Research Announcement

Young Faculty Award (YFA)

Defense Sciences Office

DARPA-RA-19-01

August 27, 2019

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PART I: OVERVIEW INFORMATION

- **Federal Agency Name:** Defense Advanced Research Projects Agency (DARPA), Defense Sciences Office (DSO)

- **Funding Opportunity Title:** Young Faculty Award (YFA)

- **Announcement Type:** Research Announcement

- **Funding Opportunity Number:** DARPA-RA-19-01

- **Catalog of Federal Domestic Assistance (CFDA) Number(s):** 12.910 Research and Technology Development

- **Dates** (All times listed herein are Eastern Time)
  - Posting Date: August 27, 2019
  - Executive Summary Due Date: September 18, 2019, 4:00 p.m.
  - FAQ Submission Deadline: November 9, 2019, 4:00 p.m. See Section VIII.A.
  - Full Proposal Due Date: November 19, 2019, 4:00 p.m.

- **Anticipated Individual Awards:** Multiple awards are anticipated.

- **Anticipated Funding Available for Award:** Each award will include a 24-month base period (a maximum of $500,000) and a 12-month option period (a maximum of $500,000).

- **Types of Instruments that May be Awarded:** Grants

- **Agency Contacts**

  - **RA Email:** YFA2020@darpa.mil

  - **RA Mailing Address:**
    DARPA
    ATTN: DSO/DARPA-RA-19-01
    675 North Randolph Street
    Arlington, VA 22203-2114

  - **DARPA/DSO Opportunities Website:** http://www.darpa.mil/work-with-us/opportunities

- **Teaming Information:** See Section VIII.B for information on teaming opportunities.

- **Frequently Asked Questions (FAQ):** FAQs for this solicitation may be viewed on the DARPA/DSO Opportunities Website. See Section VIII.A for further information.

PART II: FULL TEXT OF ANNOUNCEMENT

I. Funding Opportunity Description

This Research Announcement (RA) constitutes a public notice of a competitive funding opportunity as described in 32 CFR§ 22.3 as well as 2 CFR § 200.203. Any resultant negotiations and/or awards will follow all laws and regulations applicable to the specific award instrument(s) available under this RA.

A. Introduction

The Defense Advanced Research Projects Agency (DARPA) Young Faculty Award (YFA) program aims to identify and engage rising stars in junior faculty positions in academia and equivalent positions at non-profit research institutions and expose them to Department of Defense (DoD) and National Security challenges and needs. In particular, this YFA will provide high-impact funding to elite researchers early in their careers to develop innovative new research directions in the context of enabling transformative DoD capabilities. The long-term goal of the program is to develop the next generation of scientists and engineers in the research community who will focus a significant portion of their future careers on DoD and National Security issues. DARPA is particularly interested in identifying outstanding researchers who have previously not been performers on DARPA programs, but the program is open to all qualified applicants with innovative research ideas.

Before preparing an executive summary or proposal submission, proposers are encouraged to review the DARPA mission statement and current program descriptions at the DARPA website https://www.darpa.mil to familiarize themselves with examples of current DARPA investments. This is not meant as instruction to duplicate those efforts, but rather to illustrate that current programs are aimed at research that will substantially advance our capabilities in these areas. Once awards are made, each YFA performer will be assigned a DARPA Program Manager with interests closely related to their research topic. The Program Manager will act as project manager and mentor to the YFA award recipients.

Proposers should also familiarize themselves with the "Heilmeier Catechism." Details about the catechism and questions it seeks to answer can be found at https://www.darpa.mil/work-with-us/heilmeier-catechism.

B. Program Description/Scope

DARPA is soliciting innovative research proposals in the areas of interest to DARPA's six technical offices: Biological Technologies Office (BTO), Defense Sciences Office (DSO), Information Innovation Office (I2O), Microsystems Technology Office (MTO), Strategic Technology Office (STO), and Tactical Technology Office (TTO). Further detail regarding the specific technical areas of interest can be found under Section I.E "Topic Areas (TAs)." Proposed research should investigate innovative approaches that enable revolutionary advances in science, devices, or systems. Specifically excluded is research that primarily results in evolutionary improvements to the existing state of practice.

Submissions responding to this RA should clearly describe the DoD problem being addressed, the current state-of-the-art technology, new insights to address the problem, a credible research plan and schedule, and critical, quantitative milestones to be pursued over the research period. This RA seeks grant proposals only. Submissions for any other award instrument type may be considered non-conforming with the RA and may not be reviewed.

C. Program Structure

This RA seeks grant proposals for a research activity consisting of a 24-month base period. No award type other than grants will be issued under this RA. Each 12-month interval of the base period shall not exceed $250,000. Proposals should also include a 12-month option period with a maximum funding level of $500,000. The 12-month option period, referred to as the "Director's Fellowship," will be reserved for a limited number of awardees who demonstrate exceptional YFA project performance over the 24-month base period.

A target start date of July 2020 may be assumed for planning purposes.

As part of the program, a number of visits/exercises at a variety of DoD sites and facilities will be scheduled. These briefings and visits will provide YFA recipients a unique, first-hand exposure to DoD personnel and technologies in the field, issues faced by the Military Services in execution of their missions, and current National Security challenges. It is expected that YFA recipients will participate in a subset of the visits/exercises made available to them. Participation in all such opportunities is not a requirement; however, lack of participation may impact the award of the Director's Fellowship. Proposers are expected to include the necessary travel funds within the total budget of their proposal. For budgeting purposes, please plan for a minimum of 6 two-day meetings (three meetings in the Washington, D.C. area and three meetings in the San Francisco, CA area). Of the six meetings, four should occur over the course of the 24-month base period and two over the course of the 12-month option period.

D. Eligibility

Participation in the YFA program is limited to any current tenure-track Assistant or Associate Professors and to tenured Assistant or Associate Professors within three (3) years of their tenure appointment at a U.S. institution of higher education or equivalent at a U.S. non-profit science and technology research institution. Proposals will not be accepted from foreign organizations. Previous YFA recipients are not eligible to apply to this or any future YFA program. Please see Section III for more details.

E. Topic Areas (TAs)

This RA solicits single principal investigator (PI) proposals for research and development in the specific TAs of interest articulated below. Prior to submitting a full proposal, proposers are *strongly encouraged* to first submit an executive summary as described in Section IV. At the executive summary phase, proposing PIs are limited to one executive summary per TA. At the full proposal phase, proposing PIs are limited to submitting only one full proposal to only one topic under this RA. Submitting more than one full proposal may result in all of the PI's proposal submissions being determined non-conforming and being removed from award consideration.

Potential applicants are encouraged to carefully consider the descriptions of the TAs before submission. Each submission (executive summary or full proposal) must specify ONE and only one TA for the submission and identify this TA on the submission's cover sheet. Executive Summaries and Full Proposals (limit of one proposal per proposer) that do not clearly address a specific topic may be deemed non-conforming and may not be reviewed. DARPA reserves the right to assign a proposal or an executive summary to a different topic area than indicated by the proposer.

Technical inquiries should be emailed to YFA2020@darpa.mil with the TA stated in the subject line. Your question will be distributed to the appropriate contact. Please see Section VIII.A for more details regarding the question and answer process.

1. Unlocking the Secrets of Roman Concrete

Developing new, extremely durable, and crack resistant materials for use in the marine environment is of great national interest. DARPA is particularly interested in developing concrete that can be used to construct a variety of marine structures including seawalls, artificial reefs, and breakwaters, and that is composed of materials available within the United States supply chain. The Romans developed a concrete material that enabled the construction of seawalls that remained intact for over 2,000 years. Rather than degrading in the presence of seawater, Roman concrete gains durability through dissolution, ion exchange, and crystallization processes. While some information about the material composition was recorded in Vitruvius Pollio's "The Ten Books on Architecture," the exact composition and processing technique used by the Romans has been lost to history. DARPA is seeking proposals on work to rediscover the material compositions and processing techniques that produce Roman concrete, as well as conducting the microscale and macroscale characterization of the developed material. Proposals must include development of material samples macroscale durability testing in the presence of seawater, microscale and macroscale analyses.

