<u>ARL Strengthening Teamwork for Robust Operations in Novel Groups (STRONG)</u>

I. OVERVIEW OF THE FUNDING OPPORTUNITY

A. REQUIRED OVERVIEW CONTENT

1. **Federal Awarding Agency Name**
   U.S. Army Research Laboratory, 2800 Powder Mill Road, Adelphi, MD 20783-1197

   Issuing Acquisition Office
   U.S. Army Contracting Command – Aberdeen Proving Ground, Research Triangle Park (RTP) Division, 800 Park Office Drive, Suite #4229, Research Triangle Park, NC 27709

2. **Research Opportunity Title**
   Strengthening Teamwork for Robust Operations in Novel Groups (STRONG)

3. **Announcement Type**
   Initial

4. **Funding Opportunity Number**
   W911NF-19-S-0001

5. **Catalog of Federal Domestic Assistance (CFDA) Number(s)**
   12.630 - "Basic, Applied, and Advanced Research in Science and Engineering"

6. **Key Dates**
   The following is a summary of the events and dates associated with the STRONG Funding Opportunity:

EVENT	ESTIMATED DATE/TIMEFRAME
Opportunity released	October 2018
Opportunities Webinar	15 November 2018
Deadline for Questions on Funding Opportunity	30 November 2018
Proposals due for Cycle 1*	21 December 2018
Cycle 1 Awards*	Feb2019 (Expected)

   *The Key dates above delineate the timeline for proposal receipt and award related to Cycle 1 under this Funding Opportunity Announcement (FOA). See below for information on subsequent cycles.

B. ADDITIONAL OVERVIEW INFORMATION

Purpose: The future vision for the U.S. Army includes teams of humans and intelligent agents working together to accomplish missions. The U.S. Army Research Laboratory (ARL) has established this new collaborative program, Strengthening Teamwork for Robust Operations in Novel Groups (STRONG), with the goal of developing the foundation for enhanced teamwork within heterogeneous human-intelligent agent teams. This collaborative venture will bring together diverse, multidisciplinary expertise to support scientific breakthroughs relevant to specific and critical scientific questions that must be addressed to enable this future vision.

STRONG focuses directly on coordination and cooperation in human-agent teams via individualized and adaptive technologies. It has a **specific long-term goal** *to identify and implement the fundamental research necessary to develop individualized, adaptive technologies that promote effective teamwork in novel groups of humans and intelligent agents*. This effort addresses the teamwork (states and

processes) that is critical to the future vision of human-agent teaming in the military. Decostanza et al. (IEEE, 2018; https://brain.ieee.org/brain-storm/enhancing-human-agent-teaming/) provide a detailed vision and discussion of some of the scientific questions critical to achieving this goal. Importantly, this interactive paper also provides a public forum for commentary and feedback from the scientific community at large and will serve as a valuable resource for understanding the research objectives of this program.

STRONG addresses a critical objective within a broader Army goal to enable effective integration of Artificial Intelligence / Machine Learning (AI/ML) in the battlefield. This program has been developed in coordination with other related ARL-funded collaborative efforts (see descriptions of ARL collaborative alliances at https://www.arl.army.mil/www/default.cfm?page=93) and shares a common vision of highly collaborative academia-industry-government partnerships; however, it will be executed with a program model different than previous ARL Collaborative Research/Technology Alliances. Specific components of the program are highlighted below:

- STRONG will be executed through a series of eight annual program cycles (i.e., Cycles 1-8). The FOA will be amended annually to identify a specific problem statement, or topic, for that specific Cycle. The topic for each Cycle will be chosen to systematically converge on the **specific long-term program goal.**
    - Eight new topics (Cycles 1-8) are expected from FY19-FY26, with each topic focused on addressing a different scientific area within the scope of the broad research aims of STRONG. These topics will be carefully chosen based on both program achievements from the previous year and on scientific and technological advancements by the broader research community.
    - For each topic, funding will be provided to those Recipients selected for 1 year under a cooperative agreement (CA) described as the "seedling" project.
    - The Recipients of a "seedling" CA are then eligible to receive funding for a single optional extension of up to 3 years at the conclusion of the "seedling" project. The period of the performance of the option will be based on the research and available funding. It is envisioned that "seedling" Recipients will work with government researchers and/or other "seedling" Recipients to collaboratively develop a proposal for an optional extension to the initial seedling CAs. Opportunities for planning and enabling these collaborations in support of an option will be provided at the annual Summer Innovation Summits (see below), as well as via regular communication between "seedling" Recipients and government researchers.
- Recipient participation in a yearly Summer Innovation Summit at one of the Center for Agent Soldier Teaming (CAST) Innovation Hubs will be REQUIRED.
- Proposals from junior investigators (e.g., students, research fellows, and early-career researchers with less than 5 years past reception of their PhD or less than 5 years' experience within the primary field of their organization) are appropriate under this opportunity.

The success of this multidisciplinary effort will require meaningful collaborative partnerships between government, academia, and industry to advance the science of human-agent teaming. The STRONG program incorporates new initiatives to grow and support an eco-system of high-quality, innovative researchers addressing scientific gaps critical to the Department of Defense. At the beginning of each annual Summer Innovation Summit, Recipients will be expected to demonstrate their scientific principles and approach to the community, providing evidence of progress toward scientific breakthroughs that support the criticality of the particular concept or approach to the specific topic. Over the course of each yearly Summer Innovation Summit, Recipients will be expected to coordinate their future research plans with complimentary ongoing or planned efforts executed by other Recipients and government researchers. In other words, it is expected that the best methods or findings from individual "seedlings" will be leveraged to inform strategy and best practice approaches for subsequent future option proposals. Following each annual Summit, 1-3 collaborative proposals will be selected for up to three additional

years of effort being funded for each selected Recipient (with more details on the option process to be provided during "seedling" year).

Funding Cycles:

	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	Proposal Submissions
Cycle 1	B	O	O	O								DEC 2018
Cycle 2		B	O	O	O							SEP 2019
Cycle 3			B	O	O	O						SEP 2020
Cycle 4				B	O	O	O					SEP 2021
Cycle 5					B	O	O	O				SEP 2022
Cycle 6						B	O	O	O			SEP 2023
Cycle 7							B	O	O	O		SEP 2024
Cycle 8								B	O	O	O	SEP 2025

Note: B is for Base ("seedling") period of Cooperative Agreement; O indicates 3-yr Option

The Cycle 1 Topic is described in this FOA. Future topics will be released annually as amendments to this FOA.

Award Instrument: This Funding Opportunity is expected to result in the award of multiple seedling cooperative agreements (CA) during each Cycle as defined at 31 U.S.C. 6305 for the execution of the program. The CA is used to enter into a relationship:

a. The principal purpose of which is to transfer a thing of value to the Recipient to carry out a public purpose of support or stimulation authorized by a law or the United States, rather than to acquire property or services for the Federal Government's direct benefit or use.

b. Substantial involvement is expected between the Federal Government and the Recipient when carrying out the activity contemplated by the CA.

c. No fee or profit is allowed

Structure of Award: The CAs will consist of an initial 12-month Base award that will be executed and considered as "seedling" CAs. Each seedling CA will provide for the potential for exercising an option, adding up to three more years to the base award, as outlined in the table above. This proposed additional effort may be scoped for one to three years based on its objectives, will be collaboratively developed with Government scientists during the period of performance of the seedling CA, and will be presented as part of the outcome of collaborations during the annual Summer Innovation Summits (described below).

Proposal Submission: The application process (see **PART II.D)** consists of proposal submissions from applicants for each Cycle under this FOA. Applicants should note that there are page limitations and other requirements associated with the submission process. Submissions in connection with this FOA are due by the date and time specified in **PART II.D.3.** FOA amendments for future topics will include the submission requirements for those submissions. The Government's decision to award a seedling CA will be based upon the evaluation results of the proposal submission.

Period of Performance: The CA Awards made as a result of this FOA will provide for a period of performance of one year, with the potential to add up to three additional years to the period of

performance at the discretion of the Government.

Place of Performance: There is no limitation on the place of performance, except for Recipient participation in the annual Summer Innovation Summits. The initial Summit will take place in Burlington, MA and in the surrounding areas in the summer of 2019 and then the Summits thereafter will rotate between ARL CAST Innovation Hub locations (*e.g.,* Aberdeen Proving Ground, MD; greater Boston, MA area; TBD) Further details on this requirement are outlined in **PART II.A.2 (Collaboration).**

Funding: This FOA is issued subject to the availability of funds. ARL has submitted the requisite documents to request funding for the period covered by the program. However, Applicants are reminded that this request is subject to Presidential, Congressional and Departmental approval. Funding levels specified in this Funding Opportunity are estimated funding levels and are for proposal preparation purposes only; actual funding levels of the CAs will be updated annually as part of the federal appropriation process.

Profit/Fee: Profit/fee is not permitted under the CA.

Cost Sharing: Cost sharing is not required under this FOA.

Evaluation and Award: Evaluation and Award in connection with this FOA will be performed in accordance with **PART II.E.** Proposals that are in compliance with the requirements of the FOA will be evaluated in accordance with merit-based, competitive procedures. These procedures will include evaluation factors and an adjectival and color rating system. A review team, consisting of a qualified group of scientists and managers will evaluate the compliant Proposals and provide the results of that evaluation to the decision-maker for the Government.

