

# 2018 Research Campaign Descriptions Additional Information Can Be Found at

<https://www.arl.army.mil/opencampus/>

## Analysis & Assessment

Premier provider of land forces engineering analyses and assessment of technologies through unprecedented analytical capabilities and expertise.

ARL's A&A Campaign is focused on guiding the development and integration of technologies, substantially broadening the range of issues that can be addressed with analytical rigor, and improving the throughput and responsiveness of the analytical processes. This campaign builds on fundamental pillars of mathematics, statistics, physics, materials science, network science, computer science, engineering, and chemistry to conduct Survivability, Lethality, and Vulnerability (SLV) analyses and Human Systems Integration (HSI) analyses.

Strongly supported by these foundational pillars, the Analysis and Assessment Campaign is scientifically rigorous with a focus on addressing vulnerability, lethality, and HSI challenges to aid development and fielding of Army-critical materiel systems. The areas of emphasis include science of analysis and assessment; developing tools, techniques, and methodologies to aid SLV analyses; conducting analysis and assessment on technologies; and conducting analysis and assessment on systems and associated personnel.

Science of Analysis and Assessment concentrates on understanding the key types of analytical problems likely to confront the Army of 2030, exploiting the latest developments in the other Science & Technology (S&T) campaigns, academia, and industry, and performing basic and applied research to develop the new tools required. Areas within the Science of Analysis and Assessment include research and application of advanced mathematical, statistical, and network science within analytical and assessment capabilities; research on how to model and assess complex adaptive and collaborative systems; and research into analytical approaches to failure, healing, and resilience of platforms and personnel.

[Developing Tools, Techniques, and Methodologies](#) concentrates on improving the analytical toolkit used for analyses and assessment of systems, associated personnel, and technologies. Tools, techniques, and methodology development aligns with the Core Campaign Enablers (CCEs) of Ballistics SLV, Electronic Warfare (EW) SLV, Cyber SLV, Personnel Survivability, HSI, and Complex Adaptive Systems Analysis. For all of these areas, verifying and validating assessment techniques are used to improve the ability to provide stakeholders and customers with analysis and assessments that are technically compliant, accurate, precise, usable, and defensible.

Conducting Analysis and Assessment on Technologies concentrates on understanding the survivability, lethality, and vulnerability of technologies developed for the Army in the other ARL S&T Campaigns as well as within the Research Development and Engineering Centers, elsewhere in government, industry, academia, or internationally. Technology trade-space analysis and assessment estimates the benefits and potential payoffs of research efforts, shaping the technology development, and identifying potential integration challenges. Conducting Analysis and Assessment on Systems and Associated Personnel concentrates on understanding and exploiting system's technologies, design, and employment together with current—and likely future—state-of-the-art developments to optimize designs and to inform evaluation and acquisition decisions with analyses that are both technically sound and practically efficient. Key analysis areas include SVL and HSI.

## Computational Sciences

ARL's basic and applied research in Computational Sciences is focused on advancing the fundamentals of emerging computing architectures, computing sciences, predictive simulation sciences, and data intensive sciences, and to transform the future of complex Army applications. Gains made through these underpinning multidisciplinary research efforts and exploiting emerging advanced computing systems will lead to scientific breakthroughs that are expected to have significant impact on Army materiel systems. Technologies resulting from this multidisciplinary research, collaboratively with other ARL S&T campaign innovations, will have a significant impact on Power Projection Superiority, Information Supremacy, Lethality & Protection Superiority, and Soldier Performance Augmentation for the Army of 2030.

Computational Sciences uses advanced computing to understand and overcome complex fundamental challenges of importance to the Army, including weapon systems design; materials-by-design; information dominated and networked battle command applications; system-of-systems analyses; human performance modeling; platform maneuverability; and tactical supercomputers. There are natural synergies among the challenges facing Computational Sciences and other ARL S&T campaigns. Synergistic advances across all campaigns are expected to enable next-generation scientific breakthroughs. The Computational Sciences area heavily relies on ARL's research expertise and facilities devoted to emerging advanced computing architectures, mobile High Performance Computing (HPC), multi-scale and interdisciplinary predictive simulation sciences, multidimensional distributed data analytics, and computing sciences. Discoveries and innovations made in this area will exert a significant impact on the Army of the future.