2. *In Vivo* Biosensors

Warfighter performance and resilience post-injury will increasingly rely on dynamic, adaptive, and personalized treatments. Currently, large, multi-tissue wounds from blast injuries or severe burns are difficult to treat and typically heal incompletely with scarring or abnormal tissue regeneration. These issues overwhelmingly prevent redeployment of injured Service members who are often otherwise young and healthy. To monitor biological changes in response to military-relevant injuries, DARPA is seeking innovative biosensor technologies and platforms to detect a range of relevant biomolecules. These minimally invasive sensors should collect and transmit the concentration of a target molecule in real-time or near real-time and should be biocompatible for use *in vivo*. Biomolecules of particular interest include cytokines, chemokines, and/or growth factors associated with the wound healing and regenerative process. Simpler measurements for biomarkers such as pH or oxygenation are not of interest nor are biophysical sensors.

3. Decision Making Algorithm for Medical Countermeasure (MCM) Development

The DoD has a need to develop effective medical countermeasures (MCMs) for the warfighter in a timely manner. There are currently many challenges along the MCM development pipeline from initial MCM identification, manufacturing, formulation, potency, delivery, safety, pharmacokinetic and pharmacodynamic profiles. Specifically for biologic (protein or nucleic acid) MCMs, there is an opportunity to use advanced analytic approaches based on the sequence information to streamline the MCM development process. Previous investment in DNA or RNA vectored protective monoclonal antibodies has begun to address some of these challenges, but many questions remain around the ability of the nucleic acid to express the desired antibody to sufficient high levels *in vivo*.

DARPA seeks to develop algorithms to address the ability to predict the translation efficiency of a monoclonal antibody from a nucleic acid construct *in vivo*. It is envisioned that the proposed work will consist primarily of three components: data generation, computational analysis and *in vivo* validation of the computational results. In the first component, data generation, proposers shall obtain data on monoclonal antibody sequence and subsequent *in vivo* expression of that antibody from an RNA and/or DNA construct – obtaining available data from the public domain or a previous effort is appropriate. Proposals will address how the magnitude of the data set will be able to sufficiently support the model development. Secondly, proposers will develop computational approaches to predict the *in vivo* translation efficiency of a monoclonal antibody from the corresponding RNA and/or DNA construct. Models should address either an absolute prediction of *in vivo* expression and/or a rank order of highest to lowest expressing antibodies. Finally, proposers will validate the computational approaches in an appropriate animal model. *In vivo* expression can be defined as rodent expression and need not be larger animal models.

4. Microbial Community Modeling

Computational modeling of metabolic processes in single microbial species has accelerated their use in metabolic engineering and application in synthetic biology. From geochemistry to the human microbiome, complex microbial ecosystems drive chemical processes across the globe. For this YFA topic, novel modeling approaches are sought to generate predictive models of dynamic multi-organism systems and their environmental interactions that account for the following: intracellular metabolism, extracellular chemical/biochemical processes, maintenance of membrane chemical/charge potentials, associations with other organisms, and dynamic extracellular conditions. Models should be physiologically accurate and predict intracellular and extracellular conditions of individuals in multi-organism populations in chemically dynamic environments. It is within radically diverse environments that microorganisms employ their membranes to separate intracellular and extracellular chemical processes, and maintaining desired chemical gradients across the membrane is a major energy demand for cells. Dynamic extracellular conditions could alter which membrane transport and interior/exterior biochemical processes are most energy efficient and beneficial for survival. Understanding how the compartmentalized physiologies of microorganisms—in the context of other organisms and their environment—contribute to emergent properties of microbial ecosystems is crucial for engineering these systems. The primary goal of this program is to develop new advanced modeling methodologies to predict the behavior of these cellular control processes and their responses to dynamic changes in extracellular conditions.

5. Biological Systems for Sensing, Reporting, and Mitigating Air Contamination

The aim of this topic is to develop platform technologies that allow complex engineered living communities to sense, report, and mitigate airborne pollutants and toxins. DARPA envisions that this fundamental research will be instrumental in developing technology that allows for engineering self-sustaining, low-cost biological systems (e.g., microbiomes) which activate to monitor, detect, diagnose, respond, and remediate contaminated indoor air conditions. Potential approaches within scope of this topic are development of methods to speed growth and delivery of populations of microorganisms to non-biological systems (e.g., building components), identify key signals to activate desired functions within microbial populations and/or indoor ecosystems, and direct living organisms to control air and surface microbiomes within a confined space. The overall objective is to implement living organisms to balance the indoor air's natural microbiota in the event of heightened pathogen, chemical, and/or pollutant presence.

6. Distributed Intelligence in Flexible Robots

Traditional robotic designs use rigid materials with fixed geometric shapes. Such robots have a low tolerance for locomotion errors and are dangerous when operating in cluttered environments. Advances in materials open the possibility for the development of soft continuum robots, featuring high compliance and inherent safety of operation; however, soft materials have infinitely many degrees of freedom and consequently their complex control remains a computation challenge. Recent research in reservoir computing and morphological computing proposes viewing the complex dynamics of compliant bodies not as problems, but rather opportunities. The idea is that the highly nonlinear dynamics of soft bodies may be considered an exploitable computational resource to solve computational problems. This YFA topic area builds upon this material computation concept that utilizes the computing power inherent in the diverse dynamics of actuating soft materials to achieve a form of distributed intelligence. Soft materials may enable sensing, locomotion control, and even high-level intelligent behaviors such as pose awareness and control, obstacle avoidance, and path planning, all to be directly built into the robotic bodies without relying on a centralized processing unit. The research will cumulate in a lab-scale demonstration of materials executing controlled, purposeful behaviors (as oppose to reactive behaviors) for applications in robots.

7. Bioinspired Soft-Matter Electrical Circuits

Electrical and magnetic phenomena are fundamental properties of all phases of matter but the technological advances we enjoy today are grounded in circuit theories that have largely evolved from, and been confined to, small sets of materials. Concepts of resistance, capacitance and inductance describe biostructures but equivalent circuits describing their electrical functionality are less developed. The task is challenging because of complex boundaries between diverse three dimensional cellular structures some of which exhibit high electrical potentials and all of which transport charged ions. While these active and passive soft-matter circuits drive efficient electromechanical systems and information processing networks, predictive circuit models, like Hodgkin and Huxley's, remain scarce. DARPA is interested in new approaches to develop ion-based circuit models that incorporate soft-matter components with functionality that may be

inspired by a biosystem. Examples at the molecular level include the physiological effects of certain ions and radical reactions on a cell influenced by weak magnetic fields, to coupled magnetic circuit models for the vestibular or limbic system's conducting loops in the brain. All circuit elements, including electromechanical or vibrating components, need to be accurately modeled by their equivalent circuits. Such an approach will provide a quantitative model of electrical and magnetic phenomena in soft-matter systems. This quantitative approach is expected to identify new insights regarding biosystem circuits and bioinspired soft matter circuits whose functionalities are likely to be highly nonlinear, dynamic and ionic current-based. Soft-matter circuit design can lead to the development of firmware/wetware that can interface with biological systems for medical (e.g. wound healing) and communication purposes (prosthetic and neural interfaces). It may also point towards as new efficient green technology opportunities manufactured from soft-matter electronic components and systems.

8. Room-temperature Chip-scale Quantum Opto-mechanical Sensors

This topic seeks development of technologies that enable the coupling between single phonons and photons, i.e. quantum optomechanic, to enable mechanical sensors with ultimate sensitivity. Typically in order to approach the standard quantum limit of displacement measurement, a mechanical mode needs to be laser-cooled to its quantum ground state—a feat that is elusive at room temperature, where most sensing modalities are performed. A fundamental component of this work will be the development of a new breed of quantum optomechanical sensors operated at room temperature developed on a chip-scale slab-on-substrate, and based on long-lived phonons trapped in the radiation continuum. Such architecture would facilitate the dissipation of thermal phonons as well as other non-resonant phonons while trapping coherent phonons of specific frequencies. DARPA envisions sensors that would find extensive applications across DoD missions based on such approach.