Eligibility. Eligible applicants under this FOA include institutions of higher education, nonprofit organizations, and for-profit organizations (i.e., large and small businesses) for scientific research in the knowledge domains outlined throughout this Funding Opportunity. Federally Funded Research and Development Centers (FFRDC) may propose as well, with effort as allowed by their sponsoring agency and in accordance with their sponsoring agency policy. Proposals will be evaluated only if they are for fundamental scientific study and experimentation directed toward advancing the scientific state of the art or increasing basic knowledge and understanding. Additional eligibility information is provided in **PART II.C**.

Opportunity Webinar: ARL will host an opportunity webinar on 15 November 2018. A link to the webinar will be posted on the STRONG Program website at https://www.arl.army.mil/strong.

Contact Information. Outside of questions posed at the Opportunity Webinar, all questions or comments concerning this FOA shall be submitted to the Government through the STRONG Program website at https://www.arl.army.mil/strong. Comments or questions submitted should be concise and to the point. In addition, the relevant part and paragraph of the FOA to which a comment or question pertains must be referenced. Responses to non-proprietary questions received will be posted to the STRONG Program website under the "General Information/Questions & Answers" section for the benefit of all interested parties. All clearly identified and marked proprietary questions posed will be responded to via an individual email response, not posted to the STRONG Program website. Applicants are encouraged to submit questions as early as possible. The deadline for submission of questions which will be answered under this FOA is 30 November 2018. Any answers provided to questions do not change the requirements of this FOA. Future amendments to this FOA, including new cycle topics, will be issued via an amended FOA posted in grants.gov.

II. DETAILED INFORMATION ABOUT THE FUNDING OPPORTUNITY

A. PROGRAM DESCRIPTION

1. **ARL Strengthening Teamwork for Robust Operations in Novel Groups (STRONG)**

The recent acceleration in the emergence and widespread application of artificial intelligence and machine learning (AI/ML) is leading to a fundamental revolution in the way that society functions on all levels across the globe. Whether in wrist-worn sleep and activity monitors, online shopping carts, "smart" mobile devices, or even in our vehicles, AI/ML-enabled intelligent agents are quickly becoming ubiquitous and, as such, fundamental to life experience in the developed world. With ever-more intelligent technological capabilities and particularly the increasing availability, modes, and transmissibility of information that can reshape our understanding of the global context and human action within it, the U.S. Army Research Laboratory has established a new collaborative, basic research program (STRONG) with the intent of providing a foundation for enhanced teamwork within heterogeneous human-intelligent agent teams. This new collaborative venture will bring together diverse, multidisciplinary expertise to support scientific breakthroughs within specific, critical scientific questions that must be addressed to enable this future vision.

Background

As the vision for the Internet of Things and Artificial Intelligence promises a world of interconnected devices that anticipate and respond to our needs, we can expect future military teams to be equipped with an array of intelligent, autonomous, and networked agents that perform core team functions, anticipate and respond to the needs of the team, and make decisions both in coordination with their human teammates. This will differ fundamentally from the human-centered team concepts on which military doctrine and organizational psychology are currently built. We are expectedly rethinking the mechanisms that we employ to train personnel and perform complex team operations in the U.S. Army. At present, military teams train and operate with a host of advanced technologies, but at its core, technology endows human team members with greater individual capabilities and does not necessarily enhance or fundamentally change the short- and long-term emergent properties of team performance. However, the future vision for human-agent teaming in the Army will require close cooperation, coordination, and communication between ad-hoc teams of humans and agents (e.g., robots, intelligent assistants, and intelligent sensors acting as discrete teammates rather than as tools). Further, both Soldiers and intelligent agents (both envisioned to have varied levels of training, experience, and operational capabilities and roles) will likely be required to adapt to new missions on demand. This future concept of human-agent teaming assumes:

(1) First, human capabilities within the environment will continue to be necessary. The specific capabilities required of humans will change from what they are today, but technology will not replace humans completely.

(2) Second, the roles of humans and the nature of the interactions they have with intelligent agents will change. The concept of technology being a tool for humans will be replaced by technology as mentored actors in the environment, teammates with unique non-human skills, and technology that augments fundamental human capabilities.

(3) Third, the training required for humans to be effective will change dramatically. Training will have to enable humans to handle the dynamic and rapid evolution of technology as well as the shift in critical analysis and action from humans to intelligent technology.

Advancements across many different domains are considered critical to this future human-agent teaming vision. Piekarski et al. (2016) document many of the challenges from an intelligent systems perspective, including: how to integrate and control large autonomous teams with varying levels of autonomy and

intelligence across spatially and temporally distributed systems; how to combine autonomous agents, sensors, and tactical super-computing to establish distributed networked intelligent systems; and how to develop methods for heterogeneous teams to carry out tasks under dynamic and varying conditions. Similarly, Suri et al. (2016) describe research challenges related to fundamental understanding of how to learn and devise complex models of the Internet of Battlefield Things (IoBT), including goals, networks, information, and analytics that enable intelligent command and control, and battlefield services. In 2017, the Army Research Laboratory began two large-scale collaborative research programs (IoBT CRA and DCIST CRA) to address these challenges (see https://www.arl.army.mil/www/default.cfm?page=532 for more details.

Neither of these current efforts specifically target solutions to enhance human strengths and mitigate human weaknesses, nor do they directly address development of the inherent teamwork (states and processes) between humans and intelligent agents that is critical to realize the future Army vision. STRONG focuses on a specific long-term goal *to provide the fundamental research necessary to develop individualized, adaptive technologies that promote effective teamwork in novel groups of humans and intelligent agents*.

What do we mean by teamwork? Many researchers have argued that team performance is a multilevel process that includes both individual taskwork and individual- and team-level teamwork processes (Kozlowski and Klein, 2000; Salas et al., 2007). Marks et al. (2001) provided definitions of taskwork and teamwork to distinguish the two, suggesting that, "taskwork represents what it is that teams are doing, whereas teamwork describes how they are doing it with each other" (p. 357, emphasis added). When we refer to human-agent teaming and human-agent teamwork, we are focused on the team-level emergent properties, including states and processes, that influence performance and effectiveness (e.g., cohesion, shared mental models, shared situational awareness, coordination, and communication), rather than individual taskwork.

What do we mean by technology? Agent? We expect future teams to be composed of humans as well as distributed sensors, robots, autonomous ground and air vehicles, intelligent assistants, and other advanced technologies that can perform taskwork as part of the larger team. Hence, an agent can perform interdependent taskwork. We reserve the term technology for those devices, software, protocols, and other interventions that target the members of the team with the goal of improving team processes. It is entirely possible that a technology will both perform taskwork and provide interventions that target team processes. We use the term technology when referring to its role as assisting in team performance as opposed to satisfying its role in the team (i.e., completing its assigned task work).

Technologies of the future should be individualized and adaptive. For over a century, military technologies and doctrine have prioritized the interchangeability of operators (see Howard, 1961). Although this leads to robust performance, it also limits system capabilities and likely constrains high-performing individuals from fully utilizing their own and the system's capabilities. Future technologies need to be adaptive and individualized, accounting for individuals' capabilities and limitations in real-time to achieve greater performance, especially in complex environments under operational tempos that may be faster than possible through human capabilities alone. By allowing individual agents to behave in manners that are consistent with their own strengths rather than imposing uniform behavioral requirements or constraints, individual performance should be dramatically improved. Shifting to this paradigm will also enable technological solutions to target particular individual capabilities that improve team-level properties and performance.

Given the above context, this program focuses on science and technology to enable the interactions and interdependencies between heterogeneous members of human-agent teams, and specifically, on influencing individual team members, human or agent, to enhance positive emergent team properties and performance. Within this program, we anticipate the need for research in three broad, intertwined areas that frame the technical and scientific challenges: (1) Developing theory and models to characterize the linked relationships between individual team member dynamics and the emergent, dynamic properties of human-

agent teams; (2) Systems-based approaches to dynamically individualize and adapt technologies to optimize human-agent team performance; and (3) Approaches for training and developing individuals and groups that account for and exploit unique learning and adaptation among human and intelligent agents to enable enhanced human-agent team performance over time.

Critically, our perspective is not solely focused on the differences between individuals. Rather, we expect that detecting, understanding, and predicting intra-individual performance fluctuations will enable the largest innovations for technology that can adapt to the real-time needs of the team. These intra-individual performance fluctuations occur at multiple time scales in both humans and agents. Within the STRONG program, we extend the focus on individual differences for individualized performance prediction, and we ask how individual dynamics and variability can be exploited to improve team-level properties and performance in heterogeneous, human-agent teams well beyond the modern state-of-the-art.

