STATEMENT OF OBJECTIVES
18 APR 2022

1. INTRODUCTION

The International Technology Center Indo-Pacific and Air Force 374CONS are seeking fundamental research proposals in the engineering, physical, life, and information sciences with the goal to Operationalize Science for Transformational Overmatch. The research sought generally align with (but are not limited to) eleven Foundational Research Competencies: Biological and Biotechnology Sciences (BBS); Electromagnetic Spectrum Sciences (EMSS); Energy Sciences (ES); Humans in Complex Systems (HCxS); Mechanical Sciences (MS); Military Information Sciences (MIS); Network, Cyber and Computational Sciences (NC&CS); Photonics, Electronics, and Quantum Sciences (PE&QS); Sciences of Extreme Materials (SEM); Terminal Effects (TE); and Weapons Sciences (WS). These competencies are structured to create discovery, innovation, and transition of technologies for transformational overmatch. Proposals are sought from institutions of higher education, nonprofit organizations, state and local governments, foreign organizations, foreign public entities, and for-profit organizations (i.e., large and small businesses) for scientific research in mechanical sciences, mathematical sciences, electronics, computing science, physics, chemistry, life sciences, materials science, network science, and environmental sciences among others. Proposals are expected to be for cutting-edge innovative research that could produce discoveries that would have a significant impact on enabling new and improved operational capabilities and related technologies. <u>The specific research areas and topics of interest described in this document should be viewed as suggestive, rather than limiting</u>.

2. FOUNDATIONAL RESEARCH COMPETENCIES

COMPETENCY	CORE COMPETENCY	CORE COMPETENCY DESCRIPTION
Biological and Biotechnology Sciences (BBS) *biological related disciplines, including synthetic biology, biological materials, biolological / abiological interfaces and biological effect*	Bio Synthesis for Precision Materials	Research related to producing hierarchical and hybrid materials using synthetic biology and biotechnology for acceleration of the discovery-to-product timeline.
	Control in Military Environments	Research related to understanding and controlling living materials in military environments with an emphasis on speed of functional effect synchronized to operational timeframes.
	Incapacitating Effects	Multi-disciplinary research into novel mechanisms that modulate cognition and physiology of Soldiers. Fundamental understanding and controlled manipulation of the structure-property-function of brain components for development of performance enhancing technologies.
	Synthetic Biology Tools	Multidisciplinary research related to understanding, controlling, and testing biological constructs and modifications for the creation of new functionality in materials, devices, or subsystems within military environments and specialty applications.
Electromagnetic Spectrum Sciences (EMSS) *novel approaches to sensing and operating across the entire electromagnetic (EM) environment; counter-sensing across the EM spectrum; protection from EM effects; emerging concepts for RF, radars, and EW*	EW	Research related to new methods and concepts for electronic attack, electronic protection, and electronic warfare support through integration of concepts, underpinning hardware, and algorithm development.
	RF Technology	Research related to the development, modeling, and characterization of RF sensor components, sensor concepts, antenna design, and RF phenomenology.
Energy Sciences (ES) *science of mechanical and electrical power generation, storage, conditioning and distribution; and energy conversion; and emerging concepts for lasers, DE, DE protection and propagation*	Battery Science	Research related to electrochemical energy storage technologies; design, development, characterization and analysis of battery materials and interfaces; and hybrid power systems technology.
	Directed Energy	Research related to materials, optics understanding, and atmospheric transmission effects for the delivery of and protection from highly focused energy.
	Expeditionary Power	Research related to emerging and disruptive technologies in energy materials, compact power subsystems, alternative energy sources, energy scavenging, and long-lived power ideas.
	Power Integration and Architecture	Research related to power control, generation, distribution, conditioning, conversion, and thermal management.
Humans in Complex Systems (HCxS) *multi-disciplinary non-medical approaches to understand and modify the potential of humans situated in and interacting within complex social, technological, and socio-technical systems*	Bi-Directional Human-System Communication	Research underpinning effective and efficient real-time multimodal communication between Soldiers and systems.
	Estimating and Predicting Humans in Complex Systems	Research to develop novel approaches to sense, interpret and predict human state changes across time scales to enable effective and efficient technology adaptation and inference of operational environment context.
	Human-Guided System Adaptation	Research underpinning novel approaches for Soldiers to effectively and efficiently guide the adaptation of intelligent technologies to create new or upgraded human-system capabilities.
	Human-System Team Interactions	Research underpinning an understanding of dynamic team interactions and leveraging emergent team properties to enhance human-system team performance.
	Hybrid Human-Technology Intelligence	Anti-disciplinary research aimed at uncovering foundational hybrid approaches to enhance human-system teams in multi-domain operations.
	Neuroscience and Neurotechnologies	Research to harness the power of the human nervous system to enable neuroscientific principles to maximize Soldier performance and to drive the understanding and development of novel computational approaches necessary for creating future intelligent systems.
Mechanical Sciences (MS) *science of novel mechanics, mechanisms and control to enable manned/unmanned ground and air vehicle concepts*	Platform Design and Control	Basic and applied research to establish interdisciplinary scientific foundations to enable maneuverable, adaptive, tactical platforms through advances in theoretical mechanics, machine-enabled and conceptual design, and non-classical mechanical systems and actuators.
	Vehicle Propulsion Sciences	Fundamental research to understand and exploit energy conversion and power transfer mechanisms to enable extended reach, endurance, and readiness of Army platforms.

