology threats. Elements of this program include: improved missile and small arms fire detection sensors; a lightweight laser countermeasure for MANPAD missiles and integrated visual laser dazzling of small arms threats; lightweight beam directors; and closed-loop threat identification techniques.

Detection for In-Road Threats

This ATO matures and demonstrates an advanced mine- and threat-detection capability to address a broader spectrum of in-road threats—including those deeply buried—at higher rates of advance for modular engineer platforms and the Early Infantry Brigade Combat Team (E-IBCT). In order to meet current and Future Force needs, this effort matures and then integrates ground-penetrating radar and metal-detection technologies onto vehicles to detect the evolving underbelly threat on primary and secondary roads. The technologies demonstrated include an optimized metal detector, a downward-looking ground penetrating radar, signal processing, and algorithms optimized for both shallow and deep targets.

Extended Area Protection & Survivability (EAPS) Integrated Demo

The Extended Area Protection and Survivability (EAPS) ATO is developing and demonstrating critical technologies to provide the capability to defeat rockets, artillery, and mortars (RAM) at extended ranges. The EAPS effort is developing two missile concepts and one gun concept to provide mobile, 360-degree hemispherical area protection to meet the objective Counter-RAM requirements.

This effort includes subsystems development of the technical fire control node to process the decision logic for intercept, the tracking and fire control radar to provide a precise location of the threat, the launch system, and the interceptors. The EAPS effort will demonstrate intercept of single RAM threats and multiple simultaneous RAM threats. The system architecture is being developed to integrate with the architecture being developed by Program Manager Counter-Rocket, Artillery, and Mortar, Program Executive Office, Command, Control, and Communications Tactical.

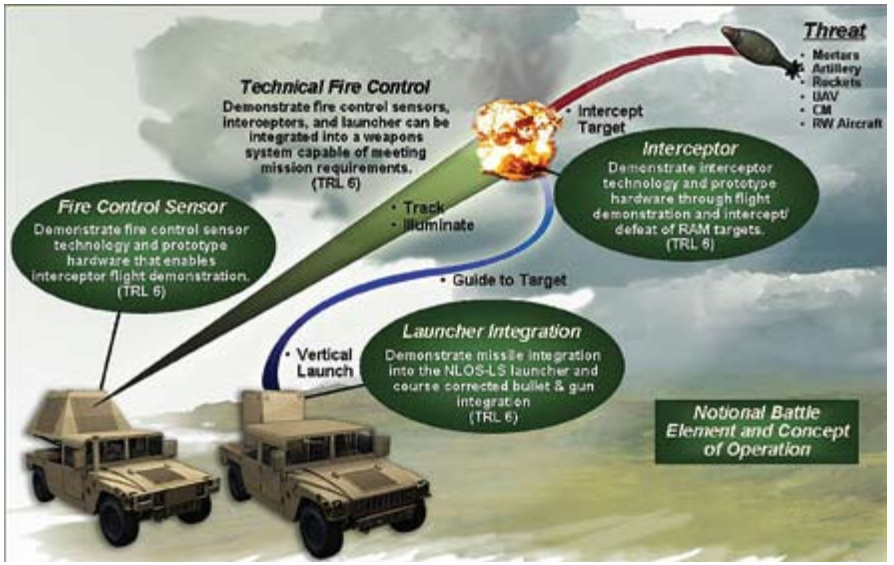

Figure 5: Extended Area Protection & Survivability (EAPS) Integrated Demo

INTELLIGENCE, SURVEILLANCE, RECONNAISSANCE

Battlespace Terrain Reasoning Awareness—Battle Command

This ATO provides integrated battle command capabilities to create and utilize actionable information from terrain, atmospheric, and weather effects on systems, platforms, and Soldiers. This will enable agile, integrated ground and air operations in all operational environments. An initial spiral of urban-based technologies from the Network-Enabled Command and Control ATO program will be incorporated, resulting in a net-centric, terrain reasoning service, embedded with battle command applications.