Cycle 1: Theory development and Team-Level Processes

We have focused this announcement (Cycle 1) on *fundamental research aimed at theories of team-level processes for heterogeneous human-agent teams*. Critically, the Cycle 1 topic research must provide the building blocks for identifying and developing the Cycle 2-8 research topics in support of STRONG's overall long-term goal. Specifically, it must provide the building blocks for these potential future topic areas:

- Theories linking individual dynamics to emergent processes in human-agent teams
- Models bridging dynamic, continuous individual and group attributes, emergent team behaviors, and team performance
- Predicting and leveraging individual performance fluctuations for improved overall team performance

When human teams fail, breakdowns are commonly due to problems with team states and processes: insufficient communications, misunderstanding of team goals, undefined team responsibilities, lack of shared mental models, and conflict; as examples (Kohn et al., 2000; Salas et al., 2007). Team-focused training and development literature suggests that the best human teams can overcome external demands (e.g., distributed environments, lack of resources, time pressures) and some individual performance problems by implementing effective team processes that may not always lead to superior performance on any given task by any specific individual, but that will achieve superior overall team performance over time (Weaver et al., 2014). However, in teams composed of humans, intelligent software agents, embodied agents, and networked sensors, emergent complexities may arise that are not necessarily predictable based on our current comprehension of team processes. Considering cognitive and behavioral processes such as decision-making and coordination, humans and agents will be working in disparate dimensions (time, space, world views, representations, mental models, etc.), yet need to seamlessly synchronize for collective action. For example, intelligent agents will process information, reason, and make decisions at scales beyond that of humans in both time and magnitude; and yet, we will want to include humans in the decision-making loop for many, if not most, decisions. Similarly, intelligent agents will learn and adapt far more rapidly than their human counterparts, but may possess less flexibility and range in what they can learn. *Clearly, we need methods and technologies to capitalize on the individual advantages of both humans and agents while simultaneously enhancing the performance of the collective.*

Not only are methods needed to bridge diverse capabilities, processes, and beliefs, but much of what we currently know about critical states and processes in human teams may not be applicable. The notion of a shared mental model among humans and intelligent agents raises significant scientific and philosophical questions. Shared understanding of team responsibilities and goals among humans and intelligent agents, as it is practiced in human teams, assumes intelligent agents with human-like intelligence. However, non-human teammates will likely span the spectrum of machine intelligence — from passive sensors to advanced, adaptive machine learning algorithms.

Breakthroughs in representation learning and explainability should facilitate human understanding of machine reasoning, but are shared mental models like those targeted in human teams the right approach to human-agent teaming? The nature of these emergent properties is fundamentally different than our conceptualization today, and it is perhaps naïve to assume that human-agent team cohesion, coordination, and collective performance will develop in ways similar to human teams without targeted scientific focus. *Therefore, this problem space demands research to identify and characterize the critical states and processes for effective performance in human-agent teams.* In identifying and characterizing these critical states, understanding how individual dynamics influence these emergent properties is critical to the broader goal of utilizing individualized and adaptive technologies to elicit resilient, emergent processes in human-agent teams.

Specifically, ***proposed research should seek innovative solutions to advance the development and validation of theoretical principles related to identifying, measuring, understanding, and predicting the team-level states and processes that are critical for effective group-level performance in heterogeneous human-agent teams.*** Below are several related core scientific questions addressing interactions between humans and agents that may be addressed in the proposed work. This list is not expected to be comprehensive and Applicants may offer additional critical questions *related to the Cycle 1 focus and its linkages to STRONG's long-term program goal.*

(1) Shared mental models underlie the effective communication and coordination of human teams, and similar concepts have emerged in multi-agent systems both organically and by inspiration from human teaming. In complex teams of the future, will it be necessary to maintain a shared mental model amongst teams of humans and intelligent agents? If so, we must understand how to operationalize "shared" mental models in these complex teams. Research may ask how human-agent teams will develop, manage, and communicate shared mental models of the problem, environment, and the states and intentions of other team members in order to facilitate rapid mission planning and adaptation.

(2) Effective teams capitalize on a rich knowledge of each other's strengths, weaknesses, and patterned behavior to inform role assignment predict each other's performance in specific situations. For example, in a future human-agent teaming scenario wherein intelligent agents can readily download new behavior models, no coherent team may exist for longer than a single mission or sub-goal. Research is thus needed to define necessary and sufficient mechanisms that can achieve the effect of rapid rapport development and effective communication with new team members. What are the requirements of anticipating actions or recognizing strengths and weaknesses of new members? How do we develop intuitive, common languages (e.g., incorporating body language, facial expressions, tones of voice, or even physiological measures) in human-agent teams? Research questions may focus on identifying which aspects of rapport-building and trust are most critical in evolving heterogeneous teams as well as how to develop these constructs of interaction in both humans and agents.

(3) A rich body of literature connects particular teamwork processes such as communication, shared mental models, and coordination with effective performance in human teams. Studies are needed to determine whether current and proposed models of the critical emergent team processes will generalize to human-agent teams. Will the same emergent team processes be critical in human-agent teams, or will other novel team processes emerge? How will emergent team properties (states and processes) be validated and measured? What is the most effective means of communication in order to facilitate coordination and optimal team performance, especially taking into account dynamic operational environments (darkness, battlefield noise, radio loss), state-related constraints (fatigue, attention, equipment failure), and changing task demands?

While proposed efforts need to focus on the specific topic within this Funding Opportunity: research

proposals *MUST* align with the broader, long-term program goals of optimizing a system of interdependent agents through individualized and adaptive technological and training solutions aimed at improving critical team-level properties and group performance. A successful research project will lay the scientific foundations for enhanced human-agent teaming using individualized, adaptive approaches by combining new developments in theory, computationally efficient modeling techniques, empirically driven model development, and principled experimental validation.

2. Collaboration

This program continues the ARL concept of creating collaborative relationships between ARL and its partners. Experience has shown that persistent collaboration across government, academic, and industry performers enhances innovation and has a high return on investment. Therefore, collaboration between Awardees and Government researchers is integral to the execution and success of the program. It is ARL's fundamental belief that work conducted under the STRONG Program cannot be successful either in whole or in part without collaboration. Creation of an environment that is conducive to collaboration is therefore a critical element in establishing the program. ARL will specifically fund internal researchers to foster direct, highly collaborative partnerships between STRONG Recipients and the Government. ARL will shape its mission program to maximize synergies with the STRONG research strategy and the annual STRONG Cycles, thus supporting a direct and continuing collaboration across the program. The Government may also leverage and/or integrate other interested Government agencies (and funding where appropriate).

This section describes potential avenues to collaborate under the STRONG program. The implementation of the collaboration with ARL will be through the CA.

a. *Participation in CAST Innovation Hubs*

A significant goal of this effort will be to create a critical mass of collaborating scientists and engineers focused on solving STRONG research challenges outlined within the scope of the program. This intellectual synergy is also expected to include sharing equipment, personnel and facilities to promote efficiency and enhance collaboration.

The ARL Center for Agent-Soldier Teaming

Research coordination and collaboration within the STRONG program, as well as within other ARL internal human-agent teaming research programs, will be facilitated through the ***Center for Agent-Solder Teaming (CAST; https://www.arl.army.mil/CAST)***. The CAST is a collaborative nexus where basic and applied researchers will create new theories, methods, and technologies to enable heterogeneous groups of humans and intelligent agents to team as dynamically as units of highly trained Soldiers do today. Using a combination of physical and virtual spaces, the CAST is designed to co-locate and integrate highly invested and engaged researchers, novice and expert alike, from across the spectrum of science and engineering related to human-agent teaming. It is expected that successful research teams may include, but not be limited to, agile and adaptive mixtures of experts in human sciences (e.g., social, cognitive, physiological) and intelligent systems (e.g., robotics, artificial intelligence, machine learning). Such collaborative teams may be formed among proposers or through planned collaborations with ARL investigators and engineers within the CAST.

Currently, CAST comprises two core innovation hubs: CAST-APG includes an integrated set of laboratories at the Aberdeen Proving Ground (APG) near Baltimore, Maryland; CAST-Northeast at ARL Northeast is comprised of government, university, and industry partnerships in Boston, MA and the surrounding areas. Both hubs provide essential tools for fostering innovation among teams of ARL researchers and participants in the STRONG program. Importantly, the CAST creates a network of online and physical resources for the formation of tight collaborations and alignment of

research agendas with ongoing programs within human-agent teaming; therefore, it is critical that the proposed research will be formulated in anticipation of direct collaborations with ARL researchers and programs.

ARL recognizes that an important element of collaboration is the advancement, education and rotation of research staff through short-term temporary assignments. Staff rotations may be undertaken as part of this program to foster and facilitate collaborative research where face-to-face interaction is advantageous, to enable a researcher to utilize unique facilities, to enable STRONG personnel to obtain specialized training or experience and to facilitate the exchange of research results. In addition, this exchange, or cross-fertilization, of personnel will provide ARL partners with insight into Army-unique requirements and will provide Government personnel with insight into state-of-the-art research and commercial practices and/or the opportunity to pursue fundamental research with noted researchers.