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Military Information Sciences (MIS) *underpinning sciences, physical autonomy and enablers required to provide timely, mission-aware information to humans and systems at speed and scale for all-domain and coalition operations*	Artificial Reasoning for Intent and Discourse	Theories, methods, algorithms and experimental approaches to enable computer systems, autonomous physical systems, and humans to reason about available data and interactions betw een those entities; to understand the intent and meaning of the communicated information; and to conduct discourse over time w here communications depend on history of previous interactions and situational conditions.
	C-4 for Multi Domain Operations	Theories, methods, algorithms and experimental approaches to enable distributed teams of humans and intelligent agents (softw are and robotics) to integrate a broad range of dynamic, complex, and disparate information arriving from the multi-domain battlespace; comprehend situational implications; generate and recommend effective decisions; and monitor/assess decisional effects.
	Complex Behaviors for Ground Autonomy	Theories, methods, algorithms and experimental approaches to enable ground autonomous systems to coordinate, collaborate and execute goal-driven and tactically appropriate behaviors and activities that comprise multiple actions in complex ground environments.
	Comprehensive Spatiotemporal Scene Understanding	Theories, methods, algorithms, sensors and experimental approaches to enable intelligent systems to understand the content, meaning and implications of complex situations and events unfolding in physical environments over space and time; and to identify and label mission-relevant elements of the observed scene and actions performed w ithin the scene.
	Data Science Enablers	Theories, methods, processes, algorithms, framew orks and experimental approaches to identify, characterize, extract and integrate entities, patterns, relations, insights and ultimately know ledge from collections of diverse types of structured and unstructured data.
	Heterogeneous Characterization & Sensing of Atmospheric State & Constituents	Methods, algorithms and empirical approaches that couple diverse sensing modalities w ith new theories of near-surface atmospheric processes and predictive models to understand the physical environment and enable Warfighters and intelligent systems to tactically exploit environmental impacts.
	Low SWAP ML and graph neural netw orks (GNN)	Theories, methods, processes, algorithms, and experimental approaches to create machine learning models that acquire ability to perform complex tasks by self-modifying from experience w ithout being explicitly programmed. Of particular emphasis are low size w eight and pow er (SWaP) enabled methods and algorithms suitable for tactical edge operations; and often use graphs and netw orks that function by passing messages betw een the nodes and storing information w ithin links and nodes.
	Robotics and Physical Autonomy	Fundamental research tow ard embodied systems capable of executing tasks in complex environments through the use of artificial intelligence and machine learning.
Network, Cyber and Computational Sciences (NC&CS) *sciences to enable and ensure secure resilient communication networks for distributed analytics in multi-domain operations*	Cyber-defense/Cyber-security	Theories, models, optimized algorithms, experimentation for prevention, detection, mitigation, monitoring, and prediction of adversarial activities and their impacts w ithin cyber space; development of cyber deception and counter-deception strategies to provide resilience and defenses against adaptive and sophisticated adversaries. Scope includes traditional enterprise level and tactical information netw orks as w ell as non- traditional netw orks such as communication buses found on vehicle platforms.
	Interactions of Earth Terrain w ith EM Communications	Theories, experimental studies, and models to characterize the combined effects of the EM propagation channel, multipath, diffraction, ground impedance, terrain, vegetation, infrastructure and meteorological influences on the source signature . Full-w ave and other modeling tools to characterize effects at local and urban scale, resulting in high-fidelity models informing netw orking protocols.
	Netw ork Structure, Dynamics & Protocols	Theories, methods, algorithms, and experimental approaches to enable resilient communications in complex and contested environments via novel communication modalities, multi-layer adaptive protocols for robust information delivery (including storage, computing, and communications), emerging quantum netw orks, interpretable and adversarial machine learning to enable autonomous control of heterogeneous netw ork structures and dynamics for resilience to adversarial attacks.
	Novel Computing Architecture	Theories, models, analyses and development of advanced and unconventional computing architectures and algorithms optimized to run on such systems and application-specific computing architectures, including lightw eight, non-von-Neumann and other emerging architectures, distributed/decentralized communication and energy-efficient computing, and scalable computing.
	Predictive Computational Modeling of Complex Physical Systems	Development of mathematical algorithms, deterministic and stochastic models, multi-scale methods and uncertainty quantification to simulate complex, physical systems for the purpose of understanding variability, predicting system evolution w ith quantified confidence, and enabling exploitation of those predictions in both high-performance and limited-compute settings.