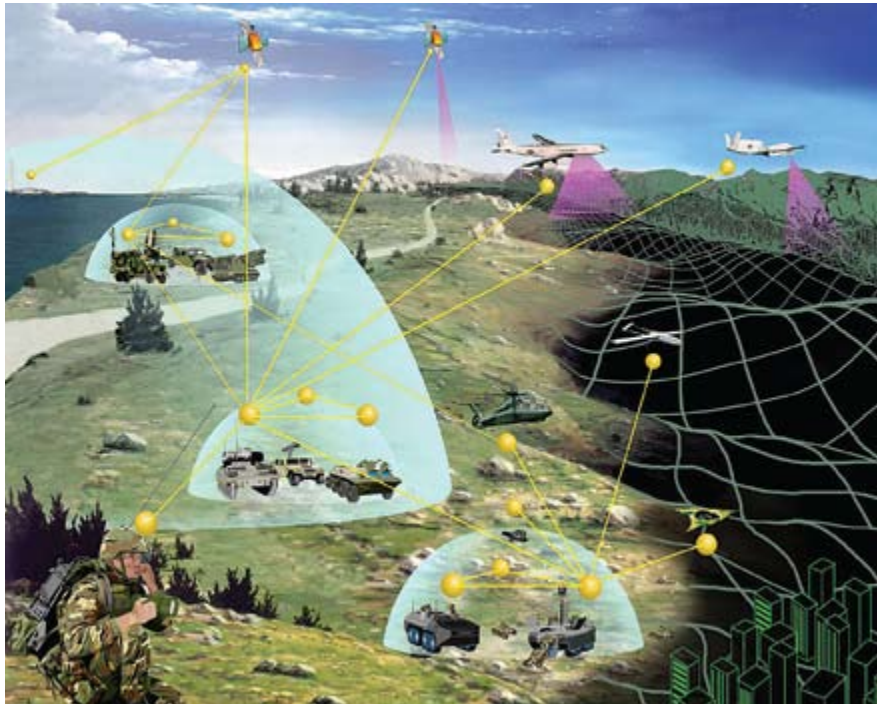

Figure 6: Battlespace Terrain Reasoning Awareness—Battle Command

This effort is working with key transformational battle command programs and TRADOC schools to (1) conduct controlled demonstrations to gain insight into effectively integrating actionable terrain, atmospheric, and weather information into battle command system-of-systems (SoS), staffs, processes, and functions; (2) improve, extend, and mature terrain- and weather-based information products and embedded applications within battle command SoS; (3) transition capabilities to the Distributed Common Ground System–Army (DCGS-A), BCT, and commercial joint mapping toolkit; and (4) support the development of a geo-battle management language that extends the current model to include representation of actionable terrain, weather, and atmospheric information.

Target Location Designation System

This ATO demonstrates an improved, man-portable, target acquisition and laser designation system with reduced size, weight, and power. This ATO provides: (1) an improved mid-wave IR focal plane array; (2) a common designator module using end-pumped, mono-block laser technology; and (3) precision target location through an improved global positioning, gyroscope, and magnetometer. The results of this effort will demonstrate to the warfighter improvements in real-time target acquisition, precision target location, and laser designation capabilities that increase combat effectiveness and lethality. The overall result will be an increased target acquisition range that provides greater standoff range and increased Soldier survivability, while the reduced weight will achieve greater Soldier mobility.

Advanced Common Sensor Payload

The Advanced Common Sensor Payload ATO provides day/night wide-area persistent imaging and enhanced reconnaissance, surveillance, and target acquisition capabilities for insertion into the common sensor payload (CSP). There will be two CSP variants—one with a high-definition sensor and the other with a dual-color, third-generation, forward-looking radar. Both of these systems will have the following capabilities: Step Stare Software that provides persistent imaging scan modes to improve resolution and Tiered Data Processing that adds onboard modules for enhanced data exploitation and compression to allow operation over existing extended-range and multipurpose data links. The payoff will be a payload that provides persistent wide-area activity monitoring and enhanced capabilities to include target search at ID resolution, reduced operator workloads, and improved data exploitation.

IRON Symphony

The IRON Symphony ATO defines and develops a next-generation Army Electronic Warfare (EW) networking capability, based on an integrated and distributed EW framework, to enable the coordinated detection, geolocation, reporting, and engagement of multiple diverse threat waveforms. Most current EW systems are designed to mitigate a single threat waveform. Multiple threats force the development of multiple systems, resulting in a rapid escalation of interoperability and spectral de-confliction issues. The robust proliferation and simultaneous use of modern communication threats, as well as the complexity of the threat signals themselves, have created an environment where the use of individualized solutions is no longer feasible.