At a minimum, proposals should include participation in the Summer Innovation Summit at the CAST Innovation Hub by at least one individual of each CA awarded. Costs associated with the Summit participation should be identified in the budget. All salary and travel costs associated with the rotation of Government personnel will be borne by the Government. All other salary and travel costs associated with staff rotations of STRONG performers may be funded under the CA.

b) *Summer Innovation Summit*

To achieve collaborative STRONG program goals, a yearly Summer Innovation Summit will be held. Each summer, the Summer Summit will be 4-8 weeks in length and targeted for graduate student, post-doc, early career scientist and engineer participation of each Recipient with support from senior faculty or industry representatives. ARL leadership, Government STRONG project collaborators, other government stakeholders, and industry partners will also attend, and participation will be encouraged from a broad community interested in the STRONG program goals. The location of the Summer Innovation Summit will rotate between the CAST Innovation Hubs, with the summer of 2019 expected to be held in Burlington, MA for 5 weeks from July 9th through August 10th. While attendance for the entirety of the multi-week Summer Summit is not required of all individuals who are members of a Recipient's research team, planned participation by the Recipient throughout the entirety of the Summer Summit by AT LEAST one individual of each Recipient research team is required. While we expect attendance throughout the entirety of the Summit by at least one individual of each Recipient research team, we encourage additional participation by the Recipient teams and can accommodate multiple personnel and schedules, with emphasis placed on the importance of successfully presenting evidence of progress toward scientific breakthroughs as a result of each seedling CA, and for supporting the 3-yr option determination. The Summer Summit is expected to add critical value to the Recipient research teams and transition opportunities through the planned activities. Consistency in attendance by at least one individual of a Recipient research team will be critical to building collaborative partnerships, successful demonstrations, and transition opportunities. The planned participation by one or more individuals on the Recipient research team should be documented in the proposal.

One purpose of the Summer Innovation Summit is to provide an opportunity for Recipients of seedling CAs to work collaboratively to develop follow-on option proposals. The Summer Innovation Summit will start with Recipients demonstrating, with prototypes when possible, their initial concept, scientific approach, and accomplishments to date. A daily program will combine knowledge-building, brainstorming, technology/prototype development, and dedicated time and resources to conduct research, with the goal of quickly translating research into products that can transition into multiple environments. The Summer Innovation Summit is expected to culminate in collaboratively developed follow-on efforts, with proposed concepts and approaches demonstrated to a review panel. Full proposals for follow-on efforts (Option) will be submitted after the completion of the Summer Innovation Summit. Specific details for the submission of

the follow-on proposals and evaluation criteria will be provided to the seedling Recipients during the course of their seedling award and prior to the Summer Innovation Summit.

The following description is intended to provide a vision of the Summer Innovation Summit activities for Summer 2019 for planning purposes, but does not constitute a finalized plan by the government. In addition to space and resources for developing and executing research aligned with the STRONG program, ARL is developing an agenda that includes some combination of the following activities: teaching seminars mixing academic, industry, and Army perspectives, focused on innovative practices and successful transition (e.g. military, business start-up); Army science planning and strategy development; Hack-a-thons with quick-solution challenges and mixed teams; brainstorming of research applications and development of transitions; development of scientific demonstrations and an Industry Day (a day of demonstrations targeted toward industry stakeholders designed to develop multiple transition pathways); and planning and development of new "seedling" proposals. With that in mind, the following is a <u>notional</u> timeline of events being planned for Summer of 2019:

> *Notional Timeline*
> Week 1 (8-12 July): Demonstrations of initial concept and approach from all Cycle 1 Awardees; orientation, team-building
> Week 2 (15-19 July): Collaboration building week + research
> Week 3 (22-26 July): Army science planning and strategy week + research
> Week 4 (29 July – 2 Aug): Application Brainstorming Week / Hackathon + research
> Week 5 (5-9 August): Demonstrations of proposed follow-on efforts, Industry Day

Investigator Experience

ARL strategically designed the Summer Innovation Summit to target development of junior investigators to build onto the ecosystem of researchers working on questions relative to Army priorities. Aligned with this vision, ARL recognizes that a Recipient's junior investigators may constitute the majority of researchers attending the Summer Innovation Summit for its entirety. Where applicable, the Recipient's senior faculty members and/or mentors shall participate in particularly relevant portions of the Summer Innovation Summit (*e.g.,* supporting demonstrations, follow-on effort development, mentorship, lectures, etc.). All proposed efforts, whether led by a junior or senior investigator, must include a plan for attendance and support of the Summer Innovation Summit as described above.

Investigators at various levels of hierarchy (e.g., undergraduate students, graduate students, post-doctoral fellows, research associates; Assistant, Associate, Full, or Distinguished Professors, and comparable industry classifications) are encouraged to submit proposals as Principal Investigators within the STRONG program. To encourage diversity and enable the review team to select a range of participants, proposals must be designated as originating from either Junior or Senior Investigators.

- **Junior Investigators:** Junior investigators consist of students, research fellows, and early-career faculty who are less than 5 years past reception of PhD or equivalent doctoral degree at the time of application submission. In the case of industry and non-profit organizations, this includes representatives who have less than five years of experience within the primary field of the organization.

- **Senior Investigators:** Senior investigators consist of faculty and staff who are five years past reception of PhD or equivalent doctoral degree at the time of application submission. In the case of industry and non-profit organizations, this includes representatives whom have more than five years of experience within the primary field of the organization.

3. **Proposal Intent**

It is the intent of this FOA to solicit the most creative, innovative, and flexible approaches to the ultimate goal of generating and exploiting research to solve pressing research gaps and issues impacting both the military and commercial sectors. This FOA seeks Proposals which will result in the award of multiple CAs. In response to the Funding Opportunity, applicants will be required to provide evidence of the following in their proposal:

- Formulate a basic research project that clearly demonstrates innovative, detailed, and substantive scientific plans to address the specific scientific challenge articulated in the Cycle 1 Topic Announcement, while aligning with the goals of the STRONG program. Focus should be placed on the goals you aim to accomplish in a 12-month seedling, with a brief notional concept of how this initial research could feed into a larger, potential 3-year effort in collaboration with government scientists and/or other seedling Recipients (focused on research goals and outcomes, rather than specific collaborators). Sufficient resources should be allocated to make progress in both science and forming effective collaborations within a 12-month period.

- Identify a plan for attendance at the Summer Innovation Summit and any additional expected interactions at CAST. This could include a statement regarding potential collaborative partnerships with ARL programs or personnel based on interests defined on the CAST website and could include proposed staff rotations to a CAST Innovation Hub.

- Present the experience, qualifications, and availability of the scientific staff and the quality and relevance of research facilities.

The research proposed and performed must comply with the definition for basic (6.1) research as outlined in the DoD Financial Management Regulation (FMR), Volume 2B, Chapter 5 as follows:

- This announcement is for basic (6.1) research, which is defined as "systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind." (DoD 7000.14-R)
- This announcement is NOT for applied (6.2) research, which is defined as "systematic study to understand the means to meet a recognized and specific need" and includes the "expansion and application of knowledge to develop useful materials, devices, and systems or methods." (DoD 7000.14-R)

4. **Research Timeline**

The CAs will consist of an initial 12-month Base award that will be executed and considered as "seedling CAs." Each seedling CA will provide for the potential of adding up to three more years to the CA period of performance. It is envisioned that the additional effort, up to three years, will be collaboratively developed with Government scientists and potentially other Recipients of "seedlings" during the subject Cycle (*i.e.,* the 12-month period of performance of the seedling). The proposed effort and timeline for completion of an option (not to exceed three years) will be presented as part of the outcome of collaborations during the Summer Innovation Summit (described above), and followed by a written proposal for the option due following the Summer Innovation Summit.

Factors influencing the Government's decision to fund further years of the research project will include: technical merit of the proposed science, the potential for the proposed science to serve as a building block for the future topics of the STRONG program, performance and collaboration throughout the first year (seedling) of the CA, participation in the Summer Innovation Summit, and collaborative development of the

proposal. Specific criteria will include: (1) demonstration of scientific accomplishments at the beginning of the Summer Summit, (2) evaluation of a written proposal and demonstration of proposed follow-on at Summer Summit, (3) relevance of the work to ARL, and (4) collaboration. It is anticipated that Recipients on multiple CAs may come together to propose collaborative follow-on efforts, along with research partners from the government.

More specific details regarding the follow-on proposals, including requirements, timelines, and evaluation criteria will be provided after award of the seedling.

5. Funding

Funding for most seedling project efforts will range from $50,000 to $100,000. Award of 10-15 seedling CAs is expected during each yearly cycle.

Funding for additional years beyond the seedling CA is expected to be larger in scope than the seedling CA. Additional efforts may be added for up to 3 years ranging between $350,000 and $500,000 per year. It is anticipated that multiple Recipients may come together to collaboratively propose a follow-on effort with Government partners. Recipients may also bring additional entities (as subawardees) into proposed follow-on efforts that were not awarded as part of the CA initially based on the direction of their follow-on proposal.

B. AWARD INFORMATION

Multiple CAs will be awarded from this FOA. The Applicants selected for award will be notified by the Grants Officer or his/her designee telephonically or via email. The CA award is not official until the Recipient has received the award signed by the Grants Officer.