9. AI System Engineering

Artificial Intelligence (AI) is being considered for many applications in the near future, not only in DoD, but also elsewhere in Government and in industry. Effective and efficient development and deployment of large numbers of AI applications require consistent standard processes and techniques useable by non-specialists. Acceptance for mission critical applications requires assurance of reliability, maintainability, transparency, explainability, accountability, and other factors. AI is frequently included as a component of a large, complex, heterogeneous system with non-AI software, hardware, and even human components, rather than as a stand-alone software application. Application systems span several dimensions, from non-adaptive to adaptive (i.e., non-AI to AI), simple to complex, and pure information systems to heterogeneous cyber-physical systems. Development and integration methodologies currently exist for complex adaptive information systems (supported by the multitude of software development techniques and tools used by, for example, web application development companies) and complex but non-adaptive cyber-physical systems (large-scale system engineering techniques used by, for example, aerospace manufacturers). However, a mature system comprising an AI component and capable of addressing DoD needs would be adaptive, complex, and cyber-physical. To support the incorporation of AI in complex, non-adaptive, cyber-physical systems and the inclusion of physical components in complex, adaptive, information systems, new techniques for AI system

engineering are required. These techniques must enable scalable, rigorous, repeatable, and reliable design and development of complex, adaptive, cyber-physical systems comprised of both AI and non-AI components.

This effort should focus on extending state-of-the-art software and system engineering design, implementation, application, and evaluation methods, techniques, and tools that are appropriate, effective, and scalable for large, complex, heterogeneous, adaptable cyber-physical systems comprising AI and other types of components. Where current methods fail, novel methods and techniques should be identified, implemented, and applied to real system development efforts. They should be evaluated against existing tools and baseline methods, using appropriate metrics, to understand the applicability, benefits, and limitations of the methods, techniques, and tools. This evaluation should take place in the context of real system development project(s) in which the principal investigator is participating.

10. Advanced Corrosion Control

Corrosion detection and mitigation represents a significant source of cost for the DoD, not only for legacy systems, which can operate for >50 years or more, but also for newer systems that use multi-material lightweighting strategies where corrosion concerns are more difficult to predict. Current understanding of corrosion initiation is generally empirical and in some cases phenomenological, based on extensive field experience and laboratory testing under proxy conditions. A fundamental understanding of the transient microscale initiation mechanisms that drive nucleation and growth of corrosion is needed to develop a more predictive and prescriptive approach to corrosion mitigation.

This topic seeks combined theoretical-experimental efforts to connect atomic-level corrosion nucleation mechanisms with mesoscale chemistry and the surface/interface microstructural features conducive to nucleation. An understanding of how transient environmental conditions affect nucleation kinetics is also desired. Proposers are highly encouraged to utilize advanced materials modeling, high-throughput synthetic data generation and machine learning-enabled materials techniques along with new methods for obtaining high quality atomic-level data. Any DoD-relevant material system may be considered (but must be specified, along with a use case) under an expected range of environmental and/or microbial-induced conditions.

11. Economics-driven Secure Multiparty Computation

While there has always been some intersection of economics and secure multiparty computation (MPC), notably in notions of the covert security model, fairness, and efforts to bring economic utility into security definitions for simulation-based security, the rise of virtual currencies such as Bitcoin demonstrate that even basic cryptographic primitives can be leveraged to build global-scale secure computation protocols when the added lens of economics is brought to bear (in this case, via proof of work). This effort should focus on looking to further bridge the gap of using sophisticated understandings of economics in order to create novel secure multiparty computation that critically rely on understanding of economics notions (e.g., utility functions, equilibrium theories) to enable breakthrough new capabilities for MPC, particularly those that examine more realistic use cases (and greater incentives for use) via economic analyses. This effort is explicitly not aimed at new cryptocurrency research. Basic extensions to existing

cryptographic models that leverage economic utility (e.g., fairness, the covert security model) are also not in scope.

12. Cross-Cultural Extrapolation of Privacy-Oriented Human-Technology Interactions

It is well understood that human-technology interactions are a critical aspect of cybersecurity and privacy. However, these studies have largely been conducted within specific socio-cultural environments (most notably, groups within the United States that enjoy relatively broad access to sophisticated technology). This effort looks to create greater understandings of human-technology interaction for privacy amongst communities that have not previously been examined. This may include foreign communities that have critical privacy needs (e.g., due to living under pervasive state surveillance). Means of quantitatively extrapolating from such studies of one population to another are of interest in order to help broaden the scope of rigorous evaluation.

13. Scientific Model Aware Computing

Software systems are integral to the scientific endeavor and have a large design space that depends on the choice of scientific model. The choices of data structures, algorithms, databases, parallel computing strategies, and numerical methods all depend on properties of the model under consideration, and the effort expended on increasingly advanced software development slows the pace of scientific discovery. Model Aware Computing would be the automated generation of specialized, optimal software tailored to the needs of a specific scientific model under consideration without the complexity of highly generic simulations capable of representing many possible phenomena, which fundamentally changes how scientists interact with software development. Model Aware Computing will support the improvement of scientific software and the automating of scientific reasoning, but it will also expose, represent, and realize the interconnected nature of the modeling structures within and between scientific domains.

14. Push Science

Computational models have the potential to elucidate complex systems in a predictive and explainable way but their building is a laborious process that requires significant manual effort to gather expert information and implement the model. The need for human curation results in models that are subject to the limitations of an individual's knowledge and biases. This topic seeks the development of technologies to build and maintain rich models of complex systems (scientific, social, etc.) by identifying new data and information resources automatically, extracting useful information (causal relations, correlations, context, parameters, etc.), and integrating this into machine-curated expert models. These models should return rich explanations under a variety of different expert queries and eventually be capable of generating (and testing by linking to structured data source) machine-generated hypotheses. Applications will include automatic verification of published scientific results and real-time monitoring of fragile economic, political, social, and environmental systems undergoing complex events.

15. Visualization Innovations for Cyber Terrain Operations Representation (VICTOR)

Human-computer symbiosis will integrate multiple sensing and actuation modes. These span a many order of magnitude range in information rate capacities, with visual input at the apex. Interactive gaming and the desire for realistic visual experiences have spurred the development of high performance graphics processing hardware and display technology.

The emergence and continuing evolution of cyberspace, and its elevation as a national security concern motivate this topic. First and foremost, foundational conceptual and theoretical work to develop a physics for cyberspace is necessary. This physics provides the basis for a visual representation for objects, actors and mathematical representations of cyber-kinetics, cyber-inertia and cyber-thermodynamics and development of a physics of cyberspace should be advantageous in dominating interactions with adversaries.

VICTOR research efforts should be focused on disruptive and novel approaches to a physics of cyberspace. This physics will aid situational awareness for US cyberwarriors operating in cyber terrain, e.g., heatmaps, selective revelation of information, and its urgency and persistence. An experimental software implementation that demonstrates the new physics representation idea(s) and exploits available acceleration hardware in doing so is highly desirable/expected.

16. Reducing Errors in Quantum Systems

Quantum systems, both for sensing and information processing are typically limited by noise and errors associated with coupling to classical environmental effects. This topic seeks to accomplish two objectives: 1) improve the realism of error correction in gate-based quantum computation and 2) finding advantages for computation and/or sensing by combining error correction and sensing techniques. Error correction currently considers those errors that arise from coupling of qubits to random noise processes including non-markovian processes and typically these errors have no spatial dependence. The most realistic error model should also include noise sources with probability distributions that vary in both space and time (e.g. a time dependent temperature gradient), 2nd order couplings (e.g. temperature coupling to a control field coupling to qubits), and systematic errors (e.g. the source for a microwave control field changes and effects multiple qubit operations in a systematic way). Those working to reduce classical noise in quantum sensors would benefit from novel noise and error mitigation techniques (e.g. extending coherence in an interferometer). Additionally, quantum computation may benefit from sensor derived techniques. The most successful proposal to this topic will identify methods and techniques to improve error correction realism, develop the theory necessary to understand their effectiveness, develop classical computation simulations of these techniques, and improve both computation and sensing applications in some way.

17. Dielectrics for High-Temperature CMOS FETs

Investments in wide bandgap (WBG) materials such as silicon carbide (SiC) and gallium nitride (GaN) have enabled new commercially available power electronics. The WBG material foundation can be leveraged for other applications such as high temperature capable electronics. A current limitation is the availability of dielectric materials that would enable CMOS FETs at high temperature ranges. Innovative approaches to dielectrics for high-temperature CMOS electronics, including gate- and interlayer-dielectrics, that can operate at 500°C and beyond are sought for this topic. Approaches should address leakage, breakdown, and bias instabilities as

well has thermomechanical stresses. Characterization of dielectric materials operating at a minimum of 500°C is expected at the end of the base period.