Flexible Display Technology for Soldiers and Vehicles

This ATO develops flexible display technologies for affordable, lightweight, rugged, low-power, and reduced-volume displays in conjunction with the development of human factors parameters for systems utilizing flexible displays. Flexible displays have reduced weight and are inherently rugged with ultra-low power electro-optic technologies, compared with traditional liquid-crystal, glass-based displays. The development of displays on flexible substrates enables novel applications that cannot be achieved by glass-based technologies (e.g., wearable and conformal for Soldier applications, conformal for vehicle and cockpit applications, and compact display that can be rolled out for multiuser applications). This ATO program is coordinated with human factors studies to optimize design trade-offs and will produce flexible, four-inch diagonal displays (greater than 320 x 240 resolution), as well as technology for color emissive and reflective displays. Benefits to the warfighter include a 60 percent weight reduction of display components compared to glass displays, and a 30 to 90 percent power reduction compared to liquid crystal displays.

Figure 7: Flexible Display Technology for Soldiers and Vehicles

COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTERS (C4)

Collaborative Battlespace Reasoning and Awareness

The Collaborative Battlespace Reasoning and Awareness ATO develops and demonstrates multiplatform, cross community applications and software services that support the integration and synchronization of intelligence and operations functions through the design, development, and implementation of information interoperability, and through collaborative management and decision-support technologies. This ATO also develops and demonstrates systems that will improve mission execution success by providing software to more tightly couple operations and intelligence and to better facilitate collaboration. Research and development is focused on mapping intelligence and geospatial information requirements to military tasks. This effort enables faster and higher quality decision cycles and increased battle command unification through collaboration and real-time sharing, exploitation, and analysis of information to support the operational mission, tasks, and desired effects.

RF Adaptive Technologies Integrated with Communications and Location

This ATO develops and demonstrates Radio Frequency (RF) dynamic spectrum technologies for tactical communications and improved position determination in Global Positioning System (GPS)-degraded environments (Figure 8). The ATO efforts include the development of a software module that enables spectrum policy management for dynamic spectrum access-enabled radios, architecture to integrate and enhance disruption tolerant networking (DTN) in the tactical environment, and a software module that improves position determination based on net-assisted GPS and RF ranging technologies. This ATO builds upon the Defense Advanced Research Projects Agency (DARPA) Wireless Network After Next (WNAN) program to provide consistent dynamic spectrum policy management using software implementation, ensure reliable message delivery in a disruptive communications environment by enhancing and extending the DTN technology into tactical networks, mitigate multipath interference through RF ranging, and improve GPS performance through net-assisted GPS technologies.

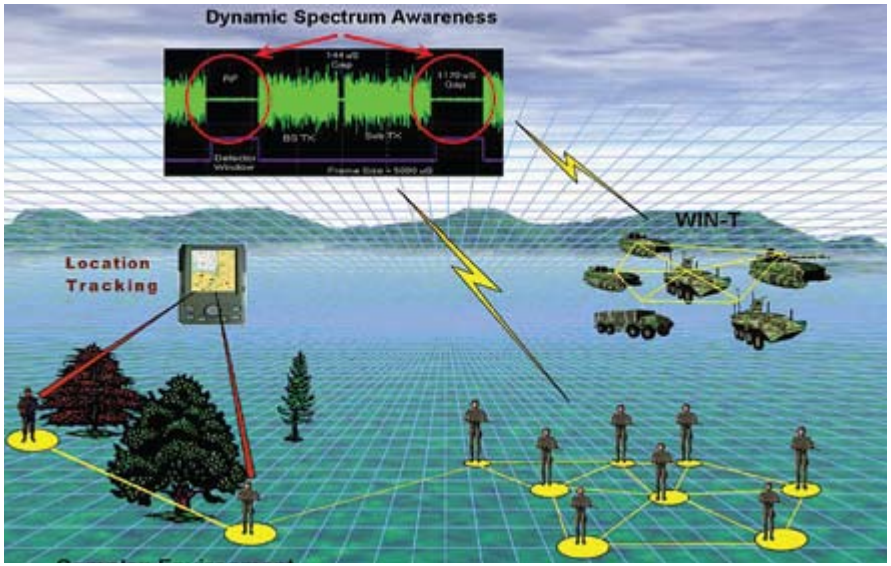

Figure 8: RF Adaptive Technologies Integrated with Communications and Location (RADICAL)

LETHALITY

Advanced Lasers and Unmanned Aerial System Payloads

This ATO develops, integrates, and demonstrates a seven-pound advanced sensor payload with laser rangefinding and laser designating capabilities to address the reconnaissance, surveillance, and target acquisition mission requirements for the BCT Class I unmanned aerial system (UAS). Under this ATO, new multifunction lightweight lasers, optical receiver components, and electronics suitable for UAS and other Soldier applications are developed. The new laser components will be integrated with a compact, small-pixel, uncooled IR imaging sensor into a two-axis pointing platform (gimbal) to enable an airborne organic laser designation capability for the lower echelon warfighter. The advanced lasers and UAS sensor payload will enable Soldiers to quickly see and characterize potential targets as well as nontarget objects that are in the open or in complex and urban terrain, and support beyond-line-of-sight situational awareness, targeting, and engagement with precision weapons. A parallel Manufacturing Technology effort seeks to develop an optimized manufacturing process for a universal, monoblock laser designator module component that can be integrated into a wide variety of laser applications.