[Computing Architectures](#) concentrates on understanding and exploiting the fundamental aspects of hardware and associated system software for emergent and future computing architectures for tactical, scientific, and data intensive applications. Computing systems include both mobile and fixed architectures optimized for limited communications, lower power consumption, hierarchical memory, distributed algorithms, resiliency.

[Predictive Simulation Sciences](#) concentrates on understanding and exploiting the fundamental aspects of verified and validated computational simulations that predict the response of complex Army systems and guide Army materiel design, particularly in cases where routine experimental tests are not feasible.

[Data Intensive Sciences](#) focuses on understanding and exploiting the fundamental aspects of large-scale multidimensional data analytics. Experiments, observations, and numerical simulations are on the verge of generating petabytes of diverse data at ever increasing rates. These sources of data are distributed over disparate locations on a heterogeneous collection of platforms and pose a challenge in providing real-time analytics that support U.S. military operations.

## Human Sciences

ARL's research in Human Sciences is focused on identifying, creating, and transitioning scientific discoveries and technological innovations underlying Human Behavior, Human Capability Enhancement, and Integration of Humans and Systems that are critical to the U.S. Army's future technological superiority. This campaign concentrates on high-risk and high-payoff transformational basic research; critically-focused, promising applied research; and selective advanced technology development that are expected to have revolutionary impacts on the Army's warfighting capabilities. In addition to significantly improving the Army's existing warfighting capabilities, it creates disruptive and game-changing Soldier-centric technologies for the Army, while also preventing technological surprises from potential adversaries.

[Human Behavior](#) encompasses basic and applied research, which aims to discover, understand, and predict human perceptual, cognitive, affective, physical, and social behaviors in settings ranging from individuals and teams to organizations and societies. Human Behavior research focuses on critical research gaps necessary to transition extant knowledge and new discoveries into innovative technologies that are expected to create revolutionary capabilities for the Army of 2030 and beyond. Innovations in this area are expected to generate capabilities to predict warfighter performance and provide fundamental enablers for enhancing Soldier capabilities and maximizing Soldier-system performance well beyond the capabilities of today's Army.

[Human Capability Enhancement](#) is a basic research, applied research, and advanced technology development effort, which aims to discover, innovate, and develop technologies that directly and indirectly enhance human perceptual, cognitive, physical, and social capabilities ranging from individuals and teams to organizations and societies for the Army. Innovations in this area are expected to generate equipment and training technologies that will provide unprecedented capabilities for future warfighters and enable future leaders to make sound decisions effectively in complex socio-cultural contexts.

[Integration of Humans and Systems](#) includes basic and applied research that aims to discover, understand, exploit, and apply fundamental principles of integrating humans and systems across domains, including but not limited to complex information systems, human-agent teams,

cybersecurity, and organizational and social networks. Discoveries of fundamental principles governing networked communications and human-system relationships and dynamics are expected to lead to technological and methodological innovations critical in poising the Army of 2030 to quickly shape its operational environment. These discoveries are expected to be relevant across the full range of social and cultural environments.

## Materials Research

ARL's Materials Research Campaign builds on fundamental pillars of materials science, physics, mathematics, computational chemistry, synthetic chemistry, biology, and engineering to conduct research in areas including Advanced Experimental Techniques; Modeling and Simulation; Bridging the Scales—a materials-by-design paradigm; Material Property Characterization to measure materials properties and performance to inform the research community across the scales; and Growth or Synthesis and Processing—a materials-on-demand paradigm.