18. A Physics-Based Re-exploration of Spectrum Allocation

The electromagnetic (EM) force operates at just the right level of field strength to be useful for moving, storing, and controlling information. Once discovered as a means to create wireless telegraphy, applications in radio, computers, and information theory, the utility of and access to EM spectrum (EMS) has become a critical part of the digital world. Since days of wireless telegraphy by Marconi, the last century has been a very tight coupling of technology, economics, policy, and society. Today, we have wideband, tunable software defined radios and free and open source software such as GNU Radio that change how we can interact with the EMS. The growing importance of EMS for governments, military, and general society, especially given the current spectrum issues with 5G, is undeniable. The difficulty is in working with a century of regulations and incumbents despite a vastly different world of technology, application needs, and societal demands. In this topic, DARPA wants to rethink approaches to EMS management through a holistic and physics-driven methodology.

The research should first contextualize the problem based on the history of applications, spectrum regulations, and technology. This background will include work in dynamic spectrum access (DSA) such as DARPA xG technology and DARPA's current Spectrum Collaboration Challenge (SC2) as well as research in DSA from the IEEE DySPAN Symposium and new regulatory approaches such as licensed shared access (LSA).

The research should clearly identify possible applications of EM spectrum and map them to the physics requirements needed to support them such as power, dynamic range, frequency, bandwidth, latency, and size, weight, and power (SWaP) constraints. All possible degrees of freedom should be accounted for. The work in representing these problems should have a rigorous mathematical model with an information theoretic-driven approach to modeling how information is moved and distorted/reduced through interference.

The work should produce a new perspective on EM spectrum device capabilities to inform new approaches to spectrum sharing and point the way to inform the next generation of EM devices. The models are the output goal of this research work and should culminate in mathematical models, experimental analysis, and a set of recommendations for future technology development. Proposers should plan on continuous engagements with regulators, the wireless industry, and wireless researchers, including the GNU Radio and DySPAN communities. The work should focus on a full perspective of the history, technology, understood physics of EM, and known technology solution to EMS from start to finish.

19. Detecting Cognitive Dissonance & Belief Shift Over Time

This topic seeks to develop and validate methods: 1) for detecting and identifying cognitive dissonance – or when a person or community holds two beliefs that are in conflict, and specifically when a belief is in conflict with an action, and 2) for predicting when confronted with the conflict, what action the conflicted will take to resolve the tension (e.g., change beliefs, change actions, add rationalizing thoughts, trivialize the inconsistency, etc.). Of particular interest is how repeated and recursive cycles of confrontation and resolution shift belief and/or

actions over time – weeks, months or even years. For example, a woman may believe smoking is bad for her health, but continue to smoke. She may resolve the conflict by changing her behavior, trivializing the conflict, or justifying it with additional, moderating beliefs regarding her healthy eating habits and active lifestyle. Over time she may shift her thinking to believe that because she smokes she is driven to exercise and therefore smoking is actually improving her overall health. Scalable methods are preferred over small-sample methods, however applicants may consider testing theories in controlled conditions to compliment and validate scalable approaches. Proposers should describe their plan to: test the method; to demonstrate the method's generalizability (e.g., should apply to any area of the world); and to quantify uncertainties, limitations, and/or prediction horizons. Applicants may propose to apply methods from other domains to this particular challenge provided the proposal describes how and why the approach is applicable to meet topic goals. Please indicate whether the work will include Human Subjects Research and how Independent Review Board (IRB) approvals will affect schedule. DARPA encourages preregistration of all research studies.

20. Chip-scale Blind Sampled Wideband Periodogram and Time Transfer by Machine Learning

Detecting, synchronizing and establishing peer-to-peer wireless cognitive communications without a centralized reference signal are critical for many DoD and future 5G/6G commercial wireless applications. This topic seeks to explore how machine learning chip-scale solutions can provide low latency detection, synchronization and timing transfer of accurate clocks between cognitive mobile devices operating in the absence of centralized reference clock signals, such as provided by a basestation or GPS. Successful proposals will focus on blind capture, processing and extraction of single/multiple periodic clocks to establish two-way time transfer for ultra wideband and/or multi-band signals over a wide spectrum (>10 GHz) without a priori knowledge, while mitigating undesirable fading, interferences and impairments in the communication channel. While this is a basic research exploration, culmination in a working demonstration is expected, including the implementation of a chip-scale energy-efficient low latency (< 10us) electronic integrated circuits designed using these algorithms.

21. Practical Antineutrino Detectors

This topic seeks to advance antineutrino detector technology toward the practical use of antineutrinos as a tool for national security applications. Nuclear reactors produce antineutrinos in copious quantities. The antineutrinos cannot be shielded because they rarely interact with matter. By the same token, they are extremely difficult to detect. Fundamental physics experiments have successfully demonstrated remote detection of (anti-)neutrinos from reactors and other sources. The detectors used in these experiments have been very large, deep underground, and expensive. Furthermore, teams of experts were required to calibrate and maintain the equipment and to analyze the data. The aim of this topic is to investigate promising next-generation technologies for the detection of reactor antineutrinos with the goal of an order of magnitude improvement over the current state of the art in any one of size, required overburden, cost, robustness, automation, background rejection, or angle-of-arrival precision.

22. RF Power Harvesting for Remote Sensing

Ambient RF energy harvesting concepts have been around since the early 2000's when microelectronics became efficient enough to make use of their low energy yield. A key player in RF energy harvesting is the rectenna which uses an integrated rectifier and antenna to convert RF power to DC power at much greater efficiencies. However, rectenna conversion efficiency is not maintained at low RF power (<<1mW) on account of limiting diode characteristics used in rectification. This relegates RF energy harvesting to regions in close proximity to an RF transmitter. DARPA is seeking innovative methods for harvesting RF energy with high efficiency in regions with low RF power (<<1mW).

23. Low Loop Latency Distributed Time Transfer

Distributed time transfer is the process of synchronizing reference clocks via a wireless link between multiple radios. Distributed time transfer can improve relative position and timing measurements leading to new applications in distributed computing, communications, navigation, geo-location and sensing. Accurate time transfer requires continuous feedback and adjustment to maintain clock alignment. The primary limitation to highly accurate distributed time transfer is prediction of future phase in the presence of phase noise. During time transfer one clock transmits to a remote clock whereby the remote clock is able to update its clock based on a prediction of the phase of the originating clock. However, the originating clock, being subject to phase noise, will drift in the intervening time. In these distributed systems, loop latency is dependent on distance between nodes plus integration and processing time leading to loop latencies >1ms. This topic seeks innovative solutions for significantly reducing the effect of loop latency for the purpose of maintaining tightly synchronized reference clocks from multiple radios (>10) across long distances (>> 1 km) despite the presence of substantial phase nose.

24. High-Entropy Alloys Study

High entropy alloys are materials which are comprised of 5 or more elements (typically 3d metals) decorating a single crystal lattice. The large chemical entropy in these materials increases their melting temperature to >2000° C, while the short-range disorder tends to resist oxygen migration. These qualities are ideal to meet the challenges of extreme environments, such as atmospheric reentry. DARPA seeks proposals that investigate ultra-low density materials (<1% wt. bulk) comprised of high-entropy alloys, that could be used for a low density "skin". We also seek ideas for deposition of these skins (such as electrodeposition from ionic solutions) or their creation via in situ nuclear decay. Electrodepositing into polycarbonate track-etched membranes, creates high-entropy alloy nanowires which can be harvested, dispersed and freeze-dried, leaving a nanoscale birdsnest, with densities of ≈0.1% of bulk with excellent thermal and electronic properties. Sintering these structures crosslinks the wires and provides significant structural strength. Similar and alternative approaches are encouraged as are studies of the broader mechanical, thermal, electromagnetic properties of such structures.

25. Ocean Object Identification via Distributed Sensors

This topic seeks new methods or technologies that enable detection of man-made objects in an ocean environment utilizing 'through the sensor' environmental data from large distributed

arrays of in-situ sensors. Low cost sensors and platforms with numerous observation modalities and robust communications capabilities continue to emerge, and their potential for deployment in massive sensor arrays is presently being demonstrated. Research should focus on exploiting the distributed nature of the sensor placement as well as using environmental data that is not explicitly intended or tuned for object detection. DARPA envisions systems that can simulate new and innovative sensor arrays, provide synthetic data for exploitation algorithm development, and predict array performance for object detection. Ideas that employ integrated (sensor and environment) modeling, sparse data assimilation, and machine learning techniques are encouraged.