Applied Smaller, Lighter, Cheaper Munitions Components

Affordably reducing space, weight, and power at the component level remains essential to increasing affordable precision munition lethality for full spectrum operations, particularly military operations on urban terrain (MOUT) (Figure 9). This ATO focuses on developing increasingly smaller, lighter, cheaper components and subsystems that enhance current system capabilities against asymmetric threats and mature technologies for next-generation small precision munitions. Primary investment areas include: nano/advanced composite structures and new fabrication techniques to save weight while maintaining or enhancing structural and thermal properties; miniaturized electronics to reduce size and weight, and support increased processing demands for capability enhancements like image stabilization; sensor/image processing for MOUT environments, including people tracking; and warhead safe and arm integration for precision lethality against expanded target sets in urban terrain. Major warfighter payoffs are enhanced precision lethality and cost savings through common components.

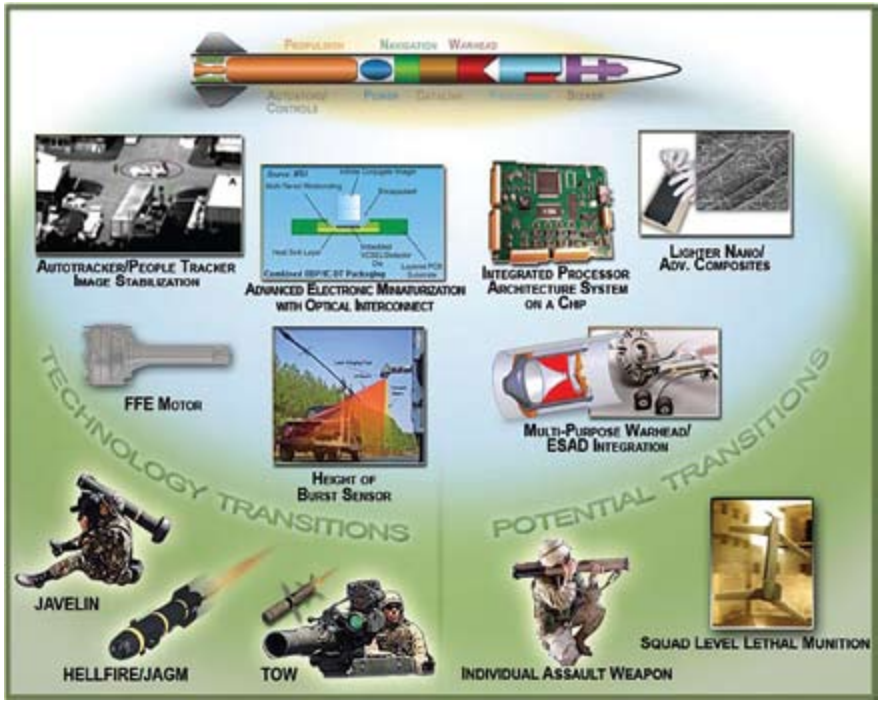

Figure 9: Applied Smaller, Lighter, Cheaper Munitions Components

Scalable Technology for Adaptive Response

The Scalable Technology for Adaptive Response (STAR) ATO matures and demonstrates new energetic materials, fuzes, and warhead technologies designed to provide selectable and scalable effects against platforms and personnel. The STAR ATO will demonstrate technologies for selectable lethal effects in large-, medium-, and small-diameter munitions and missiles; as well as the development of controlled lethal effects, multipurpose energetics and formulations, reactive materials, and advanced fuzing and power technologies. The STAR ATO will demonstrate scalable lethality within 250mm (Guided Multiple Launch Rocket System), 155mm (Excalibur), and 30mm (M789/Mk238) munitions validating improved weapon effectiveness and lethality and reduced collateral damage and logistics.