Key enablers, which are expected to lead to disruptive discoveries yielding new Army capabilities, are emphasized. Discovery enablers include biological and bio-inspired materials, metamaterials, two-dimensional and nanoscale materials, and multifunctional and hierarchical materials. Recent scientific emphasis areas that promise disruptive capabilities include quantum science to alter time, space, and information processing; the coupling of energy fields to matter to create new materials and selectable system responses with vast performance improvements; and interfacial science research from which many key Army capabilities are enabled. Recent discoveries in these scientific areas are setting the course of future ARL research.

Materials research areas of specific emphasis include Structural Materials; Electronics; Photonics; Energy and Power; Biotechnology and Bio-Inspired; Lethality and Protection; and Materials Manufacturing Science.

Structural Materials is focused on novel and specialized materials to enhance the structural efficiency and systems performance of advanced platform structures while maintaining the same or greater levels of protection compared to today's platforms.

**Electronics** is focused on specialized electronic materials and devices and circuits to achieve Army dominance over the entire electromagnetic spectrum, particularly in contested environments. The two primary thrusts of this area are Energy-Efficient Electronics and Hybrid Electronics. Energy-Efficient Electronics focuses on low-power-demand electronic components having increased performance capabilities, and Hybrid Electronics focuses on high-performance semiconductor-based conformable, flexible electronics for advanced sensors and processors.

**Photonics** is focused on materials and devices for photonic sensors and sources, scalable high-energy lasers, secure communications via quantum networking, and protection of sensors and human eyes against high-power and short-pulse laser threats.

**Energy and Power** is focused on materials and devices for more efficient power generation, energy storage, energy harvesting, fuel processing, micropower, and novel alternative energy solutions at lower cost.

[Biotechnology and Bio-Inspired](#) is focused on new biological materials derived through synthetic biology as well as classical approaches. Novel biological materials are combined with inorganic devices to sense chemical and biological agents, generate power from organic sources, and produce materials to create new protection designs inspired by nature.

[High Strain Rate and Ballistic Materials](#) is focused on novel and specialized materials to enhance the performance and efficiency of Army weapons and protection systems, including lightweight extreme performance materials, novel energetic materials, and energy-absorbing materials.

[Materials Manufacturing Science](#) is focused on discovery, innovation, and maturation of manufacturing innovations to facilitate agile, adaptive mobile processing and manufacturing capabilities to enable superior performance and implementation of cost reduction methodologies.

## Information Sciences

ARL's S&T investments in Information Sciences are focused on gaining a greater understanding of emerging technology opportunities that support intelligent information systems that perform acquisition, analysis, reasoning, decision-making, collaborative communication, and assurance of information and knowledge. Understanding gained through these research efforts will lead to technological developments that make it possible to manage and utilize information flows in the battlespace. Technologies resulting from these efforts will have a direct impact on the Information Supremacy of the Army of 2030.

[Sensing and Effecting](#) research concentrates on understanding and exploiting information gained through sensing and exploiting data to drive effectors. Both sensing and effecting necessitate detailed understanding of corresponding physical behaviors that generate and utilize data, as well as effective means for storage, retrieval, and manipulation of data. Additionally, knowledge of the physical environment is necessary to understand the impacts on mission planning and decision-making including quantifying uncertainty and reducing the element of surprise.

[System Intelligence and Intelligent Systems](#) research concentrates on understanding and exploiting interactions between information and intelligent systems, such as software agents or robots. Information can be thought of as data in context. In order to fully exploit that data, the context must be taken into account. The data can then be used in providing automated intelligence: perception, reasoning, planning, collaborating, and decision-making. These broad issues in automated intelligence can be applied to a wide range of systems and environments, like cyber virtual environments or decision support. Aspects of Intelligent Systems complement research conducted in the Sciences for Maneuver Campaign, which focuses on Intelligent Systems concepts applied to vehicles or robotic platforms.

[Human and Information Interaction](#) research concentrates on understanding and exploiting interactions between information and humans. It involves complex mixed-initiative processes of information acquisition, processing and comprehension. Aspects of this research complement efforts in the Human Sciences Campaign, with the delineation being that research in the Information Sciences Campaign places greater emphasis on information structure, dynamics, phenomena and properties.