26. Flame Stability and Ignition in Partially-Premixed High-Speed Flows

Flame stabilization in high-speed flows is often understood based on studies of premixed combustion. Eventually reusable high-speed engines may exist that will operate over a wide range of conditions, often utilizing cavities in a partially-premixed regime that has not been studied to the same extent as the premixed regime. Understanding how to properly design such engines for flame stability and ignition requires a greater understanding of the scaling parameters and stabilization mechanisms involved in these flows. This effort should be focused on the application of modern diagnostics and computational modeling to better understand the mechanisms by which these flames ignite and stabilize relative to flame stratification, degree of partial-premixing, and burning location.

27. On-Orbit Servicing Architectures for Proliferated Low Earth Orbit (LEO) Constellations

This topic seeks innovative approaches to on-orbit servicing of proliferated LEO constellations. The primary client focus for current and next-generation servicers (e.g., RSGS, RESTORE-L) has been large, long-lived, high-value assets such as GEO comsats and LEO/MEO science and weather satellites. The envisioned LEO constellation spacecraft are, instead, small low-value spacecraft with limited lifetimes. So far there has been relatively little consideration of the potential role for on-orbit servicing of these assets, given that self-disposal and replacement appears to be a relatively low-cost alternative. Proposed efforts may address technical, economic, and policy objectives that enhance existing capabilities or enable new capabilities for proliferated LEO constellations through on-orbit servicing. Notional servicing capabilities could include docking (connecting) with client vehicles not designed for docking, docking with rotating vehicles not under control, controlling and maneuvering the combined servicer and client stack, attaching secondary payloads to ad hoc hard points on a client, accessing client ground test power and data ports on-orbit, attaching de-orbit packages to derelict objects, and more. Note: This call seeks proposals at the architecture and/or system level, and is not seeking individual component-level technologies.

II. Award Information

A. General Award Information

DARPA anticipates multiple awards.

The level of funding for individual awards made under this RA will depend on the quality of the proposals received and the availability of funds. Awards will be made to proposers[1] whose proposals are determined to be the most advantageous to the Government, all evaluation factors considered. See Section V for further information.

The Government reserves the right to:

- select for negotiation all, some, one, or none of the proposals received in response to this solicitation;
- make awards without discussions with proposers;
- conduct discussions with proposers if it is later determined to be necessary;
- segregate portions of resulting awards into pre-priced options;
- accept proposals in their entirety or to select only portions of proposals for award;
- fund awards in increments with options for continued work at the end of one or more phases and increase the cost ceiling of the award for additional work within scope;
- request additional documentation once the award instrument has been determined (e.g., representations and certifications); and
- remove proposers from award consideration should the parties fail to reach agreement on award terms within a reasonable time or the proposer fails to provide requested additional information in a timely manner.

Proposals identified for negotiation will result in a grant.

B. Fundamental Research

It is DoD policy that the publication of products of fundamental research will remain unrestricted to the maximum extent possible. National Security Decision Directive (NSDD) 189 defines fundamental research as follows:

> 'Fundamental research' means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons.

As of the date of publication of this RA, the Government expects that program goals as described herein may be met by proposers intending to perform fundamental research and does not anticipate applying publication restrictions of any kind to individual awards for fundamental research that may result from this RA. Only fundamental research will be funded under this RA.

[1] As used throughout this RA, "proposer" refers to the lead organization on a submission to this RA. The proposer is responsible for ensuring that all information required by a RA--from all team members--is submitted in accordance with the RA. "Awardee" refers to anyone who might receive a prime award from the Government. "Subawardee" refers to anyone who might receive a subaward from a prime awardee (e.g., subawardee, consultant, etc.).

III. Eligibility Information

A. Eligible Applicants

Participation is open to individuals who are U.S. Citizens, U.S. Permanent Residents, and Foreign Nationals who meet the eligibility criteria listed below:

- Proposers must be one of the following (excluding any personal leaves of absence) by the full proposal deadline listed in Part One: Overview Information:
  - current Tenure-Track Assistant/Associate Professors;
  - current Tenured faculty within 3 years of their Tenure date; or
  - an equivalent at a non-profit research institution within 12 years of the receipt of their Ph.D.

- All proposers must be employed at a U.S. Institution.

- Previous YFA recipients are not eligible for this or any future, YFA program.

- Former DARPA Program Managers are not eligible to apply for funding under this program.

- Researchers working at Federally Funded Research and Development Centers, and Government Entities are not eligible to apply as PIs for funding under this program; however, they may be proposed as subawardees, – please see Section III.A.1 for eligibility information, and Section VIII.B for teaming

- Non-U.S. individuals employed by U.S. Institutions may participate to the extent that such participants comply with any necessary nondisclosure agreements, security regulations, export control laws, and other governing statutes applicable under the circumstances. See Section III.A for more information.

- At the executive summary phase, proposing PIs are limited to one executive summary per TA. At the full proposal phase, proposing PIs are limited to submitting only one full proposal to only one topic under this RA. Submitting more than one full proposal may result in all of the PI's proposal submissions being determined non-conforming and being removed from award consideration. A proposer is strongly encouraged to submit an executive summary in advance of a full proposal to determine DARPA's interest and minimize the effort and expense of preparing an out of scope proposal.

- Recipients of non-YFA DARPA awards are eligible to propose. Proposers must provide a listing of federal support (past, current, and pending). This list must include the sponsor, amount, and performance dates of all federally-funded research efforts and should be present on the submission cover sheet as indicated in Section IV.

There is no limit to the number of applications that can be submitted by an institution; however, each submission must have a single PI. Submissions to young investigator programs sponsored by other agencies are not restricted.

1. Federally Funded Research and Development Centers (FFRDCs) and Government Entities as Subawardees

a. FFRDCs

FFRDCs are subject to applicable direct competition limitations and cannot propose to this RA as a subawardee unless they meet the following conditions. (1) FFRDCs must clearly demonstrate that the proposed work is not otherwise available from the private sector. (2) FFRDCs must provide a letter, on official letterhead from their sponsoring organization, that (a) cites the specific authority establishing their eligibility to propose to Government solicitations and compete with industry, and (b) certifies the FFRDC's compliance with the associated FFRDC sponsor agreement's terms and conditions. These conditions are a requirement for FFRDCs proposing to be subawardees.

b. Government Entities

Government Entities (e.g., Government/National Laboratories, Military Educational Institutions, etc.) proposing as subawardees are subject to applicable direct competition limitations. Government Entities must clearly demonstrate that the work is not otherwise available from the private sector and provide written documentation citing the specific statutory authority and contractual authority, if relevant, establishing their ability to propose to Government solicitations and compete with industry.

Authority and Eligibility

At the present time, DARPA does not consider 15 U.S.C. § 3710a to be sufficient legal authority to show eligibility. While 10 U.S.C.§ 2539b may be the appropriate statutory starting point for some entities, specific supporting regulatory guidance, together with evidence of agency approval, will still be required to fully establish eligibility. DARPA will consider FFRDC and Government Entity subawardee submissions on a case-by-case basis; however, the burden to prove eligibility for all team members rests solely with the proposer.

2. Foreign Participation

Non-U.S. organizations may not propose to this RA in any capacity.

B. Organizational Conflicts of Interest

Proposers are required to identify and disclose all facts relevant to potential OCIs involving the proposer's organization and any proposed team member (subawardee, consultant). Under this Section, the proposer is responsible for providing this disclosure with each proposal submitted to the RA. The disclosure must include the proposer's, and as applicable, proposed team member's OCI mitigation plan. The OCI mitigation plan must include a description of the actions the proposer has taken, or intends to take, to prevent the existence of conflicting roles that might bias

the proposer's judgment and to prevent the proposer from having unfair competitive advantage. The OCI mitigation plan will specifically discuss the disclosed OCI in the context of each of the OCI limitations referenced in FAR 9.505-1 through FAR 9.505-4.

Agency Supplemental OCI Policy
In addition, DARPA has a supplemental OCI policy that prohibits contractors/performers from concurrently providing Scientific Engineering Technical Assistance (SETA), Advisory and Assistance Services (A&AS) or similar support services and being a technical performer. Therefore, as part of the disclosure requirement above, a proposer must affirm whether the proposer or any proposed team member (subawardee, consultant) is providing SETA, A&AS, or similar support to any DARPA office(s) under: (a) a current award or subaward; or (b) a past award or subaward that ended within one calendar year prior to the proposal's submission date.