MEDICAL

Psychological Resetting after Combat Deployment: Advanced Battlemind

This ATO develops and validates an advanced unit-training program to reduce combat-related psychological problems, including symptoms related to mild traumatic brain injury (mTBI) and post-traumatic stress disorder (PTSD) during the post-deployment resetting phase. The goal of this effort is to facilitate recovery from psychological injuries related to combat, build individual and unit resilience in preparation for subsequent deployments, reduce the incidence of debilitating symptomatic problems, and reduce risk-taking behaviors that have the greatest impact on a Soldier's mental health, well-being, relationships, and job performance. An in-depth, six-session training package will be developed that integrates state-of-the-art cognitive-behavioral approaches to traumatic stress, while maintaining the focus on Soldier strengths, unit cohesion, leadership skills, and individual cognitive skill building. The package incorporates cognitive education strategies shown to be effective in reducing symptoms from mTBI, which often overlaps with PTSD. Finally, this ATO benchmarks key deployment-related behavioral health reactions and develops and validates novel approaches to assessing the psychological transition home following a combat deployment in order to determine the effectiveness of the proposed early intervention.

Damage Control Resuscitation

This ATO pursues the best combination and optimal use of alternatives to whole blood (e.g., plasma, red blood cells, blood-clotting agents) to prevent bleeding and maintain oxygen delivery and nutrients to damaged tissue (Figure 10). These products enhance survival of casualties after severe blood loss, which is the leading cause of death to injured warfighters. Recent data from the battlefield suggests that blood-clotting disorders and immune system activation, which damages normal cellular metabolic processes, commonly occur in severely injured patients. Therefore, a priority is to maintain blood-clotting capability and oxygen and nutrient delivery to tissues by using the best resuscitation products that can be administered at far forward deployed locations.

Figure 10: Damage Control Resuscitation

Drug for the Treatment of Traumatic Brain Injury (TBI)

This ATO is testing a candidate drug to treat TBI to determine its safety and effectiveness in 200 human subjects who have suffered TBI. TBI survivors often have physical and cognitive impairment, memory loss, and mood and personality disorders and currently no drugs exist to treat or reduce these brain-related injuries. It is estimated that 15 to 25 percent of all injuries in recent conflicts are to the head.

Prophylactic Drugs to Prevent Drug-Resistant Malaria

This ATO develops candidate antimalarial preventive drugs and tests these candidates in animals. Successful completion of this ATO will allow clinical testing of candidates in humans, potentially leading to a safe and effective replacement antimalarial preventive drug. The goals in developing these candidate preventive drugs are to replace the current drugs that are becoming

less effective due to the emergence of drug resistant malaria parasites, to reduce or eliminate unwanted side effects that impact Soldiers' use of the drugs, and to allow for a less critical and more convenient dosing schedule for deployed Soldiers. These new drugs will also increase operational readiness by maintaining a healthy force, as well as reducing the logistical and combat health support burden associated with treatment in theater or after evacuation.

Alternative Dengue Fever Vaccine Strategy

This ATO develops a strategy for developing single vaccine that is effective against the four major types of Dengue. This strategy should demonstrate human safety and provide initial data on the body's immune response. The current live-attenuated dengue virus vaccine in advanced development is suboptimal for rapid deployment since it requires two doses at six month intervals. Successful completion of this ATO will produce a vaccine strategy that will lead to a more rapid and complete protection from dengue infection.

Candidate Multivalent Vaccine Against HIV-1

This ATO seeks to evaluate novel Human Immunodeficiency Virus (HIV-1) vaccination strategies using a modified virus as the delivery vehicle of candidate vaccines into the human body. The objective is to demonstrate that these vaccines are safe for human subjects and capable of inducing an immune response which protects against HIV-1.

UNMANNED SYSTEMS

Safe Operations of Unmanned Systems for Reconnaissance in Complex Environments

This ATO develops, integrates, and demonstrates robust robotic technologies required for Future Modular Force unmanned systems (Figure 11). The ATO advances the state of the art in perception and control technologies to permit unmanned systems (UMS) to autonomously conduct missions in populated, dynamic urban environments while adapting to changing conditions; develop initial tactical/mission behavior technologies to enable a group of heterogeneous UMS to maneuver in collaboration with mounted and dismounted forces; optimize soldier operation of UMS; and provide improved situational awareness for enhanced survivability. Modeling and simulation will be used to develop, test, and evaluate the unmanned systems technologies (e.g., tactical behaviors and perception algorithms). Test bed platforms with software, appropriate mission modules, and associated hardware developed under this program support warfighter experiments in a militarily significant environment in conjunction with TRADOC.

