



Broad Agency Announcement
Real Time Machine Learning (RTML)
Microsystems Technology Office
HR001119S0037
March 15, 2019

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ATTACHMENT 1: Cost Volume Proposer Checklist
 ATTACHMENT 2: Proposal Summary Slide Template

PART I: OVERVIEW INFORMATION

- **Federal Agency Name:** Defense Advanced Research Projects Agency (DARPA), Microsystems Technology Office (MTO)
- **Funding Opportunity Title:** Real Time Machine Learning (RTML)
- **Announcement Type:** Initial Announcement
- **Funding Opportunity Number:** HR001119S0037
- **Catalog of Federal Domestic Assistance Numbers (CFDA):** 12.910 Research and Technology Development
- **Dates:** (All times listed herein are Eastern Time)
 - Posting Date: March 15, 2019
 - Proposers Day: April 2, 2019
 - FAQ Submission Deadline: 1:00 PM on April 15, 2019
 - Proposal Due Date: 1:00 PM on May 1, 2019
 - Estimated period of performance start: October 1, 2019

Concise description of the funding opportunity:

A grand challenge in computing is the creation of a processor that can proactively interpret and learn from data in real-time, solve unfamiliar problems using what it has learned, and operate with the energy efficiency of the human brain. The National Science Foundation (NSF) and the Defense Advanced Research Projects Agency (DARPA) are teaming up through the Real-Time Machine Learning (RTML) program to develop the foundational breakthroughs in hardware and machine learning needed to build systems that respond and adapt in real time.

- **Anticipated Funding Available for Award:** \$10M
- **Anticipated individual awards:** Multiple awards are anticipated
- **Anticipated funding type:** 6.1 and 6.2
- **Types of instruments that may be awarded:** Procurement contract, cooperative agreement or other transaction.
- **Agency contact:**
 - Andreas Olofsson, Program Manager
BAA Coordinator: HR001119S0037@darpa.mil
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PART II: FULL TEXT OF ANNOUNCEMENT

I. Funding Opportunity Description

The Defense Advanced Research Projects Agency (DARPA) often selects its research efforts through the Broad Agency Announcement (BAA) process. This BAA is being issued, and any resultant selection will be made, using the procedures under Federal Acquisition Regulation (FAR) 6.102(d)(2) and 35.016 and 2 C.F.R. § 200.203. Any negotiations and/or awards will use procedures under FAR 15.4, Contract Pricing. Proposals received as a result of this BAA shall be evaluated in accordance with evaluation criteria specified herein through a scientific review process.

DARPA BAAs are posted on the Federal Business Opportunities (FedBizOpps) website, <http://www.fbo.gov/>, and, as applicable, the Grants.gov website at <http://www.grants.gov/>. The following information is for those wishing to respond to the BAA.

The Microsystems Technology Office at DARPA is soliciting innovative research proposals in the area of real time machine learning hardware. The Real Time Machine Learning program will develop machine-learning hardware generators and explore circuit architectures that can proactively interpret and learn from data, solve unfamiliar problems using what it has learned, and operate at power levels on par or better than the human brain. Proposed research should investigate innovative approaches that enable revolutionary advances in science, devices, or systems.

A. Real Time Machine Learning (RTML)

1. Program Description

Driven by rapidly evolving challenges from our adversaries, future defense systems will need access to low size, weight, and power (SWaP) artificial intelligence (AI) solutions that can rapidly transition from idea to practice. In recent years, we have seen significant advancements in our ability to learn from large data sets thanks to increases in hardware performance, advances in machine learning (ML) algorithms, and the availability of high quality open datasets. However, current ML systems are generally trained prior to deployment and are not capable of adapting to new datasets in the field, limiting real-time function. Critical next generation defense systems, such as autonomous vehicles and arrays of sensors will be deployed in distributed settings where resources for exporting newly encountered data might be scarce or unavailable.

Competing challenges of low SWaP, low latency, and adaptability will likely require from the ground-up development of algorithms and circuits specifically for real time machine learning. Despite recent advances in deep learning training and inference throughput, there remains strong potential in a breadth of technical areas that will allow for foundational improvement in real time machine learning, including development of new devices, circuit architectures, non-digital processing hardware and algorithms. To address real time embedded system challenges, the National Science Foundation (NSF) and the Defense Advanced Research Projects Agency (DARPA) have teamed up to explore rapid development of energy efficient hardware and ML

architectures that can learn from a continuous stream of new data in real time. The NSF-led RTML program is dedicated to path finding research, while the DARPA program will create the tools and circuit development infrastructure needed to enable rapid innovation in next wave AI hardware.¹ While the DARPA RTML program is distinct from the NSF Real Time Machine Learning (RTML) program, the NSF program will offer collaboration opportunities to awardees from DARPA (and DARPA will offer similar opportunities to the NSF awardees) during the duration of this program.