[Networks and Communications](#) research concentrates on understanding and exploiting information's interactions with socio-technical networks, particularly communications, and command and control networks, both formal and social. Of particular importance is Network Science - the study of structure, dynamics, behaviors and evolutions of networks, especially in the context of interactions between communications, information and social networks.

[Cybersecurity](#) research concentrates on understanding and exploiting interactions of information with cyber users, defenders and attackers - human and/or intelligent agents. These interactions involve friendly operations against adversary information systems and networks, defense of friendly information systems and networks, and assurance of persistent information support to Soldiers even when parts of the friendly systems and networks are compromised.

## Sciences For Lethality & Protection

ARL's investments in Sciences for Lethality and Protection are focused on gaining a greater understanding of emerging overmatch technologies (EOT) that support weapon systems, protection systems, and the mechanisms of injury affecting the Warfighter. Knowledge gained through these research efforts will lead to technological developments that make it possible to develop a broad array of lethality systems as well as resilient vehicle and personnel protection systems.

Technologies resulting from these efforts will have significant impact on the lethality and protection superiority of the Army of 2030.

Active research areas and specific projects seeking Open Campus collaborative engagement include:

[Kinetic Lethality](#) concentrates on technologies that deliver energy of motion (observable as the movement of an object, particle, or set of particles) sufficient to cause lethal effects.

[Kinetic Protection](#) concentrates on technologies capable of sufficiently degrading, redirecting, or defeating the kinetic energy of objects, particles, or sets of particles from causing lethal effects.

[Non-Kinetic Lethality](#) concentrates on technologies that deliver an energy beam of concentrated electromagnetic energy or atomic/subatomic particles sufficient to cause lethal effects.

Non-Kinetic Protection concentrates on technologies capable of sufficiently degrading, redirecting or defeating energy beams of concentrated electromagnetic energy or atomic or subatomic particles from causing lethal effects.

## Sciences For Maneuver

The Sciences for Maneuver area is focused on gaining a fundamental understanding of advanced mobility systems and their supporting architectures. This area heavily relies on ARL's research expertise and facilities devoted to decision support sciences, autonomy, and high-efficiency energy generation, storage, and distribution. Discoveries, innovations, and developments made in this area are expected to significantly impact the Army of the future by greatly enhancing mobility. ARL's Sciences for Maneuver research is focused on gaining a greater fundamental understanding of advanced mobility systems and their supporting architectures—critical to the future Army's movement, sustainment, and maneuverability. Knowledge gained through these research efforts will lead to technological developments that make it possible to design, fabricate, integrate, control, and support platforms that will have a significant impact on Power Projection Superiority for the Army of 2030.

ARL's basic and applied research in the Sciences for Maneuver area specifically emphasizes Energy and Propulsion, Platform Mechanics, Platform Intelligence, and Logistics and Sustainability.

[Energy and Propulsion](#) concentrates on understanding and exploiting the applications of energy generation, storage, conversion, and management. The goal of this research is to provide energy and power applications to enhance Army operational effectiveness, improve efficiency, and accelerate development of critical military platform systems ensuring Army Power Projection superiority.

[Platform Mechanics](#) focuses on fundamental research that enables the development of the highly maneuverable platforms for the Army of the future. Knowledge gained in this area is expected to impact a wide array of vehicle systems, including the ground, air, and maritime domains, as well as from micro- to macro-scales.

[Platform Intelligence](#) focuses upon fundamental research that enables effective teaming of Soldiers and robots to conduct maneuver and military missions. ARL's activities are centered upon enhancing the autonomous capabilities of unmanned systems. Knowledge gained in this area is expected to impact a wide array of vehicle systems, including the ground, air, and maritime domains, ranging from micro- to macro-scales.

[Logistics and Sustainability](#) focuses on fundamental research to enable the rapid and reliable assessment of future Army platform reliability, health, and usage. Knowledge gained in this area is expected to impact a wide array of vehicle systems, including the ground, air, and maritime domains, ranging from micro- to macro-scales.