Figure 11: Safe Operation of Unmanned Systems for Reconnaissance in Complex Environments

SOLDIER SYSTEMS

Soldier Planning Interfaces and Networked Electronics

This ATO develops a government-owned, Soldier-borne electronic equipment architecture that incorporates a National Security Agency-approved wireless personal area network subsystem (Figure 12). The Soldier Planning Interfaces and Networked Electronics (SPINE) ATO reduces the Soldier-borne footprint and electronics system weight by 30 percent through the loss of wires and connectors. The wireless network will be powered by a conformal battery currently under development that increases power by 50 percent for a 24-hour period. Additionally, the ATO utilizes emerging software services to enable Soldier connectivity and data exchange to current and future tactical radio networks and battle command systems. Throughout this effort, capability demonstrations are conducted at the C4ISR On The Move (OTM) test bed at Ft. Dix, NJ, to monitor progress.

Figure 12 : Soldier Planning Interfaces & Networked Electronics

High-Definition Cognition (HD-COG) In Operational Environments

This ATO researches real-time understanding of brain function in operational environments to allow matching of Soldier capabilities and advanced technologies. For example, vehicle crewstations could cue Soldiers based on how their brains process what they see, hear, and feel. Such neuro-ergonomic designs can exploit how the brain functions, providing tremendous Soldier performance improvements. This program develops technologies to assess Soldier neuro-cognitive processes in operational environments, as well as techniques to use them for neuro-ergonomic design. Technology development will focus on solutions to cognition, visual scanning, and platform control for mounted and dismounted operations. Approximately three experiments will be performed each year to look at ATO-developed technologies in a motion-based simulation environment.

LOGISTICS

Power for the Dismounted Soldier

This ATO matures and demonstrates technologies to provide small, lightweight, low-cost power sources. It demonstrates batteries that are half the size and twice the energy of C4ISR primary batteries (e.g., SINCGARS, Advanced SINCGARS Improvement Program (ASIP); conformal rechargeable Soldier system batteries; a Soldier-mission-extending hybrid fuel cell; and a JP8-powered Soldier-portable power source for tactical battery recharging. The goals of the efforts include reduction in weight by 50 percent for Soldier power; extended mission times in Soldier and sensor applications; reduction in resupply quantity, weight and costs; and increased Soldier mobility, sustainability, survivability, and deployability by providing higher-energy sources and recharging capability.

Advanced Affordable Engine Technology

The goal of this ATO is to develop a 3,000 horsepower gas turbine engine for improved operational capability for Blackhawk, Apache, and other Future Force rotorcraft. Target goals include a 25 percent reduction in specific fuel consumption, a 65 percent increase in horsepower-to-weight ratio, a 35 percent reduction in operation and support cost, and a 20 percent improvement in design life. By the end of FY11, the goal is to complete rig testing of optimized component designs (TRL5) and demonstrate the ATO via an engine test. This demonstration provides a technology base supporting significant increases in rotorcraft range and payload capability while reducing logistical burden. Results of this ATO also provide technology base/tools for application to Future Force rotorcraft.

Mobile Power

This ATO develops and demonstrates innovative, cross-platform power technologies that extend the power spectrum, extend the battlefield mission, and enhance strategic mobility/deployability without adversely impacting logistics costs, capability, or readiness for tactical soldier, UGV, mobile, and TriGeneration applications. The Mobile Power ATO evaluates the impact of changes to the DoD approach to fuel utilization and will reconstruct traditional assumptions for development. Non-traditional power technologies will be investigated for Modular Force application. The ATO extends the power spectrum through the development of alternative prime movers such as fuel cells, Stirling, closed-cycle Brayton, and Dual Pressure turbine engines. It enhances power delivery and reduces fuel consumption through the use of advanced materials and combustion controls; extends the battlefield mission through the use of transitional power for unmanned ground vehicles/robotics, communications, and power electronic controls; reduces logistics footprint (50 percent fuel savings/50 percent less hardware) with Tri-Generation approaches; and enhances strategic mobility/deployability without adversely impacting logistics costs, capability, or readiness.

High Performance Lightweight Track

This ATO provides two high-performance lightweight track system options for 30–40 ton class vehicles: a Segmented Band Track and a Lightweight Metallic Track. Future combat vehicles need lightweight track with acceptable maintainability, durability, and survivability. The current lightweight track ATO developed a 16.5-foot wide segmented band track for a 25-ton vehicle. Requirements growth for the proposed Ground Combat Vehicle (GCV) has caused critical demand for a higher capacity, more survivable lightweight track. Lightweight track systems are challenged by increased vehicle weights and performance requirements and require innovative materials and design improvements to meet high strength, durability, and survivability targets. This program will improve/optimize lightweight segmented track technology through utilization of “Best in Class” high-performance elastomers and designs to enhance durability and survivability. This ATO seeks to develop and refine Lightweight Metallic Track through optimized and innovative designs and materials that deliver performance, maintainability, and survivability at 30–40 tons.