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Photonics, Electronics, and Quantum Sciences (PE&QS) *materials (and related manufacturing methods) and devices intended for achieving photonic, electronic, and quantum-based effects*	Advanced Electronics	Research related to electronic, photonic, and electro-optical materials, devices, circuits, and subsystems whose functionality is derived from electron transport, rectification, amplification, storage, and interaction with solid-state, gases, vacuum, and energy including underpinning theory, design, modeling, fabrication, characterization and analysis.
	Integrated Photonics	Research related to materials development, device design, and processes necessary to achieve extremely complex optical processing in highly integrated and compact low-power form factors, capable of high bandwidth signal processing of optical and traditional electronic functions modulated to optical frequencies.
	Quantum Components and Technologies	Research related to exploiting nonintuitive aspects of quantum mechanics in atoms, materials, and nanophotonics for advancements in sensors (e.g. magnetic, gravimetric, and RF), precision timekeeping, communications, and information processing.
	Sensing	Research related to sensor physics, non-traditional sensing, processes and analysis of sensor design, multi- modal sensing integration, sensor/environment modeling and experimentation, sensor networks, and insertion of sensors onto platforms.
Sciences of Extreme Materials (SEM) *materials and related manufacturing methods focusing on mechanical response and performance extremes, including active, adaptive, and flexible/soft materials; novel manufacturing science for energetic materials*	Advanced Manufacturing Sciences	Fundamental understanding and process development of modular, on-demand and by design, material and shape agonistic manufacturing. Manufacturing from the "bottom up" where a structure can be built into its designed shape to create capabilities for unique military needs.
	Functional Materials	Discovery of multifunctional materials with tailored properties or properties that change in a controlled fashion by external stimuli (temperature, electric/magnetic field, etc.).
	High Strain Rate Materials Response	Characterizing the strain-rate sensitive deformation and failure of materials under ballistic and blast loading.
	Materials and Data Science	Discovery and application of materials via the merging of materials science, computational science, and information science within an integrated design framework. Exploitation of these specific opportunities to accelerate materials design and deployment.
	Mechanics of Materials	Fundamental understanding of solid objects subjected to stress and strain used to predict the response of structures to various types of loading, and to analyze the vulnerability of these structures to various failure modes.
	Novel Synthetic Molecular Systems	Design and discovery of stable structure and synthetic routes of designer molecules to be employed for the novel and efficient production of military relevant chemicals, fuels and materials.
	Structural and Ballistic Materials Synthesis, Processing, and Characterization	Exploration and evaluation of fundamental properties for design and creation of defense critical materials to mitigate ballistic (high-temperature, high-rate, impact and blast) loading.
Terminal Effects (TE) *sciences and applied research of weapon target interactions*	Armor Mechanisms and Countermeasure	Discovery and advancement of techniques to minimize or eliminate lethal effects at minimum space, weight and power.
	Mechanisms for Human Injury and Protection	Quantitative understanding of the mechanics and physics that effect human structure and function; fundamental understanding of human injury to high-intensity loading (ballistic, blast, electro-magnetic field). The exploitation of this understanding to protect or degrade soldier function.
	Mechanisms for Lethal Target Interactions	Discovery and advancement of weapon/target interactions to maximize the effectiveness and efficiency of munitions to provide lethal overmatch across all calibers and platforms.
	Terminal Effects Mechanics, Modeling and Simulation	Quantitative understanding of structural and material response due to ballistic, blast and highly energetic events. High-fidelity experimentation closely coupled to development and validation of theory, algorithms and computational techniques that enable the reduction of this understanding to technology concepts for protection and lethality.
Weapons Sciences (WS) *internal, transitional and external ballistics; launch, flight, control and navigation of guided weapons and aerial systems; development of novel weapon concepts*	Aerodynamics and Control	Understanding the dynamic interaction of solid bodies with air. Optimization of interactions to control motion of projectiles and aerial systems.
	Discovery, Synthesis, and Formulation of Energetic Materials	Propose, create and validate ingredients that can undergo rapid release of energy on demand. Formulation of novel energetic materials to optimize performance, manufacturing processes, and stability for explosive and propellant applications.
	Guidance and Navigation of Weapon Systems	Guidance, Navigation, and Control algorithms, electronics, and design of gun launched and/or missile guidance systems. This includes the evaluation of new sensing modalities (Inertial, Magnetic, GNSS, Vision, etc.) to improve the performance of navigation and terminal homing accuracy for weapons systems in challenged or degraded spaces.
	Gun and Rocket Propulsion	Explore the art-of-the-possible to substantially increase range and velocity while radically reducing weight and form factor of future weapon systems (all calibers) and armaments for next generation manned or unmanned (small-to-large air and ground) platforms.
	Modeling, Simulation, and Experimental Characterization of Energetics	Deliver exploitable knowledge through the creation and application of physics-based theoretical models to design advanced energetic materials for increased lethality and extended range munitions and to predict their performance in system concepts.