2. Program Structure and Technical Approach

The DARPA RTML program will create no-human-in-the-loop hardware generators and compilers to enable fully automated creation of ML Application-Specific Integrated Circuits (ASICs) from high level source code. As part of the DARPA RTML program, circuit implementation of various ML architectures for real-time inference and rapid learning are of interest. Centralized learning on aggregated data over time in a cloud environment often does not lend itself to real-time inference and adaptation to new unlabeled datasets. RTML is specifically developing approaches to ML in a distributed setting that can closely approximate ML performance in a centralized cloud setting. Architectures of interest include, but are not limited to:

- a) conventional feed forward (convolutional) neural networks,
- b) recurrent networks and their specialized versions
- c) neuroscience-inspired architectures, such as spike time-dependent neural nets including their stochastic counterparts,
- d) non-neural ML architectures inspired by psychophysics as well as statistical techniques,
- e) classical supervised learning (e.g., regression and decision trees),
- f) unsupervised learning (e.g., clustering) approaches,
- g) semi-supervised learning methods,
- h) generative adversarial learning techniques, and
- i) other approaches such as transfer learning, reinforcement learning, manifold learning, and/or life-long learning.

It is well understood that generality and choice equates to inefficiencies of computation and that specialized digital and analog circuits tuned for a specific application can be 1000x more efficient than general purpose programmable computing platforms. It is likely that ultra-specialized ASICs will be required to meet the physical SWaP requirements of autonomous systems with real time response and low learning latency requirements. Unfortunately, the high cost of design and implementation today has made development of ML ASICs impractical for all but the highest volume applications.

Complex ML processor chips take months/years to design and require a large team of cross-disciplinary experts, with knowledge in machine learning, low level micro-architectures, and physical chip design. The majority of today's exploratory machine learning research is done at a high level of abstraction, largely decoupled from the physical realities of leading edge manufacturable circuit technology. The absence of easily comparable performance, SWaP, and latency for different machine learning approaches makes it difficult to scientifically explore the field of real time ML hardware.

¹ See NSF Program Solicitation No. 19-566.

The complexity challenge of modern ASIC design is now being addressed by DARPA’s Intelligent Design of Electronic Assets (IDEA), Posh Open Source Hardware (POSH), and Circuit Realization at Faster Timescales (CRAFT) design automation programs:

<https://www.darpa.mil/program/intelligent-design-of-electronic-assets>

<https://www.darpa.mil/program/posh-open-source-hardware>

<https://www.darpa.mil/program/circuit-realization-at-faster-timescales>

The DARPA RTML program will leverage these approaches to improve design efficiency and the ML innovation cycle by creating no-human-in-the-loop end to end hardware generators optimized for ML. Combined with the chip layout generators from the DARPA IDEA program, the RTML compiler will enable fully automated generation of ML ASICs directly from high level source code. The orders of magnitude reductions in the cost and effort of hardware design will enable machine learning researchers to explore and receive accurate feedback on hardware performance of interesting new machine learning topologies within hours or days, bridging the gap between theory and practical realization.

The RTML program is split into two distinct research phases that are 18 months in length, with a total duration of 36 months.

Phase 1: Machine Learning Hardware Compiler [Base – 18 months]

Objective: Create fully automated hardware compilers for state of the art ML algorithms and networks, using existing ML programming frameworks as inputs.

Phase 1 of the DARPA RTML program will reduce the design cost barrier by creating automated compilers for generation of high quality implementations of networks expressed in high level ML frameworks. A notional diagram of the final RTML compiler can be found in Figure 1.

