

SUMMARY OF CHANGES

W911NF-17-S-0003 Amendment 07

Army Research Laboratory Broad Agency Announcement for Basic and Applied Scientific Research

1. Section II.A.9. Transitional Research Innovative Application Discovery (TRIAD) is added and read as follows:

This initiative is seeking research and development solutions in support of new technologies and translational research-based approaches that support the identification, alignment, and exploitation of applied research and technology to enable the Army of 2028 to be ready to deploy, fight, and win decisively against any adversary, anytime, and anywhere, in a joint, multi-domain, high-intensity conflict, while simultaneously deterring others and maintaining its ability to conduct irregular warfare. Solutions sought in conjunction with this effort consist of innovation-enabling technologies and approaches that will improve the Army's ability to rapidly and cost-effectively capitalize on global advances in the areas detailed below.

There are a number of technologies and approaches that touch more than one of the Army Modernization Priorities as well as other areas important to the Army. Advances in these areas may be highly disruptive since they could address multiple priorities or functions. Specialized capabilities and infrastructure needed to create, experiment with, validate and sustain long term research in these areas is of interest as well. Research areas of interest include, but are not limited to, the following:

- a. **Autonomous platforms** – The Army is particularly interested in research in autonomous ground and air vehicles which must operate in open, urban and cluttered environments. Robotics and autonomous systems regardless of their missions require similar concepts and technologies including:
 - i. Ability to move in very cluttered, irregular, urban and underground terrains
 - ii. Ability to move effectively in contested environments and survive attacks
 - i. Technologies to enable low electronic and physical profiles
 - ii. Techniques to allow operators to be trained quickly even for complex tasks
 - iii. Architectures to enable reprogrammable platforms under dynamic conditions
 - iv. Sensors to detect obscured targets and to characterize terrain obstacles
 - v. Autonomous ground and air structures, propulsion, and mobility components
 - vi. Technologies to significantly reduce logistical burdens

- b. **Artificial Intelligence and Machine Learning (AI/ML)** - The Army is interested in AI/ML research in areas which can reduce the load on humans and improve overall performance in many areas. AI/ML research is needed in areas such as:
 - i. Autonomous, intelligent maneuver and behaviors of autonomous ground and air vehicles - object recognition, threat warning, etc.

- ii. Ability to analyze large, diverse data sets to predict enemy intent and behaviors
 - iii. Technologies to ensure robust, resilient and intelligent networking, cyber, electronic warfare and analysis of adversary signals
 - iv. Data analysis capabilities to engage with and exploit classified and unclassified sources in order to produce enhanced intelligence products
 - v. Techniques to fuse data from disparate sources to improve a particular mission
- c. **Data visualization and synthetic environments** – The Army is interested in research in research into concepts enabling improved situational awareness and the visualization and navigation of large data sets and to enhance training. Research is needed in the visualization of data in following areas:
- i. Sensor data
 - ii. Large data sets
 - iii. Complex multi-source mode data sets
 - iv. Novel visualization and synthetic environments approaches to enable improved training
 - v. Synthetic environments and networked instrumentation approaches for virtual-live validation of concepts and prototypes
- d. **Assured Position, Navigation, and Timing (PNT)** – The Army is particularly interested in research in novel new PNT technologies which could be key enablers for many capabilities including autonomous vehicles, communications, and land navigation. Solutions that enable robust PNT on vehicles, Soldiers, munitions might include research on:
- i. PNT technologies which operate reliably in GPS-degraded or denied areas which cannot be exploited by others
 - ii. Enhancements to commercial technologies to enable them to meet Army needs
 - iii. Robust security techniques for PNT at all levels
 - iv. PNT-enabled guidance and control
 - v. Algorithms and techniques to fuse data from multiple PNT sources to provide robust capabilities
- e. **Power generation and management technologies** – The Army frequently must operate where power infrastructure is not available, on small vehicles or for individual Soldiers. Solutions that enable reliable power for vehicles, Soldiers, and munitions might include research on:
- i. Novel new power sources
 - ii. Power management algorithms to optimize generation and usage
 - iii. Advanced low-power electronic technologies to reduce demand
 - iv. Compact power sources for small UAVs, robots, smart munitions
 - v. Technologies to understand, manage and reduce overall power use