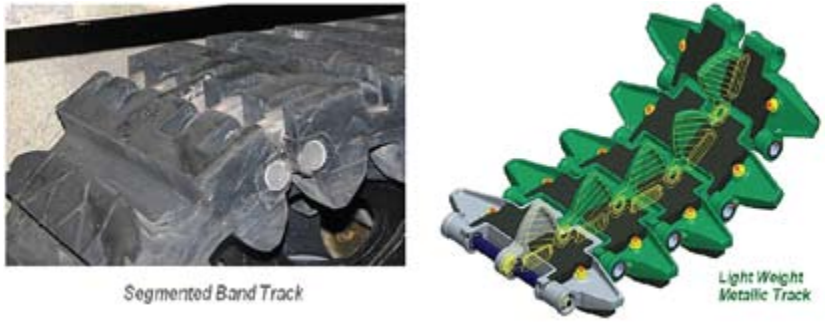

Figure 13: High-Performance, Lightweight Track

BASIC RESEARCH

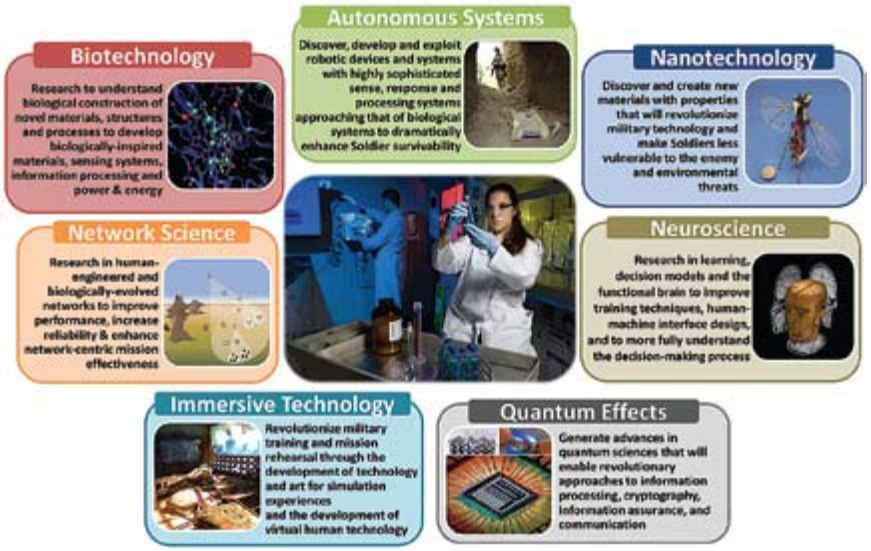

Figure 14 : Basic Research Investments

Basic research investments are a critical hedge in acquiring new knowledge in areas that hold great promise in advancing new and technically challenging Army capabilities and concepts to enable revolutionary advances and paradigm-shifting future operational capabilities. Areas of emerging interest and focus in basic research are autonomous systems, biotechnology, immersive technology, nanotechnology, network science, neuroscience, and quantum effects. Investment in basic research within the Army provides insurance against an uncertain future and guards against technological surprise. And if we are successful, these investments will make it possible to conduct ever-more complex military operations, with greater speed and precision, to devastate any adversary on any battlefield. The following is a brief summary of the areas of investment, the synergy among them, and some of the capabilities they may provide.

1 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 approaching that 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.

2 Biotechnology—Leveraging four billion years of evolution

The increasing importance 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 for improving the performance of our Soldiers. Major investments in this area through reverse engineering will lead to totally new sensing systems, new ways for the rapid processing of data into information, the development of novel sense and response systems, and biologically inspired power and energy solutions.

3 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 provide 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.

4 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 biology and 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 capability in creating 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.

5 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 are essential to advancing our ability to conduct complex military operations with greater speed and precision. However, our state of knowledge of these networks is relatively primitive and, as such, significantly impairs our ability to fully realize the potential that networks can provide on current and future battlefields. A new multidisciplinary approach is being implemented that combines communications, information, and the social/human component of networks, and that changes the way we address the challenges associated with 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.