If SETA, A&AS, or similar support is being or was provided to any DARPA office(s), the proposal must include:

- The name of the DARPA office receiving the support;
- The prime contract number;
- Identification of proposed team member (subawardee, consultant) providing the support; and
- An OCI mitigation plan in accordance with this RA.

Government Procedures
The Government will evaluate OCI mitigation plans to avoid, neutralize or mitigate potential OCI issues before award and to determine whether it is in the Government's interest to grant a waiver. The Government will only evaluate OCI mitigation plans for proposals that are determined selectable under the RA evaluation criteria and funding availability.

The Government may require proposers to provide additional information to assist the Government in evaluating the proposer's OCI mitigation plan.

If the Government determines that a proposer failed to fully disclose an OCI; or failed to provide the affirmation of DARPA support as described above; or failed to reasonably provide additional information requested by the Government to assist in evaluating the proposer's OCI mitigation plan, the Government may reject the proposal and withdraw it from consideration for award.

C. Cost Sharing/Matching

Cost sharing is not required.

IV. Application and Submission Information

Prior to submitting a full proposal, proposers are *strongly encouraged* to first submit an executive summary as described below. This process allows a proposer to ascertain whether the proposed concept is: (1) applicable to the YFA RA; and (2) currently of interest. For the purposes of this RA, applicability is defined as follows:

- The proposed concept is applicable to the technical and topic areas described herein;

- The proposed concept is important to DARPA's current investment portfolio;
- The proposed concept investigates an innovative approach that enables revolutionary advances, i.e., will not primarily result in evolutionary improvements to the existing state of practice;
- The proposed work has not already been completed (i.e., the research element is complete but manufacturing/fabrication funds are required);
- The proposer has not already received funding or a positive funding decision for the proposed concept (whether from DARPA or another Government agency);
- The proposer must meet the eligibility requirements outlined in Section III; and
- Only requests for grants may be considered.

Executive summaries and full proposals that are not found to be applicable to the YFA RA as defined above may be deemed non-conforming[2] and removed from consideration. All executive summaries and full proposals must provide sufficient information to assess the validity/ feasibility of their claims as well as comply with the requirements outlined herein for submission formatting, content and transmission to DARPA. Executive summaries and full proposals that fail to do so may be deemed non-conforming and removed from consideration. Proposers will be notified of non-conforming determinations via letter.

A. Address to Request Application Package

This document contains all information required to submit a response to this solicitation. No additional forms, kits, or other materials are needed except as referenced herein. No request for proposal or additional solicitation regarding this opportunity will be issued, nor is additional information available except as provided at the Federal Business Opportunities website (http://www.fbo.gov), the Grants.gov website (http://www.grants.gov/), or referenced herein.

B. Content and Form of Application Submission

1. Executive Summary Information

As stated above, proposers are strongly encouraged to submit an executive summary in advance of a full proposal to minimize effort and reduce the potential expense of preparing an out of scope proposal. DARPA will respond to executive summaries with a statement as to whether DARPA is interested in the idea. Regardless of DARPA's response to an executive summary, proposers may submit a full proposal. DARPA will review all conforming full proposals using the published evaluation criteria (See Section V.A) and without regard to any comments resulting from the review of an executive summary. Proposers should note that a favorable response to an executive summary is not a guarantee that a proposal based on the executive summary will ultimately be selected for award negotiation.

Executive summaries submitted in response to this solicitation may anticipate a response within approximately 30 calendar days. These notifications will be sent via email to the Technical POC and/or Administrative POC identified on the executive summary coversheet.

[2] "Conforming" is defined as having been submitted in accordance with the requirements outlined herein.

Proposing PIs are limited to one executive summary per TA. Proposers are encouraged to carefully consider the descriptions of the TAs before submission. Each executive summary submission must specify ONE and only one of these TAs for their submission and identify this TA on the submission cover sheet. Executive summaries that do not clearly address a specific topic may be deemed non-conforming and may not be reviewed. DARPA reserves the right to assign executive summaries to a different topic area than indicated by the proposer.

Executive summaries must not be submitted to DARPA via email. See Section IV.E.1.a for executive summary submission instructions.

a. Executive Summary Format

All proposers are required to use the template provided as Attachment A to this solicitation on www.fbo.gov and http://www.grants.gov.

2. Full Proposal Information

Full proposals requesting a grant must use the following Attachments in addition to the Grants.gov application package. Complete full proposals consist of Attachment B: Proposal Template - Technical and Management Volume 1, Attachment C: Cost Breakdown Template, Attachment D: Proposal Template - Administrative and National Policy Requirements Volume 3, and Attachment E: Proposal Template summary slide. Attachment F: Proposal Template Cost Volume 2 (Optional).

> *Note – Budget Justification should be provided as Section L of the SF 424 Research & Related Budget form provided via Grants.gov. The Budget Justification should include the following information for the recipient and all subawardees: (1) Direct Labor: Detail the total number of persons and their level of commitment for each position listed (in sections A and B), as well as which specific tasks (as described in the SOW) they will support.(2) Equipment (section C) Provide an explanation for listed requested equipment exceeding $5,000, properly justifying their need to meet the objectives of the program. (3) Travel (section D) Provide the purpose of the trip, number of trips, number of days per trip, departure and arrival destinations, number of people, etc. (4) Other Direct Costs (section F). Provide a justification for the items requested and an explanation of how the estimates were obtained.

Proposing PIs are limited to one full proposal submission to only one TA under this RA. Submitting more than one full proposal may result in all of the PI's proposal submissions being determined non-conforming and being removed from award consideration.

Potential applicants are encouraged to carefully consider the descriptions of the TAs before submission. A full proposal must specify ONE and only one of these TAs for the submission and identify this TA on the submission cover sheet. Full proposals that do not clearly address a specific topic may be deemed non-conforming and may not be reviewed. DARPA reserves the right to assign proposals to a different TA than indicated by the proposer.

Full proposals must not be submitted to DARPA via email. See Section IV.E.1.b for proposal

submission instructions.

a. Full Proposal Format

All proposers are required to use the templates provided as Attachments B, C, D, and E to this solicitation on www.fbo.gov and http://www.grants.gov.

3. Proprietary Information

Proposers are responsible for clearly identifying proprietary information. Submissions containing proprietary information must have the cover page and each page containing such information clearly marked with a label such as "Proprietary" or "Company Proprietary." NOTE: "Confidential" is a classification marking used to control the dissemination of U.S. Government National Security Information as dictated in Executive Order 13526 and should not be used to identify proprietary business information. See Section V.B.1 for additional information.

4. Security Information

All proposals and supporting documentation must be unclassified. All awards made under this RA will be unclassified.

C. Submission Dates and Times

Proposers are warned that submission deadlines as outlined herein are in Eastern Time and will be strictly enforced. When planning a response to this solicitation, proposers should take into account that some parts of the submission process may take from one business day to one month to complete (e.g., registering for a Data Universal Numbering System (DUNS) number or Taxpayer Identification Number (TIN)).

DARPA will acknowledge receipt of *complete* submissions via email and assign identifying numbers that should be used in all further correspondence regarding those submissions. If no confirmation is received within two business days, please contact the RA Administrator at YFA2020@darpa.mil to verify receipt.

1. Executive Summaries

Executive summaries must be submitted per the instructions outlined herein *and received by DARPA* no later than the due date and time listed in Part One: Overview Information. Executive summaries received after this time and date may not be reviewed.

2. Full Proposals

Full proposal packages--full proposal (Technical and Management Volume, Cost Breakdown, Administrative and National Policy Requirements, Summary Slide) and, as applicable, proprietary subawardee cost proposals, classified appendices to unclassified proposals-- must be submitted per the instructions outlined herein *and received by DARPA* no later than the due date and time listed in Part One: Overview Information. Proposals received after this time and date may not be reviewed.

D. Funding Restrictions

Not applicable.