- f. **Sensing** – The Army is interested in having a detailed understanding of the environment and activities in areas it operates in. Research is needed in the areas of sensors and associated processing in order to:
 - i. Detect people, equipment, weapons, and any other object or action of interest
 - ii. Detect all targets even when obscured
 - iii. Detect based upon, physical, behavioral, cyber or other signatures

- g. **Communications & networks** – It is critical the Army maintain secure, reliable communications for Soldiers, vehicles and at fixed locations even in austere environments with little or no fixed infrastructure. Research is needed in the areas related to following:
 - i. Concepts and methodologies to enable robust networks
 - ii. Protocols
 - iii. Network interoperability including multi-national partners
 - iv. High efficiency components

- h. **Computation** – The Army has a growing need for high performance computational capabilities to exploit large data sets and to perform complex AI/ML algorithms for many applications. Research is needed to improve networks and communications in the following areas:
 - i. Throughput
 - ii. Power efficiency
 - iii. Edge computing

- i. **Space** – Like many commercial interests, the Army is interested in exploiting space assets to solve a range of problems. Research is needed to improve space-based capabilities in the following areas:
 - i. Concepts enabling persistent, high-resolution sensing of ground-based features, environments, and targets
 - ii. Concepts enabling low-cost access to space

- j. **Internet of Things (IOT)** – The Army needs to better integrate a wide range of capabilities and equipment and capitalize on commercial developments in the industrial IOT. The Army's interested is driven in part by the fact that the amount of usable communication bandwidth on the battlefield will be dynamic, and as such automated reallocation of communication resources and information sharing strategies are more challenging than commercial ones. Research is needed to improve Army IOT in the following areas:
 - i. New concepts, quantitative models and technical approaches enabling automated management of IoT.
 - ii. New machine learning techniques that accelerate decision making are needed to address the scale/volume of IoT information and advance the science.
 - iii. New approaches, low-complexity algorithms, and methods to enable IoT be secure, resilient, and to automatically manage and effect risk and uncertainty in a highly deceptive, mixed cooperative/adversarial, information-centric environment.

- iv. Novel IoT approaches to enable improved training
- k. **Quantum Technologies** – The Army needs to better employ quantum sciences in a number of areas to improve the performance and security of its future systems. Research is needed in the following areas:
 - i. Quantum computing to solve highly complex problems in real time
 - ii. Quantum sensing to achieve highly sensitive sensors and enable highly accurate navigation
 - iii. Quantum communications, and networking to enable highly secure and efficient information flow
- l. **Signature reduction** – The Army needs to protect its Soldiers by making them harder to detect and locate. Research is needed to manage and reduce Army capability signatures in the following areas:
 - i. Technologies, methodologies and concepts to reduce the external signatures of Soldiers and of all Army platforms and equipment
 - ii. Capabilities to reduce RF, optical, thermal, acoustic, magnetic and any other signatures
- m. **Protection** – The Army faces a number of current and future threats which it must address to protect its Soldiers. Research is needed to enhance Army capabilities for survival in the following areas:
 - i. Sensors to detect chemical, biological, radiological, nuclear, and explosive threats
 - ii. Lightweight, easy to manufacture armor
 - iii. Cyber protection technologies, methodologies, and concepts to protect Army systems including Soldiers, platforms, networks, and munitions
- n. **Human Performance** – The Soldier is the foundation of all Army capabilities. Technologies that reduce their mental or physical burden, allow them to react faster than their adversaries, to manage Research is needed to enhance Soldier capabilities in the following areas:
 - i. Human-machine interaction to insure autonomous platforms are efficiently managed and exploited
 - ii. Measuring effectiveness of and enhancing training tools and techniques
 - iii. Methodologies and approaches for effective augmentation of Soldiers in areas of cognition, perception, and physical performance
- o. **Underpinning Methodologies** - Methodologies, frameworks, tools, facilities, techniques, and experimentation concepts, which underpin and enable advanced research and development in all of the areas of the TRIAD concept are of interest including those which enhance the abilities to:
 - i. Collect, standardize, transform, and maintain data to focus research and validate concepts

- ii. Rapid model, develop and assess technologies across widely distributed research teams
- iii. Integrate innovative technology applications into current or future warfighting systems, applications, and analysis systems to assess the potential operational effectiveness of novel new technology elements
- iv. Automated data analytics tools and approaches that enhance discovery, development and transition management of technologies that address Army capability gaps

Questions regarding this topic must be submitted to the following address:
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(End Summary of Changes)