3. PERIOD OF PERFORMANCE

Each award will have an anticipated PoP to be between 6 to 60 months.

4. DELIVERABLES

To be determined per award. See list of CDRLs attached to BAA.

5. SECURITY REQUIREMENTS

5.1. Operations Security (OPSEC)

The contractor shall participate in all activities associated with the disciplines of the organization's Industrial Security, Information Security, Personnel Security, Operations Security (OPSEC), and Antiterrorism programs, following appropriate measures in each program as required for this particular contract. Security measures are required to reduce program vulnerability from successful adversary collection, exploitation of critical information, and violations of export control requirements. The prime contractor shall ensure all subcontractors, if applicable, conform to these requirements as required by the prime contractor.

5.2. Program Protection Plan (PPP) Requirements

Any potential critical program information (CPI) generated as part of this effort will be reviewed todetermine the need for a PPP or to be included as part of an existing PPP.

6. GENERAL INFORMATION/OTHER CONSIDERATIONS

6.1. Contractor Employees

Personnel shall meet or exceed the following requirement: Contractor shall not hire employees of the United States Government and/or employees otherwise under contract for service to the United States Government if employing such persons would create a conflict of interest, or appearance of a conflict of interest as determined by the contractor. Contractor shall not employ any person who is an employee of DoD, unless such person seeks and receives approval according to DODR 5500.7, Standards of Conduct.