CAs for Institutions of Higher Education and nonprofit organizations are primarily governed by the following:
a. Federal statutes
b. Federal regulations
c. 2 CFR Part 200, as modified and supplemented by DoD's interim implementation found at 2 CFR Part 1103

The following websites may be accessed to obtain an electronic copy of the governing regulations and guidance:
- FAR, DFARS, and AFARS: http://farsite.hill.af.mil/
- Code of Federal Regulations: http://www.ecfr.gov
- DoD Research and Development General Terms and Conditions JULY 2018
- ACC-APG-RTP Division Assistance, Research General Terms and Conditions dated AUGUST 2016

C. ELIGIBILITY INFORMATION

1. Eligible Applicants

It is our goal for the program to include a diverse group of Applicants with varied long-term interests. During performance, it is envisioned that there will be two primary categories of participants from an Awardee (junior investigators and senior investigators, defined above), based upon their experience and time within their respective fields. Participants may be institutions of higher education, an industrial company, or non-profit organization. Federally Funded Research and Development Centers (FFRDC) may propose as well, with effort as allowed by their sponsoring agency and in accordance with their sponsoring agency

policy. Proposals may consist of teams from any combination of organizations *(e.g.,* prime and subawardees), but this is not a requirement and award will only be made to a single entity. For each Cycle, only those Applicants awarded a seedling CA will be eligible for consideration of an option period for that Cycle.   All eligible Applicants may submit an application for future topics under future cycles. Future cycles are expected to be released annually as amendments to this FOA.

2.   Cost Sharing or Matching

Cost sharing is not required under this Funding Opportunity.

D.   APPLICATION AND SUBMISSION INFORMATION

The application process consists of a single Proposal stage. Applicants will receive feedback regarding their proposal **ONLY IF IT IS SELECTED FOR AWARD,** in order to improve the proposal and ensure alignment of the proposed research with Government goals. **Non-selected proposals will be notified of their non-selection, but will not receive feedback**.

1.   Address to Request Application Package

This Funding Opportunity may be accessed from the following: Grants.gov (www.grants.gov). Amendments, if any, to this FOA will be posted to these websites when they occur. Interested parties are encouraged to periodically check these websites for updates and amendments.

2.   Content and Format of Application Submission

The following information is for those wishing to respond to the FOA:

Grants.gov Application Submission and Receipt Procedures

This section provides the application submission and receipt instructions for DoD program applications. Please read the following instructions carefully and completely.

DoD is participating in the Grants.gov initiative to provide the grant community with a single site to find and apply for grant funding opportunities. For this funding opportunity, DoD requires applicants to submit their applications online through Grants.gov. This funding opportunity may be found on Grants.gov by going to the Grants.gov Search Grants screen and entering the funding opportunity number for this FOA, W911NF-19-S-0001, in the Funding Opportunity search box. You can also search for the CFDA Number 12.560.

How to Register to Apply through Grants.gov

a. *Instructions:* Read the instructions below about registering to apply for DoD funds. Applicants should read the registration instructions carefully and prepare the information requested before beginning the registration process. Reviewing and assembling the required information before beginning the registration process will alleviate last-minute searches for required information.

Organizations must have a Data Universal Numbering System (DUNS) Number, active System for Award Management (SAM) registration, and Grants.gov account to apply for grants.

Creating a Grants.gov account can be completed online in minutes, but DUNS and SAM registrations may take several weeks. Therefore, an organization's registration should be done in sufficient time to ensure it does not impact the entity's ability to meet required application submission deadlines.

Complete organization instructions can be found on Grants.gov here:
https://www.grants.gov/web/grants/applicants/organization-registration.html

1) *Obtain a DUNS Number*: All entities applying for funding, including renewal funding, must have a DUNS Number from Dun & Bradstreet (D&B). Applicants must enter the DUNS Number in the data entry field labeled "Organizational DUNS" on the Standard Form (SF)-424 form. For more detailed instructions for obtaining a DUNS Number, refer to:
https://www.grants.gov/web/grants/applicants/organization-registration/step-1-obtain-duns-number.html

2) *Register with SAM*: All organizations applying online through Grants.gov must register with the System for Award Management (SAM). Failure to register with SAM will prevent your organization from applying through Grants.gov. SAM registration must be renewed annually. For more detailed instructions for registering with SAM, refer to:
https://www.grants.gov/web/grants/applicants/organization-registration/step-2-register-with-sam.html

3) *Create a Grants.gov Account*: The next step is to register an account with Grants.gov. Follow the on-screen instructions or refer to the detailed instructions here:
https://www.grants.gov/web/grants/applicants/registration.html

4) *Add a Profile to a Grants.gov Account*: A profile in Grants.gov corresponds to a single applicant organization the user represents (i.e., an applicant) or an individual applicant. If you work for or consult with multiple organizations and have a profile for each, you may log in to one Grants.gov account to access all of your grant applications. To add an organizational profile to your Grants.gov account, enter the DUNS Number for the organization in the DUNS field while adding a profile. For more detailed instructions about creating a profile on Grants.gov, refer to:
https://www.grants.gov/web/grants/applicants/registration/add-profile.html

5) *EBiz POC Authorized Profile Roles*: After you register with Grants.gov and create an Organization Applicant Profile, the organization applicant's request for Grants.gov roles and access is sent to the EBiz POC. The EBiz POC will then log in to Grants.gov and authorize the appropriate roles, which may include the Authorized Organization Representative (AOR) role, thereby giving you permission to complete and submit applications on behalf of the organization. You will be able to submit your application online any time after you have been assigned the AOR role. For more detailed instructions about creating a profile on Grants.gov, refer to:
https://www.grants.gov/web/grants/applicants/registration/authorize-roles.html

6) *Track Role Status*: To track your role request, refer to:
https://www.grants.gov/web/grants/applicants/registration/track-role-status.html

b. *Electronic Signature*: When applications are submitted through Grants.gov, the name of the organization applicant with the AOR role that submitted the application is inserted into the

signature line of the application, serving as the electronic signature. The EBiz POC **must** authorize people who are able to make legally binding commitments on behalf of the organization as a user with the AOR role; **this step is often missed, and it is crucial for valid and timely submissions.**

How to Submit an Application to DoD via Grants.gov

Grants.gov applicants can apply online using Workspace. Workspace is a shared, online environment where members of a grant team may simultaneously access and edit different webforms within an application. For each funding opportunity announcement (FOA), you can create individual instances of a workspace.

Below is an overview of applying on Grants.gov. For access to complete instructions on how to apply for opportunities, refer to:
https://www.grants.gov/web/grants/applicants/workspace-overview.html

a. *Create a Workspace*: Creating a workspace allows you to complete it online and route it through your organization for review before submitting.

b. *Complete a Workspace*: Add participants to the workspace to work on the application together, complete all the required forms online or by downloading PDF versions, and check for errors before submission. The Workspace progress bar will display the state of your application process as you apply. As you apply using Workspace, you may click the blue question mark icon near the upper-right corner of each page to access context-sensitive help.

   1) *Adobe Reader*: If you decide not to apply by filling out webforms you can download individual PDF forms in Workspace. The individual PDF forms can be downloaded and saved to your local device storage, network drive(s), or external drives, then accessed through Adobe Reader.

   NOTE: Visit the Adobe Software Compatibility page on Grants.gov to download the appropriate version of the software at:
   https://www.grants.gov/web/grants/applicants/adobe-software-compatibility.html

   2) *Mandatory Fields in Forms:* In the forms, you will note fields marked with an asterisk and a different background color. These fields are mandatory fields that must be completed to successfully submit your application.

   3) *Complete SF-424 Fields First*: The forms are designed to fill in common required fields across other forms, such as the applicant name, address, and DUNS Number. Once it is completed, the information will transfer to the other forms.

c. *Submit a Workspace*: An application may be submitted through workspace by clicking the Sign and Submit button on the Manage Workspace page, under the Forms tab. Grants.gov recommends submitting your application package **at least 24-48 hours prior to the close date** to provide you with time to correct any potential technical issues that may disrupt the application submission.

d. *Track a Workspace Submission*: After successfully submitting a workspace application, a Grants.gov Tracking Number (GRANTXXXXXXXX) is automatically assigned to the application. The number will be listed on the Confirmation page that is generated after

submission. Using the tracking number, access the Track My Application page under the Applicants tab or the Details tab in the submitted workspace.

For additional training resources, including video tutorials, refer to: https://www.grants.gov/web/grants/applicants/applicant-training.html

Applicant Support: Grants.gov provides applicants 24/7 support via the toll-free number 1-800-518-4726 and email at support@grants.gov. For questions related to the specific grant opportunity, contact the number listed in the application package of the grant you are applying for.

If you are experiencing difficulties with your submission, it is best to call the Grants.gov Support Center and get a ticket number. The Support Center ticket number will assist the DoD with tracking your issue and understanding background information on the issue.

Application forms and instructions will be available at Grants.gov. To access these materials, go to http://www.grants.gov, select "Apply for Grants", and then select "Download an Application Package." Enter the FOA number, W911NF-19-S-0001.

Applicants must complete the mandatory forms and any optional forms (e.g., SF-LLL Disclosure of Lobbying Activities) in accordance with the instructions on the forms and the additional instructions below. The required fields should be completed in accordance with the "pop-up" instructions on the forms. To activate the instructions, turn on the "Help Mode" (icon with the pointer and question mark at the top of the form). Files that are attached to the forms must be in Adobe Portable Document Form (PDF) unless otherwise specified in this announcement.

The following formatting rules apply for the file attachments:

- Paper size when printed – 8.5 x 11 inch paper
- Margins – 1 inch
- Spacing – Single
- Font – No Smaller than Times New Roman, 12 point

Form: SF 424 (R&R) (Mandatory) – Complete this form first to populate data in other forms. Authorized Organization Representative (AOR) usernames and passwords serve as "electronic signatures" when your organization submits applications through Grants.gov. By using the SF 424 (R&R), applicants are providing the certification required by 32 CFR Part 28 regarding lobbying.