E. Other Submission Requirements

1. Submission Instructions

Proposers must submit all parts of their submission package using the same method; submissions cannot be sent in part by one method and in part by another method nor should duplicate submissions be sent by multiple methods. Email submissions will not be accepted. Failure to comply with the submission procedures outlined herein may result in the submission being deemed non-conforming and withdrawn from consideration. All proposals and supporting documentation must be unclassified.

a. Executive Summaries

DARPA will employ an electronic upload submission system (https://baa.darpa.mil/) for all executive summaries sent in response to this solicitation. *Executive Summaries must not be submitted via Grants.gov, via hard copy, or via email.*

First time users of the DARPA Submission website must complete a two-step account creation process. The first step consists of registering for an extranet account by going to the URL listed above and selecting the "Account Request" link. Upon completion of the online form, proposers will receive two separate emails; one will contain a user name and the second will provide a temporary password. Once both emails have been received, the second step requires proposers to go back to the submission website and log in using that user name and password. After accessing the extranet, proposers may then create a user account for the DARPA Submission website by selecting the "Register your Organization" link at the top of the page. Once the user account is created, proposers will be able to see a list of solicitations open for submissions, view submission instructions, and upload/finalize their executive summary.

Proposers who already have an account on the DARPA Submission website may simply log in at https://baa.darpa.mil/, select this solicitation from the list of open DARPA solicitations and proceed with their executive summary submission. Note: proposers who have created a DARPA Submission website account to submit to another DARPA Technical Office's solicitations do not need to create a new account to submit to this solicitation.

All executive summaries submitted electronically through the DARPA Submission website must meet the following requirements: (1) uploaded as a zip file (.zip or .zipx extension); (2) only contain the document(s) requested herein; and (3) must not exceed 100 MB in size. Only one zip file will be accepted per executive summary and executive summaries not uploaded as zip files will be rejected by DARPA.

Technical support for the DARPA Submission website is available during regular business hours, Monday – Friday, 9:00 a.m. – 5:00 p.m. Requests for technical support must be emailed to BAAT_Support@darpa.mil with a copy to YFA2020@darpa.mil. Questions regarding submission contents, format, deadlines, etc. should be emailed to YFA2020@darpa.mil. Questions/requests for support sent to any other email address may result in delayed/no response.

Since proposers may encounter heavy traffic on the web server, DARPA discourages waiting until the day executive summaries are due to request an account and/or upload the submission. Note: Proposers submitting an executive summary via the DARPA Submission website MUST (1) click the "Finalize" button in order for the submission to upload AND (2) do so with sufficient time for the upload to complete prior to the deadline. Failure to do so will result in a late submission.

i. Electronic Upload

DARPA encourages grant proposers to submit their proposals via electronic upload at http://www.grants.gov/web/grants/applicants/apply-for-grants.html. Proposers electing to use this method must complete a one-time registration process on Grants.gov before a proposal can be electronically submitted. *If proposers have not previously registered, this process can take up to four weeks so* registration should be done in sufficient time to ensure it does not impact a proposer's ability to meet required submission deadlines. Registration requirements and instructions are outlined at http://www.grants.gov/web/grants/register.html.

Carefully follow the DARPA submission instructions provided with the solicitation application package on Grants.gov. Only the required forms listed therein (e.g., SF-424 and Attachments form) should be included in the submission. *Note: Grants.gov does not accept zipped or encrypted proposals.*

Once Grants.gov has received an uploaded proposal submission, Grants.gov will send two email messages to notify proposers that: (1) the proposal has been received by Grants.gov; and (2) the proposal has been either validated or rejected by the system. *It may take up to two business days to receive these emails.* If the proposal is validated, then the proposer has successfully submitted their proposal. If the proposal is rejected, the submission must be corrected, resubmitted and revalidated before DARPA can retrieve it. If the solicitation is no longer open, the rejected proposal cannot be resubmitted. Once the proposal is retrieved by DARPA, Grants.gov will send a third email to notify the proposer. DARPA will send a final confirmation email as described in Section IV.C.

To avoid missing deadlines, Grants.gov recommends that proposers submit their proposals to Grants.gov 24-48 hours in advance of the proposal due date to provide sufficient time to complete the registration and submission process, receive email notifications and correct errors, as applicable.

Technical support for Grants.gov submissions may be reached at 1-800-518-4726 or support@grants.gov.

ii. Direct Mail/Hand-carry

Proposers electing to submit grant proposals via direct mail or hand-carried must provide one paper copy and one electronic copy on CD or DVD of the full proposal package. Proposers must complete the SF 424 R&R form (Application for Federal Assistance, Research and Related) provided at Grants.gov as part of the opportunity application package for this RA and include it in the proposal submission. All parts of the proposal package must be mailed or

hand-carried to the address noted in Section VII below.

V. Application Review Information

A. Evaluation Criteria

Proposals will be evaluated using the following criteria listed in descending order of importance: Overall Scientific and Technical Merit; Potential Contribution and Relevance to the DARPA Mission; and Cost Realism.

- **Overall Scientific and Technical Merit**

The proposed technical approach is innovative, feasible, achievable, and complete.

The proposed technical team has the expertise and experience to accomplish the proposed tasks. Task descriptions and associated technical elements provided are complete and in a logical sequence with all proposed deliverables clearly defined such that a final outcome that achieves the goal can be expected as a result of award. The proposal identifies major technical risks and planned mitigation efforts are clearly defined and feasible. The proposed schedule aggressively pursues performance metrics in an efficient time frame that accurately accounts for the anticipated workload.

- **Potential Contribution and Relevance to the DARPA Mission**

The potential contributions of the proposed effort bolster the national security technology base, and support DARPA's mission to make pivotal early technology investments that create or prevent technological surprise. The proposed intellectual property restrictions (if any) will not significantly impact the Government's ability to transition the technology.

- **Cost Realism**

The proposed costs are realistic for the technical and management approach and accurately reflect the technical goals and objectives of the solicitation. The proposed costs are consistent with the proposer's Statement of Work and reflect a sufficient understanding of the costs and level of effort needed to successfully accomplish the proposed technical approach. The costs for the prime proposer and proposed subawardees are substantiated by the details provided in the proposal (e.g., the type and number of labor hours proposed per task, the types and quantities of materials, equipment and fabrication costs, travel and any other applicable costs and the basis for the estimates).

B. Review and Selection Process

DARPA will conduct a scientific/technical review of each conforming proposal. Conforming proposals comply with all requirements detailed in this RA; proposals that fail to do so may be deemed non-conforming and may be removed from consideration. Proposals will not be evaluated against each other since they are not submitted in accordance with a common work statement. DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons.

The review process identifies proposals that meet the evaluation criteria described above and are, therefore, selectable for negotiation of awards by the Government. DARPA policy is to ensure impartial, equitable, comprehensive proposal evaluations and to select proposals that meet DARPA technical, policy, and programmatic goals. Proposals that are determined selectable will not necessarily receive awards (see Section II). Selections may be made at any time during the period of solicitation. For evaluation purposes, a proposal is defined to be the document and supporting materials as described in Section IV.

1. Handling of Source Selection Information

DARPA policy is to treat all submissions as source selection information, and to only disclose their contents to authorized personnel. Restrictive notices notwithstanding, submissions may be handled by support contractors for administrative purposes and/or to assist with technical evaluation. All DARPA support contractors performing this role are expressly prohibited from performing DARPA-sponsored technical research and are bound by appropriate nondisclosure agreements. DARPA may also request input on technical aspects of the proposals from other non-Government consultants/experts who are strictly bound by the appropriate non-disclosure requirements.

Submissions will not be returned. The original of each submission received will be retained at DARPA and all other non-required copies destroyed. A certification of destruction may be requested via email to the RA mailbox, provided the formal request is received within 5 business days after being notified of submission status.

C. Federal Awardee Performance and Integrity Information (FAPIIS)

Following the review and selection process described above, but prior to making an award above the simplified acquisition threshold, DARPA is required[3] to review and consider any information available through the designated integrity and performance system (currently FAPIIS). Selectees have the opportunity to comment on any information about themselves entered in the database. DARPA will consider any comments and other information in FAPIIS or other systems prior to making an award.

VI. Award Administration Information

A. Selection Notices

After proposal evaluations are complete, proposers will be notified as to whether their proposal was selected for award negotiation as a result of the review process. Notification will be sent by email to the Technical and Administrative POCs identified on the proposal cover sheet. If a proposal has been selected for award negotiation, the Government will initiate those negotiations following the notification.