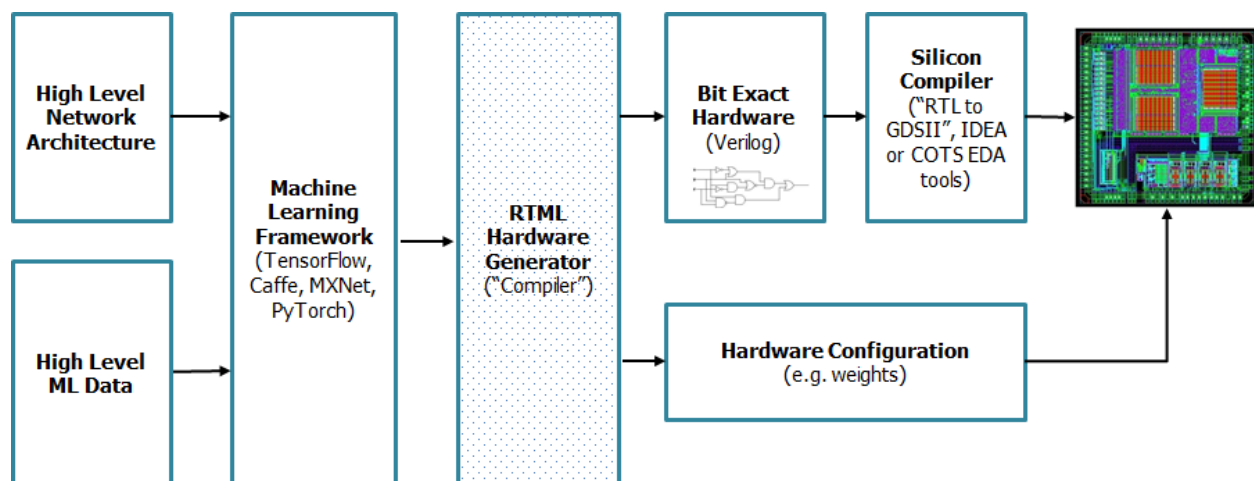


Figure 1: RTML Compiler

Phase 1 will focus on development of a hardware generator that takes programs expressed in popular ML frameworks (such as TensorFlow, PyTorch, Caffe, MXNet) as the input and generates standard Verilog code and hardware configurations as the output. Proposers are expected to integrate and test the developed hardware generator within a full “Program to GDSII” compiler flow, as shown in Figure 1. To support this vision, the RTML hardware generator should generate synthesizable Verilog code that can be fed into automated layout generation tools like the one developed by the DARPA IDEA program. Proposers should not propose new approaches to physical layout (RTL to GDSII), but should plan to interface with existing technology.

The goal of Phase 1 is to demonstrate a compiler capable of auto-generating a large catalog of scalable ML hardware instances ranked by application based performance, size, weight, area, power, throughput, and latency. The proposed solution should support generation of a wide range of ML algorithms and networks and should not be limited to traditional feed forward neural networks. The RTML compiler should be a general purpose source to source compiler capable of translating all leading high level machine learning framework code into hardware.

The RTML hardware generator is expected to carry out high level arithmetic optimizations and have the ability to map to optimized technology libraries and/or theoretically achievable macros such as multipliers, adder trees, block memories, activation functions, etc.

It is unlikely that real time ML latency requirements can be met with off the shelf standard DRAM memory, so the proposed solution should include on-chip or closely coupled on-chip, 2.5D, and 3D memory systems as a distinct mapping capability.

Program performers are expected to deliver interim and final reports with performance metrics for all ML hardware generated in the program, including accuracy, size, weight, power, latency, and throughput measured on pre-tapeout GDSII designs and recorded for a set of relevant state-of-the-art data sets and workloads. A strong diversity of architectures tested is encouraged to provide proof of generality.

The program metrics for RTML Phase 1 can be found in Table 1.

Table 1. Phase 1 RTML Generator Metrics

Type	Metric
Peak Performance	Training and Inference Scalable configurable at generation with support up to full reticle size at 14nm
Inference Energy Efficiency¹	>10TOPS/W
Min Number of Architectures²	10
Hardware Generation Automation	100% (ML to Verilog)
I/O Interface	Highly efficient chip-to-chip interface (such as from the DARPA CHIPS program)
Design Input (source code)	High level network description. Support for TensorFlow, PyTorch, Caffe2, CNTK, MXNet, ONNX
Generator (Compiler Front-end) Output	Verilog
Deliverable	Software, license ³ , generator source code, flow scripts, documentation, GDSII for generated designs

¹Program is interested in real work accomplished per Watt, not arbitrary peak mathematical ops/W. As a general guidance we are specifying a 10 TOPS/W at 14nm as a minimum threshold with the understanding that efficiency numbers are tightly coupled to accuracy, data sets, and actual applications. Efficiency metric includes all SoC power including IO power needed to sustain peak throughput. Based upon normalized MAC for the proposed application.