Form: Research & Related Other Project Information - Complete questions 1 through 6 and attach files.

- **Project Summary/Abstract (Field 7 on the form)** - The Project Summary should be a brief summary of the content of the application. It shall include a title, the research team (include roles, expertise, affiliations), designation of Junior Investigator or Senior Investigator derivation, and a brief abstract articulating the project objectives. **The project summary must not exceed 3 pages to include any cover page.** Pages in excess of the page limit may be removed for the evaluation of the application.

- **Project Narrative (Field 8 on the form)** - Chapters and Numbers of pages – Field 7 is to contain the chapters set forth below and may not exceed the stipulated page counts for those chapters. Pages in excess of the page limits may be removed for the evaluation of the application. All chapters set forth below should be in a single PDF file. For those chapters with specified page

limitations, any pages submitted beyond the specified amount for a chapter will not be reviewed or evaluation.

- **Chapter 1: Technical Component**. The pages included in Chapter 1 are to be numbered. Applicants are advised that Chapter 1 **will not exceed 10 pages**, utilizing one side of the page. Tables that extend beyond one page (fold out tables) will only count as one page.

  - **Proposed Effort (approximately 4-5 pages):** This section of Chapter 1 should include an overview of the research strategy to be employed to advance the state-of-the-art in enhancing team-level properties and performance in heterogeneous, human-agent teams; a short description and justification for annual research goals of the proposed effort; and a short technical discussion stating the background and objectives of the proposed research, the overall technical approaches to be pursued. This technical discussion should include a proposed breakdown of research tasks and short description of the technical approaches for each task. The Proposed Effort should include the specific hypotheses to be tested, and what specific tasks will be performed by the research team to test them, as well as justification for why these are the appropriate measures. Technical Proposals must also include a brief summary of how this research addresses the broader needs of the program, as summarized in the program description above.

  - **Proposed Summer Innovation Summit Participation and Collaboration Development (approximately 1-2 pages):** Include here the plan for participation in the Summer Innovation Summit in Summer 2019 in Burlington, MA. Collaboration with US Army Research Lab or other Government research personnel is highly encouraged, as well as cross-connection with other Program participants. Include a plan to foster communication and collaboration across government, academic, and industry partners, through planned participation in the Summer Innovation Summit and other methods for developing collaborations throughout performance under the seedling CA. Proposals should focus on the plan for participation in the Summer Innovation Summit and development of collaborations to propose a follow-on option effort; with these collaborations anticipated to be developed after award of the seedling CA, throughout the seedling performance year and particularly during the Summer Innovation Summit.

  - **Participant(s) roles, qualifications and bio-sketches (approximately 2 pages)**: Must include the names, primary role/availability, and brief biographies. Include plans for junior investigator development and mentorship of less experienced personnel (mentoring plan).

  - **Proposed timeline (approximately 0.5-1 page)**: An estimated timeline of tasks to be completed during the 12-month period, including (1) components to be completed at the home institution(s) and (2) components planned during the Summer Summit

- **Chapter 2: Cost Component.** The pages included in Chapter 2 will be numbered and Chapter 2 does not have a page limitation. Cost Application must include a budget for the 12 month period of performance. The cost portion of the application will contain cost estimates sufficiently detailed for meaningful evaluation. Budget justification may also be attached in this chapter. Before award it must be established that an approved accounting system and financial management system exist.

For all applications, the budget details should include:

a. *Direct Labor*: Show the current and projected salary amounts in terms of man-hours, man- months, or annual salary to be charged by the personnel performing under this agreement either by personnel or position. State the number of man-hours used to calculate a man-month or man-year. For each person or position, provide the following information:

i. The basis for the direct labor hours or percentage of effort (e.g., historical hours or estimates);

ii. The basis for the direct labor rates or salaries. Labor costs should be predicted upon current labor rates or salaries. These rates may be adjusted upward for forecast salary or wage cost-of-living increases that will occur during the agreement period. The cost application should separately identify the rationale applied to base salary/wage for cost-of- living adjustments and merit increases. Each must be fully explained;

iii. The portion of time to be devoted to the requirements of the agreement;

iv. The total annual salary charged to the agreement; and

v. Any details that may affect the salary during the project, such as plans for leave and/or remuneration while on leave.

b. *Fringe Benefits and Indirect Costs (Overhead, G&A, and Other)*: The most recent rates, dates of negotiation, the base(s) and periods to which the rates apply must be disclosed and a statement included identifying whether the proposed rates are provisional or fixed. If the rates have been negotiated by a Government agency, state when and by which agency. A copy of the negotiation memorandum should be provided. If negotiated forecast rates do not exist, applicants must provide sufficient detail to enable a determination to be made that the costs included in the forecast rate are allocable according to applicable cost provisions. Applicants' disclosure should be sufficient to permit a full understanding of the content of the rate(s) and how it was established. At a minimum, the submission should identify:

i. All individual cost elements included in the forecast rate(s);

ii. Basis used to prorate indirect expenses to cost pools, if any;

iii. How the rate(s) was calculated;

iv. Distribution basis of the developed rate(s);

v. Basis on which the overhead rate is calculated, such as "salaries and wages" or "total costs;" and

vi. The period of the applicant's FY.

c. *Permanent Equipment*: If facilities or equipment are required, a justification why this property should be furnished by the Government must be submitted. State the organization's inability or unwillingness to furnish the facilities or equipment. Applicants

must provide an itemized list of permanent equipment showing the cost for each item. Permanent equipment is any article or tangible nonexpendable property having a useful life of more than one year and an acquisition cost of $5,000 or more per unit. The basis for the cost of each item of permanent equipment included in the budget must be disclosed, such as:

> i. Vendor Quote: Show name of vendor, number of quotes received and justification, if intended award is to other than lowest bidder.

> ii. Historical Cost: Identify vendor, date of purchase, and whether or not cost represents lowest bid. Include reason(s) for not soliciting current quotes.

> iii. Engineering Estimate: Include rationale for quote and reason for not soliciting current quotes.

If applicable, the following additional information shall be disclosed in the applicant's cost application:

> iv. Special test equipment to be fabricated by the Recipient for specific requirements in the agreement.

> v. Standard equipment to be acquired and modified to meet specific requirements, including acquisition and modification costs, listed separately.

> vi. Existing equipment to be modified to meet specific research requirements, including modification costs. Do not include equipment the organization will purchase with its funds if the equipment will be capitalized for Federal income tax purposes. Proposed permanent equipment purchases during the final year of an award shall be limited and fully justified.

> vii. Grants and cooperative agreements may convey title to an eligible institution for permanent equipment purchased with project funds. At the discretion of the Contracting/Grants Officer, the agreement may provide for retention of the title by the Government or may impose conditions governing the equipment conveyed to the organization per the governing laws and regulations.

d. *Travel*: Forecasts of travel expenditures (domestic and foreign) that identify the destination and the various cost elements (airfare, mileage, per diem rates, etc.) must be submitted. The costs should be in sufficient detail to determine the reasonableness of such costs. Allowance for air travel normally will not exceed the cost of round-trip, economy air accommodations. Specify the type of travel and its relationship to the requirements of the agreement.

e. *Participant Support Costs*: This budget category refers to costs of transportation, per diem, stipends, and other related costs for participants or trainees (but not employees) in connection with DoD-sponsored conferences, meetings, symposia, training activities, and workshops. Generally, indirect costs are not allowed on participant support costs. The number of participants to be supported should be entered in the parentheses on the budget form. These costs should also be justified in the budget justification page(s) attached to the cost application.

f. *Materials, Supplies, and Consumables*: A general description and total estimated cost of expendable equipment and supplies are required. The basis for developing the cost

estimate (vendor quotes, invoice prices, engineering estimate, purchase order history, etc.) must be included. If possible, provide a material list.

g. *Publication, Documentation, and Dissemination*: The budget may request funds for the costs of preparing, publishing, or otherwise making available to others the findings and products of the work conducted under an agreement, including costs of reports, reprints, page charges, or other journal costs (except costs for prior or early publication); necessary illustrations, cleanup, documentation, storage, and indexing of data and databases; and development, documentation, and debugging of software.

h. *Consultant Costs:* Applicants normally are expected to utilize the services of their own staff to the maximum extent possible in managing and performing the project's effort. If the need for consultant services is anticipated, the nature of proposed consultant services should be justified and included in the technical application narrative. The cost application should include the names of consultant(s), primary organizational affiliation, each individual's expertise, daily compensation rate, number of days of expected service, and estimated travel and per diem costs.

i. *Computer Services*: The cost of computer services, including computer-based retrieval of scientific, technical, and educational information, may be requested. A justification/explanation based on the established computer service rates at the proposing   organization should be included. The budget also may request costs, which must be   shown to be reasonable, for leasing automatic data processing equipment. The purchase   of computers or associated hardware and software should be requested as items of equipment.

j. *Subawards (Subcontracts or Subgrants)*: A precise description of services or materials that are to be awarded by a subaward must be provided. For subawards totaling $10,000 or more, provide the following specific information:

i. A clear description of the work to be performed;

ii. If known, the identification of the proposed subawardee and an explanation of   why and how the subawardee was selected or will be selected;

iii. The identification of the type of award to be used (cost reimbursement, fixed   price, etc.);

iv. Whether or not the award will be competitive and, if noncompetitive, rationale to justify the absence of competition; and

v. A detailed cost summary.

k. *ODCs*: Itemize and provide the basis for proposed costs for other anticipated direct costs such as communications, transportation, insurance, and rental of equipment other than computer related items. Unusual or expensive items must be fully explained and justified.

l. *Profit/ Fee*: Profit/fee is not allowed for the Recipient of or subaward to an assistance instrument, where the principal purpose of the activity to be carried out is to stimulate or support a public purpose (i.e., to provide assistance), rather than acquisition (i.e., to acquire goods and services for the direct benefit of the Government). A subaward is an award of financial assistance in the form of money, or property in lieu of money, made

under a DoD grant or cooperative agreement by a Recipient to an eligible subrecipient. The term includes financial assistance for substantive program performance by the Subrecipient of a portion of the program for which the DoD grant or cooperative agreement was made. It does not include the Recipient's procurement of goods and services needed to carry out the program.