B. Administrative and National Policy Requirements

[3] Per 41 U.S.C. 2313, as implemented by 2 CFR § 200.205.

1. Solicitation Provisions and Award Clauses, Terms and Conditions

Solicitation provisions relevant to DARPA RAs are listed on the Additional RA Content page on DARPA's website at www.darpa.mil/work-with-us/additional-baa. This page also lists award clauses that, depending on their applicability, may be included in the terms and conditions of awards resultant from DARPA solicitations. This list is not exhaustive and the clauses, terms and conditions included in a resultant award will depend on the nature of the research effort, the specific award instrument, the type of awardee, and any applicable security or publication restrictions.

For terms and conditions specific to grants and/or cooperative agreements, see the DoD General Research Terms and Conditions (latest version) at http://www.onr.navy.mil/Contracts-Grants/submit-proposal/grants-proposal/grants-terms-conditions and the supplemental DARPA-specific terms and conditions at http://www.darpa.mil/work-with-us/contract-management#GrantsCooperativeAgreements.

The above information serves to put potential proposers and awardees on notice of proposal requirements and award terms and conditions to which they may have to adhere.

2. System for Award Management (SAM) and Universal Identifier Requirements

All proposers must be registered in SAM .See http://www.darpa.mil/work-with-us/additional-baa for further information.

International entities can register in SAM by following the instructions in this link: https://www.fsd.gov/fsd-gov/answer.do?sysparm_kbid=dbf8053adb119344d71272131f961946&sysparm_search=KB0013221.

NOTE: new registrations can take an average of 7-10 business days to process in SAM. SAM registration requires the following information:

- DUNS number
- TIN
- Commercial and Government Entity (CAGE) Code. If a proposer does not already have a CAGE code, one will be assigned during SAM registration.
- Electronic Funds Transfer information (e.g., proposer's bank account number, routing number, and bank phone or fax number).

3. Representations and Certifications

Prospective proposers shall complete electronic annual representations and certifications at http://www.sam.gov.

4. Intellectual Property

Proposers should note that the Government does not own the intellectual property or technical data/computer software developed under Government grants. The Government acquires the right to use the technical data/computer software. Regardless of the scope of the Government's rights, awardees may freely use their same data/software for their own commercial purposes (unless restricted by U.S. export control laws or security classification). Therefore, technical data and computer software developed under this solicitation will remain the property of the awardees,

though DARPA will have, at a minimum, Government Purpose Rights (GPR) to technical data and computer software developed through mixed sponsorship.

If proposers desire to use proprietary computer software or technical data or both as the basis of their proposed approach, in whole or in part, they should: (1) clearly identify such software/data and its proposed particular use(s); (2) explain how the Government will be able to reach its program goals (including transition) within the proprietary model offered; and (3) provide possible nonproprietary alternatives in any area that might present transition difficulties or increased risk or cost to the Government under the proposed proprietary solution. Proposers expecting to use, but not to deliver, commercial open source tools or other materials in implementing their approach may be required to indemnify the Government against legal liability arising from such use.

All references to "Unlimited Rights" or "Government Purpose Rights" are intended to refer to the definitions of those terms as set forth in the Defense Federal Acquisition Regulation Supplement (DFARS) 227.

a. Intellectual Property Representations

All proposers must provide a good faith representation of either ownership or possession of appropriate licensing rights to all other intellectual property to be used for the proposed project. Proposers must provide a short summary for each item asserted with less than Unlimited Rights that describes the nature of the restriction and the intended use of the intellectual property in the conduct of the proposed research.

b. Patents

All proposers must include documentation proving ownership or possession of appropriate licensing rights to all patented inventions to be used for the proposed project. If a patent application has been filed for an invention, but it includes proprietary information and is not publicly available, a proposer must provide documentation that includes: the patent number, inventor name(s), assignee names (if any), filing date, filing date of any related provisional application, and summary of the patent title, with either: (1) a representation of invention ownership; or (2) proof of possession of appropriate licensing rights in the invention (i.e., an agreement from the owner of the patent granting license to the proposer).

c. Grant Awards

Proposers shall follow the applicable rules and regulations governing grants, and should appropriately identify any potential restrictions on the Government's use of any intellectual property contemplated under these awards. This includes both noncommercial items and commercial items. The Government may use the list as part of the evaluation process to assess the impact of any identified restrictions, and may request additional information from the proposer, to evaluate the proposer's assertions. Failure to provide full information may result in a determination that the proposal is non-conforming. A template for complying with this request is provided in Section IV.B.2.

5. Human Subjects Research (HSR)/Animal Use

Proposers that anticipate involving human subjects or animals in the proposed research must comply with the approval procedures detailed at http://www.darpa.mil/work-with-us/additional-baa, to include providing the information specified therein as required for proposal submission.

6. Controlled Unclassified Information (CUI) on Non-DoD Information Systems

All proposers and awardees will be subject to the DARPA requirements related to Controlled Unclassified Information on Non-DoD Information Systems as detailed at www.darpa.mil/work-with-us/additional-baa.

7. Electronic Invoicing and Payments

Awardees will be required to submit invoices for payment electronically via Wide Area Work Flow (WAWF) at https://wawf.eb.mil, unless an exception applies. Registration in WAWF is required prior to any award under this RA.

8. Electronic and Information Technology

All electronic and information technology acquired or created through this RA must satisfy the accessibility requirements of Section 508 of the Rehabilitation Act (29 U.S.C. § 749d).

9. Publication of Grant Awards

Per Section 8123 of the Department of Defense Appropriations Act, 2015 (Pub. L. 113-235), all grant awards must be posted on a public website in a searchable format. To comply with this requirement, proposers requesting grant awards must submit a maximum one (1) page abstract that may be publicly posted and explains the program or project to the public. The proposer should sign the bottom of the abstract confirming the information in the abstract is approved for public release. Proposers are advised to provide both a signed PDF copy, as well as an editable (e.g., Microsoft word) copy. Abstracts contained in grant proposals that are not selected for award will not be publicly posted.

C. Reporting

1. Technical and Financial Reports

The number and types of technical and financial reports required under the contracted project will be specified in the award document, and will include, as a minimum, monthly financial status reports and a yearly status summary. A final report that summarizes the project and tasks will be required at the conclusion of the performance period for the award. The reports shall be prepared and submitted in accordance with the procedures contained in the award document.

2. Patent Reports and Notifications

All resultant awards will contain a mandatory requirement for patent reports and notifications to be submitted electronically through i-Edison (https://public.era.nih.gov/iedison).

VII. Agency Contacts

DARPA will use email for all technical and administrative correspondence regarding this solicitation.

- **RA Email:** YFA2020@darpa.mil
- **RA Mailing Address:**

  DARPA/DSO
  ATTN: DARPA-RA-19-01
  675 North Randolph Street
  Arlington, VA 22203-2114
- **DARPA/DSO Opportunities Website:** http://www.darpa.mil/work-with-us/opportunities

For information concerning agency level protests see http://www.darpa.mil/work-with-us/additional-baa#NPRPAC.

VIII. Other Information

A. Frequently Asked Questions (FAQs)

Administrative, technical, and contractual questions should be emailed to YFA2020@darpa.mil. All questions must be in English and must include the name, email address, and the telephone number of a point of contact.

DARPA will attempt to answer questions in a timely manner; however, questions submitted within 10 days of the proposal due date may not be answered. DARPA will post an FAQ list at: http://www.darpa.mil/work-with-us/opportunities. The list will be updated on an ongoing basis until the RA expiration date as stated in Part I.

B. Collaborative Efforts/Teaming

This RA solicits single Principal Investigator (PI) proposals; no co-PIs are allowed. However, investigators will be given the opportunity to propose teaming if the nature of the proposal requires it. Combined, teaming and subcontract awards will be limited to no more than 30% of the total grant value. Non-U.S organization may not be proposed as subcontractors. Please see guidance for FFRDC's and Government Entities in Section III.A.1.a and Section III.A.1.b. Specific content, communications, networking, and team formation will be the sole responsibility of the participants.

C. Proposers Day

The Proposers Day was held on August 21, 2019 from 1:00 PM to 2:30 PM. The event was held via a webcast only. Advance registration was required. See DARPA-SN-19-70 posted at www.fbo.gov for all details. Participation at the webcast for YFA Proposers Day was voluntary and was not required to propose to this solicitation.