6 Neuroscience—Understanding how the human brain works

Fundamental to the conduct of military operations is superior Soldier performance. Understanding how the human brain works, i.e., determining the brain's "software," is 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.

7 Quantum Effects—Overcoming the limitations of Moore's Law

Increasing demands for information to support rapid and effective decision-making on the battlefield require advanced sensor systems to collect relevant data, as well as the means for processing 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.

S&T ROLE IN FORMAL ACQUISITION MILESTONES

The Army S&T community role in acquisition involves not only technology development and transition but also formal participation in milestone decisions for acquisition programs of record. As the component S&T executive, the Deputy Assistant Secretary of the Army (DASA) for Research and Technology (R&T) is responsible for conducting technology readiness assessments (TRAs) at Milestone B and C decision points for major defense acquisition programs (MDAPs). This assessment has become even more important with recent statutory requirements for the Milestone Decision Authority (MDA) to certify to Congress that the technologies of an MDAP have been demonstrated to be at least at Technology Readiness Level (TRL) 6 in a relevant environment prior to making a Milestone B decision. The TRA serves as the gauge of this readiness for the MDA's certification at both Army and Office of the Secretary of Defense levels. The TRA process is a collaborative effort carried out among the program office, the S&T community, and (for acquisition category [ACAT] 1D programs) the Office of the Undersecretary of Defense (USD) Acquisition Technology & Logistics (AT&L).

SUMMARY

Army research investments are targeted in areas fundamental to realizing superior land warfighting capabilities and discovering new knowledge from research in areas highly relevant to the Army mission. These areas include research in network science to better understand, predict performance, and design future networks; neuroscience to better understand how the brain works so that we might improve human-machine interfaces and Soldier performance; new materials science to better protect our Soldiers and equipment; immersive virtual systems to improve our training capability; and biotechnology/nanotechnology autonomous systems.

Army S&T has made significant progress establishing persistent night surveillance of large areas for real-time situational awareness and forensic backtracking of suspect vehicles and personnel. Army S&T facilitated the rapid transition of technology solutions to both OIF and OEF, including protective armors for the MRAP Expedient Armor Program and IED-detection devices such as the Husky-mounted ground penetrating radar. We conducted nine independent readiness reviews to assess technology maturity of systems transitioning through acquisition milestones. We have advanced the computational understanding of the battlefield through the development of practical, intelligent, and operationally relevant software tools aiding analysis and interpretation of battlefield intelligence. We are key participants in an advanced Automotive Battery Initiative with over two billion dollars committed to dual-use battery manufacturing through the Department of Energy. We built the world's first precise, flexible, fiber-optic tool for CO2 laser surgery using flexible optoelectronic fiber based technology now performing over 175 life-saving weekly procedures. The Joint High Power Solid-State Laser (JHPSSL) program demonstrated a laser with 105 kilowatts (kW) output—the highest output recorded for a solid state laser, and a power threshold traditionally viewed as a proof of principle for "weapons grade" capable high-energy lasers. The Army Science Board completed a Quick Reaction study providing independent recommendations for survivable manned ground vehicle designs to inform Army leadership on alternatives for the cancelled Future Combat Systems manned ground vehicle. The Army Science Board completed a Soldier suicide mitigation study to develop and propose suicide mitigation actions and policy changes to reduce suicide rates among Soldiers.

In the coming years, the Army's Science and Technology (S&T) community plans to continue pursuing basic and applied research and technology development in areas of force protection, C4ISR, medical, lethality, Soldiers, logistics, rotorcraft, unmanned systems, and advanced simulation that will potentially allow the Army to maintain superior land warfighting capabilities. This strategy also retains flexibility to develop solutions that are responsive to changing warfighter needs. The technological sophistication required for 21st century operations constantly increases with the broadening nature of threats and the greater availability of technology to our adversaries. The goal of the Army's ongoing research is to provide high-payoff—the type that the private sector is not likely to sustain over the long haul because there is no linkage to acquisition programs at the outset of research. This high-risk research is essential if we are to achieve the technological breakthroughs that result in dramatic performance improvements in the Army's systems. One such breakthrough in guidance and control technology led to the Excalibur precision artillery munition that has virtually eliminated collateral damage to noncombatants. Today's Current Force has significant technology-enabled advantages as a result of the Army's past investments in S&T, particularly in night vision, precision munitions, and individual Soldier protection. Scientists and engineers continue to expand the limits of our understanding to provide technology to our Soldiers in the systems they use to achieve transformational capabilities required for decisive victories.