- **Bibliography and Reference Cited (Field 9 on the form)** – Attach a listing of   applicable publications cited in above sections.

- **Facilities and Other Resources (Field 10 on the form)** - The applicant is to provide a description of any facilities planned to be used for the project, whether at the home institution, a partner facility, or at the Summer Innovation Summit. A note of support guaranteeing access to these facilities on behalf of their primary management should also be included. Attach this information at Field 10.

- **Equipment (Field 11 on the form)** - The applicant is to include a listing of equipment available to support the application. Any Government equipment necessary for performance is to be clearly identified. Attach this information at Field 11.

- **Other Attachments (Field 12 on the form)** are as follows:

  1. Attached the completed certifications.

  2. **FORM: SF-424 Research & Related Senior/Key Person Profile (Expanded) (Mandatory)** – The Degree Type and Degree Year fields on the Research and Related Senior/Key Person Profile (Expanded) form will be used by DoD as the source for career information. In addition to the required fields on the form, applicants must complete these two fields for all individuals that are identified as having the project role of PD/PI or Co-PD/PI on the form. Additional senior/key persons can be added by selecting the "Next Person" button

  3. **FORM: SF-424 (R&R) Personal Data (Mandatory)** - This form will be used by DoD as the source of demographic information, such as gender, race, ethnicity, and disability information for the Project Director/Principal Investigator and all other persons identified as Co-Project Director(s)/Co-Principal Investigator(s). Each application must include this form with the name fields of the Project Director/Principal Investigator and any Co-Project Director(s)/Co-Principal Investigator(s) completed; however, provision of the demographic information in the form is voluntary. If completing the form for multiple individuals, each Co-Project Director/Co-Principal Investigator can be added by selecting the "Next Person" button. The demographic information, if provided, will be used for statistical purposes only and will not be made available to merit reviewers. Applicants who do not wish to provide some or all of the information should check or select the "Do not wish to provide" option.

  4. **SF-LLL – Disclosure of Lobbying Activities**. If applicable, attach a complete SF- LLL at Field 11 of the R&R Other Project Information form. Applicability: If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the cooperative agreement, you must complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying."

5. Complete the **Representations under DoD Assistance Agreements: Appropriations Provisions on Tax Delinquency and Felony Convictions** (this can be found under National Policy Requirements)

3. Submission Dates and Times

Proposals are due by 3:00pm (local time in North Carolina, USA) on 21 December 2018. An email receipt will be provided to each Applicant for each Proposal submission received. Applications submitted after the closing date and time will not be considered or evaluated by the Government.

Application Receipt Notices

Grants.gov: After an application is submitted to Grants.gov, the AOR will receive a series of three emails from Grants.gov. The first two emails will be received within 24 to 48 hours after submission. The first email will confirm time of receipt of the application by the Grants.gov system and the second will indicate that the application has either been successfully validated by the system prior to transmission to the grantor agency or has been rejected due to errors. A third email will be received once the grantor agency has confirmed receipt of the application. Reference https://www.grants.gov/help/html/help/GetStarted/Get_Started.htm from the Grants.gov User Guide for information on how to track your application package.

For the purposes of this FOA, an applicant's application is not considered received by the Government until the AOR receives email #3.

E. APPLICATION REVIEW INFORMATION

1. Criteria

Proposal Evaluation Criteria. The following represents the evaluation criteria for this Funding Opportunity:

Factor 1: Scientific Merit and Relevance: Evaluation of this factor will concentrate on the overall scientific and technical merit, creativity, innovation, and flexibility of the proposed research in light of the current state-of-the-art of STRONG-relevant scientific topics, and the expected outcomes based on the timeline of execution. The scientific merit will be evaluated with regard to the specific topic area research area to be addressed in this annual Funding Opportunity, fundamental research aimed at theories of team-level processes for heterogeneous human-agent teams. Evaluation of this factor will also concentrate on the long-term relevance of the proposed research and the likelihood that the proposed research will address scientific challenges and research barriers facing the Army and commercial sectors.

Factor 2: Experience and Qualifications of Scientific Staff and Junior Investigator Development: Evaluation of this factor will concentrate on the qualifications, capabilities, availability, proposed level of effort, and experience of both the Applicant's key research personnel (individually and as a whole), their relevant past accomplishments, and their ability to achieve the proposed technical objectives. Plans for junior investigator development and mentorship of less experienced personnel will be an evaluation factor. Key personnel are expected to be substantially and meaningfully engaged in the research and the proposed level of effort for key personnel reflected in the proposal should be commensurate with and demonstrate such engagement. The extent to which the Applicant's proposed facilities and equipment will contribute to the accomplishment of the proposed research will be evaluated, including the nature, quality, relevance, availability, and access to state-of-the-art research facilities and equipment.

Factor 3: Collaboration: Evaluation of this factor will concentrate on the Applicant's strategies, plans and experience in fostering collaborative research and managing collaborative research programs as set forth in this FOA. Evaluation of this factor will include evidence of previous successful collaborative efforts, plans for participation at the Summer Innovation Summit, the Applicant's commitment and plans for collaboration within the program and the synergistic value of the collaborations among researchers and government scientists, as well as approaches to data/coding/model sharing and transition of products that create collaborative potential amongst government, academic, and industry partners.

Factor 4: Cost. While this area will not be weighted, evaluation of this area will consider cost realism, cost reasonableness, and affordability within funding constraints. The Government may make adjustments to the cost of the total proposed effort as deemed necessary to reflect what the effort should cost. These adjustments will consider the task undertaken and approach proposed. These adjustments may include upward or downward adjustments to proposed labor hours, labor rates, quantity of materials, price of materials, overhead rates and G&A, etc.

2. **Review and Selection Process**

All timely and compliant Proposal submissions will be evaluated in accordance with the evaluation criteria set forth in this FOA. Proposals are expected to be evaluated by a group of qualified scientists and managers from the Government.

No other material outside of a Proposal will be provided to those evaluating proposals. An initial review of the proposals will be conducted to ensure compliance with the requirements of this FOA. Failure to comply with the requirements of the FOA may result in a proposal not being evaluated and receiving no further consideration for award.

Proposals that are timely and in compliance with the requirements of the FOA will be evaluated in accordance with merit based, competitive procedures. These procedures will include evaluation factors that will be evaluated using an adjectival and color rating system as follows:

> **OUTSTANDING (blue):** The proposal is evaluated as outstanding for this factor. The proposal includes **one or more significant strengths that are not offset by weaknesses.**
>
> **GOOD (purple):** The proposal is evaluated as good for this factor. The proposal includes **some strengths that are not offset by weaknesses.**
>
> **ACCEPTABLE (green):** The proposal is evaluated as acceptable for this factor. **Any strengths and weaknesses in the proposal balance out.**
>
> **MARGINAL (yellow):** The proposal is evaluated as marginal for this factor. While the proposal **may or may not contain some strengths, and strengths are more than offset by any weakness or weaknesses.**
>
> **UNACCEPTABLE (red):** The proposal is evaluated as unacceptable for this factor. While the proposal **may or may not contain some strengths, and strengths are offset by any significant weakness or weaknesses.**

A Review Team, consisting of a qualified group of scientists and managers, will evaluate the Proposals and provide the results of that evaluation to the decision maker for the Government. The decision maker will make decisions concerning award selection.

The Government will make award to the Applicant(s), whose proposal conforms to the Funding Opportunity that offers the most-favorably rated proposal(s) based on the evaluation criteria noted above. The Government reserves the right not to make an award should no acceptable Proposal be submitted.

3. Recipient Qualification

i. The Grants Officer is responsible for determining a Recipient's qualification prior to award. In general, a Grants Officer will award grants or CAs only to qualified Recipients that meet the standards at 32 CFR 22.415. To be qualified, a potential Recipient must:

(1) Have the management capability and adequate financial and technical resources, given those that would be made available through the grant or cooperative agreement, to execute the program of activities envisioned under the grant or cooperative agreement;

(2) Have a satisfactory record of executing such programs or activities (if a prior Recipient of an award);

(3) Have a satisfactory record of integrity and business ethics; and

(4) Be otherwise qualified and eligible to receive a grant or cooperative agreement under applicable laws and regulations (see 32 CFR 22.402(c)).