²To demonstrate a general purpose ML compiler, teams are expected to complete GDSII implementation of multiple ML architectures

³Delivered with a minimum of government purpose rights; open source licenses are preferred.

Phase 2: Real Time Machine Learning Systems [Option – 18 months]

Objective: Extend Phase 1 compiler work to incorporate state of the art ML advances from the NSF RTML program while adding compiler support for hardware optimization driven by system requirements.

In Phase 2 of DARPA RTML teams will extend the Phase 1 hardware generator to support optimization of ML hardware for application-specific requirements. The tunable generator should be capable of developing real time machine learning ASICs that demonstrate an order of magnitude improvement over the state of the art in terms of terms of latency, processing throughput, and SWaP. Phase 2 work should leverage best available machine learning algorithms, architectures, and circuits developed by teams in the NSF RTML program and the global ML research community and should be built on top of the compiler infrastructure created in Phase 1.

Phase 2 will consist of design space exploration through circuit implementations of multiple ML architectures and a hardware demonstration of real time machine learning for a stated application area. DARPA has identified two critical application areas of interest for Phase 2 demonstrations: 1) future high bandwidth wireless communication systems like the 60 GHz range of the emerging 5G standard and 2) high bandwidth image processing in SWaP constrained systems. As part of the proposal, teams should identify user specified goals for accuracy (and quality of results), power (and area), data throughput, and processing latency required for the target application demo.

A fundamental component of the Phase 2 research will be to continue exploring the tradeoffs between system performance and efficiency for different machine learning architectures. Table 2 is provided to illustrate the enormous design constraint space of ML hardware. Previous research in ML hardware has demonstrated clear tradeoffs between classification accuracy, latency, and processing energy efficiency. The RTML compiler is expected to support fixed objective design optimization as well as multi-objective Pareto optimization within this design space given a fixed ML architecture description and dataset as input. The philosophy of Phase 2 should be exploration across architectures of “photons/waves to knowledge”, where all components from stimulus to extracted information are considered part of the SWaP budget, including sampling, memory, computation, and power delivery.

Phase 2 will include fabrication and hardware characterization of multiple hardware instantiations of architectures which effectively explore the design space, from min to max as described in Table 2. DARPA will provide fabrication support through a number of separately funded multi-project or dedicated wafer runs; therefore, fabrication costs should not be included in proposal budgets. Proposers should assume the tapeouts will occur at a primary commercial foundry at the 14nm or equivalent CMOS technology node.

	Min ¹	Max ¹
Data Throughput	400 Kbps	400 Gbps
Latency	100 μ s	100 s
Total Power²	200 μ W	200 W
Application-Specific Accuracy³	0.6	0.99
Dataset	Proposer Defined ⁴	
I/O Interface	Highly efficient chip to chip interface (such as CHIPS)	
Design Input (source code)	High level network description. Support for TensorFlow, PyTorch, Caffe2, CNTK, and MXNet, ONNX	
Design Output	GDSII ready for manufacturing	
Hardware Generation Automation	100%	
Deliverables	Software, license ⁵ , Design Source code, flow scripts, documentation, GDSII, chiplet hardware	

Table 2. Phase 2 Hardware Guidelines

¹Teams are expected to explore a wide trade space of power, latency, accuracy, and data throughput and show the ability to tune hardware over a large range of performance metrics. Max values are not expected to be achieved simultaneously.

²Power must include everything needed to operate, including power delivery, thermal management, external memory, and sensor interfaces.

³For example, ResNet152 has an accuracy of > 0.96 on the ImageNet database:
<http://image-net.org/challenges/LSVRC/2015/results>

⁴Proposals are expected to outline a clear plan for validating the quality of the compiler output, including details of the publicly available benchmarks and datasets from industry, government, and academia that will be used

⁵Delivered with a minimum of government purpose rights; open source licenses are preferred

3. Structure of the NSF Collaboration

The NSF-DARPA collaboration for this program seeks to enable cross-pollination of ideas that are being funded through the awards individually made by NSF and DARPA. The DARPA program will select proposers from submissions to HR001119S0037, the DARPA RTML Broad Agency Announcement. NSF will independently select projects for 36-month awards from NSF Program Solicitation No. 19-566. The outcome of the DARPA Phase 1 hardware compiler will be made available to the NSF awardees as an option to evaluate their proposed new RTML approaches. New techniques and results produced by NSF awardees during the first 18 months will be made available to DARPA project teams for them to implement in their Phase 2 efforts to explore novel ML architectures and circuits that will enable RTML.