Applicants are requested to provide information with proposal submission to assist the Grants Officer's evaluation of Recipient qualification.

ii. In accordance with OMB guidance in parts 180 and 200 of Title 2, CFR, it is DoD policy that DoD Components must report and use integrity and performance information in the Federal Awardee Performance and Integrity Information System (FAPIIS), or any successor system designated by OMB, concerning grants, cooperative agreements, and TIAs as follows:

If the total Federal share will be greater than the simplified acquisition threshold on any Federal award under a notice of funding opportunity (see 2 CFR 200.88 Simplified Acquisition Threshold):

(1) The Federal awarding agency, prior to making a Federal award with a total amount of Federal share greater than the simplified acquisition threshold, will review and consider any information about the applicant that is in the designated integrity and performance system accessible through SAM (currently FAPIIS) (see 41 U.S.C. 2313);

(2) An applicant, at its option, may review information in the designated integrity and performance systems accessible through SAM and comment on any information about itself that a Federal awarding agency previously entered and is currently in the designated integrity and performance system accessible through SAM;

(3) The Federal awarding agency will consider any comments by the applicant, in addition to the other information in the designated integrity and performance system, in making a judgment about the applicant's integrity, business ethics, and record of performance under Federal awards when completing the review of risk posed by applicants as described in 2 CFR 200.205 Federal awarding agency review of risk posed by applicants.

F. AWARD ADMINISTRATION INFORMATION

1. Award Notices

Should your Proposal be selected for award, you will be contacted telephonically or via email by the Grants Officer or his/her representative to discuss additional information required for award. This may include representations and certifications, revised budgets or budget explanations, and other information as applicable to the proposed award. The anticipated start date will be determined at that time.

The award document signed by the Government Grants Officer is the official and authorizing award instrument.

2. Administrative and National Policy Requirements

a. Each award under this announcement will be governed by the general award terms and conditions in effect at the time of the award that conform to DoD's implementation of OMB guidance applicable to financial assistance in 2 CFR part 200, "Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards." The DoD Research and Development General Terms and Conditions (latest version, JULY 2018) are located at https://www.onr.navy.mil/Contracts-Grants/submit-proposal/grants-proposal/grants-terms-conditions.

These terms and conditions are incorporated by reference in this announcement.

b. You must comply with all applicable national policy requirements. The key national policy requirements that may relate to an award under this FOA are included in the terms and conditions specified in paragraph 2.a above.

c. By electronically signing the SF-424, the applicant affirms its agreement with the following certification.

Certification Required for Grant and Cooperative Agreement Awards

The certification at Appendix A to 32 CFR Part 28 regarding lobbying is the only certification required at the time of application submission for a grant or cooperative agreement award. The certification is as follows:

"By signing and submitting an application that may result in the award of a grant exceeding $100,000, the prospective awardee is certifying, to the best of his or her knowledge and belief that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employ of a Member of Congress in connection with this Federal contract,

grant, loan, or cooperative agreement, the undersigned shall complete and submit SF-LLL, "Disclosure of Lobbying Activities" in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, and loans, or cooperative agreements) and that all Subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails the required certification shall be subject to a civil penalty or not less than $10,000.00 and not more than $100,000.00 for each failure.

d. Representations Required for Grant and Cooperative Agreement Awards

Appropriations Provisions on Tax Delinquency and Felony Convictions

Check either "is" or "is not" for each of these two representations, as appropriate for the proposing institution, include the AOR signature and point of contact information, and attach the representation page to Field 12 of the SF-424 Research & Related Other Project Information form. The page for these representations is provided with the application materials that are available for download at Grants.gov.

Representations

The applicant is ( ) is not ( ) a "Corporation" meaning any entity, including any institution of higher education, other nonprofit organization, or for-profit entity that has filed articles of incorporation. If the applicant is a "Corporation" please complete the following representations:

(1) The applicant represents that it is ( ) or is not ( ) a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

(2) The applicant represents that it is ( ) is not ( ) a corporation that was convicted of a criminal violation under any Federal law within the preceding 24 months.

NOTE: If an applicant responds in the affirmative to either of the above representations, the applicant is ineligible to receive an award unless the agency suspension and debarment official (SDO) has considered suspension or debarment and determined that further action is not required to protect the Government's interests. The applicant therefore should provide information about its tax liability or conviction to the agency's SDO as soon as it can do so, to facilitate completion of the required considerations before award decisions are made.

OMB CONTROL NUMBER: 0704-0494
OMB EXPIRATION DATE: 11/30/2019

AGENCY DISCLOSURE NOTICE

The public reporting burden for this collection of information is estimated to average 5 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to the Department of Defense, Washington Headquarters Services, Executive Services Directorate, Directives Division, 4800 Mark Center Drive, East Tower, Suite 02G09, Alexandria, VA 22350-3100 [0704-0494]. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

Prohibition on Contracting with Entities that Require Certain Internal Confidentiality Agreements

Agreement with the representation below will be affirmed by checking the "I agree" box in block 17 of the SF-424 (R&R) as part of the electronic application submitted via Grants.gov. The representation reads as follows:

By submission of its application, the applicant represents that it does not require any of its employees, contractors, or Subrecipients seeking to report fraud, waste, or abuse to sign or comply with internal confidentiality agreements or statements prohibiting or otherwise restricting those employees, contractors, Subrecipients from lawfully reporting that waste, fraud, or abuse to a designated investigative or law enforcement representative of a Federal department or agency authorized to receive such information

Note that: (1) the basis for this representation is a prohibition in Section 743 of the Financial Services and General Government Appropriations Act, 2015, Pub. L. 113- 235) on provision of funds through grants and cooperative agreements to entities with certain internal confidentiality agreements or statements; and (2) Section 743 states that it does not contravene requirements applicable to SF-312, Form 4414, or any other form issued by a Federal department or agency governing the nondisclosure of classified information.

3.   Reporting

Reporting requirements, including number and type, will be specified in the award document, and will include as a minimum monthly financial status reports and annual scientific and technical reports. The reports shall be prepared and submitted in accordance with the procedures contained in the award document and mutually agreed upon before award. A final report that summarizes the project and tasks will be required at the conclusion of the performance period for the award.

If the total Federal share exceeds $500,000 on any Federal award under a notice of funding opportunity, the post-award reporting requirements reflected in Appendix XII to 2 CFR 200 will be included in the award document. This requirement also applies to modifications of awards that: 1) increase the scope of the award, 2) are issued on or after January 1, 2016, and 3) increase the federal share of the award's total value to an amount that exceeds $500,000.

G. AGENCY CONTACTS

All questions or comments concerning this FOA should be submitted on or before 30 November 2018. Questions and comments should be concise and to the point. In addition, the relevant part and paragraph of the Funding Opportunity must be referenced. Responses to non-proprietary questions received by the

specified will be posted to the STRONG website for the benefit of all interested parties. Should an Applicant have questions they believe are of a proprietary nature, the Applicant must clearly state so and identify and mark the proprietary information in the question when posed. Answers to questions of a proprietary nature will be provided via email directly to the poser of the question and not posted on the STRONG website.

H. PROTECTION OF HUMAN SUBJECTS

1. Assistance Instruments:
   a. The Recipient must protect the rights and welfare of individuals who participate as human subjects in research under this award and comply with the requirements at 32 CFR part 219, Department of Defense Instruction (DoDI) 3216.02, 10 U.S.C. 980, and when applicable, Food and Drug Administration (FDA) regulations.
   b. The Recipient must not begin performance of research involving human subjects, also known as human subjects research (HSR), that is covered under 32 CFR part 219, or that meets exemption criteria under 32 CFR 219.101(b), until you receive a formal notification of approval from a DoD Human Research Protection Official (HRPO). Approval to perform HSR under this award is received after the HRPO has performed a review of the Recipient's documentation of planned HSR activities and has officially furnished a concurrence with the Recipient's determination as presented in the documentation.
   c. In order for the HRPO to accomplish this concurrence review, the Recipient must provide sufficient documentation to enable his or her assessment as follows:
       i. If the HSR meets an exemption criteria under 32 CFR 219.101(b), the documentation must include a citation of the exemption category under 32 CFR 219.101(b) and a rationale statement.
       ii. If the Recipient's activity is determined as "non-exempt research involving human subjects", the documentation must include:
           - Assurance of Compliance (i.e., Department of Health and Human Services Office for Human Research Protections (OHRP) Federal Wide Assurance (FWA)) appropriate for the scope of work or program plan; and
           - Institutional Review Board (IRB) approval, as well as all documentation reviewed by the IRB to make their determination.
   d. The HRPO retains final judgment on what activities constitute HSR, whether an exempt category applies, whether the risk determination is appropriate, and whether the planned HSR activities comply with the requirements in paragraph (a) of this section.
   e. The Recipient must notify the HRPO immediately of any suspensions or terminations of the Assurance of Compliance.
   f. DoD staff, consultants, and advisory groups may independently review and inspect the Recipient's research and research procedures involving human subjects and, based on such findings, DoD may prohibit research that presents unacceptable hazards or otherwise fails to comply with DoD requirements.
   g. Definitions for terms used in this article are found in DoDI 3216.02.

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