There will be four joint NSF-DARPA workshops during the 36-month program: at the initial program kick-off, and then at the 9-month, 18-month, and 27-month marks. Representatives of each DARPA project are required to attend all four workshops to engage with NSF project teams. These joint workshops are expected to promote knowledge-sharing and collaboration opportunities among the teams supported by both agencies.

Before starting Phase 2 work, DARPA performers are expected to synchronize expectations with the NSF RTML program to ensure that the latest techniques that are being produced by NSF awardees are being leveraged. As an option, DARPA performer teams can propose inclusion of researchers working in the NSF RTML awards as part of their DARPA Phase 2 efforts. These “partnership supplements” may be requested near the end of Phase 1 (base). Any DARPA Phase 1 performers who do not qualify for Phase 2 support from DARPA can work with NSF awardees under this program to request supplemental funding from NSF through an existing NSF RTML Large award. This option is for informational purposes only and should not be included in proposals submitted in response to this BAA.

4. Program Guidelines

RTML seeks to answer the following research questions:

- Can we build an application specific silicon compiler for ML?
- What hardware architectures are best suited to RTML?
- What are the lower latency limits for various RTML tasks?
- What is the lowest SWaP feasible for various RTML tasks?

RTML does NOT seek proposals for:

- Investigatory research that does not result in deliverable hardware designs
- Circuits that cannot be produced in standards CMOS foundries (like 14nm)
- New Domain Specific Languages
- New approaches to physical layout (RTL to GDSII)

- Incremental efforts

In addition to novel research, the RTML program will emphasize delivery of no-human-in-the-loop hardware generators. Software and hardware created in the program are expected to be readily adopted by the broader ML research community so intellectual property rights asserted by proposers are strongly encouraged to be aligned with non-viral open source licenses such as the Apache 2.0, Massachusetts Institute of Technology (MIT), and Berkeley Software Distribution licenses. If a proposed approach includes proprietary software or technical data as a component of the approach, the proposer is expected to provide 1) clear justification for the need for the proposed software, and 2) a description of how the RTML program goals will be met with use of the proprietary model. Instructions for completing intellectual property rights assertions are detailed in Section IV.B.9, “Intellectual Property”.

An RTML proposal should address the following:

- A description of the unique technical merits and value provided by the technology to meet the goals of RTML. Proposers may use prior work to argue the technical merits of their approach
- A description of RTML task(s) to be performed and the input and output relationship as it relates to the real time hardware
- A description of any training data needed and the plan for curating the data
- A discussion of the plan to achieve a fully automated tunable generators of Verilog from a high level description of machine learning hardware
- A description of the proposer’s anticipated software release schedule
 - If open source, specify the license type and schedule for public release on an industry-leading collaborative development platform
- Identification of the target application area; either 1) high bandwidth wireless communication systems like the 60GHz range of the emerging 5G standard or 2) high bandwidth image processing in SWaP constrained systems
- A list of user-defined specifications for an RTML demo relevant to the chosen application, including accuracy (and quality of results), power (and area), data throughput, and processing latency

5. Schedule and Milestones

The RTML program schedule comprises an 18-month base period (Phase 1) followed by an 18-month option period (Phase 2), for a total of 36 months, subject to availability of funds and technical progress achieved. Approval of the next funding increment will require satisfactory progress against the performer’s metrics and a clear plan to achieving the program requirements. A program schedule with critical milestones is provided in Figure 2.

Phase 1 Milestones:

Objective: Development of a “no human in the loop” machine learning hardware generator and RTML compiler flow that meets the metrics of the program as specified in Table 1.

9 Months:

- Release of an alpha version of the machine learning hardware generator at a joint NSF/DARPA workshop on real time machine learning

16 months:

- Release of the final ML hardware generator (V1.0) at a joint NSF/DARPA workshop on real time machine learning and demonstration within a RTML compiler flow
- Hardware compiler with a projected path to meeting the Phase 2 metrics
- Pre tapeout chiplet layout based characterization of a large selection of ML components in GDSII format

Phase 2 Milestones:

Objective: Exploration of novel machine learning architectures and circuits that enable real time machine learning for autonomous machines.

9 Months:

- Release of a tunable hardware generator (V1.5) appropriate for real time autonomous machines
- Chiplet layout for circuits that enable real time machine learning for autonomous machines

18 Months:

- Hardware demonstration of a real time machine for a specified application and release of final tunable hardware generator (V2.0) and fabricated hardware
- Characterization of fabricated chiplets illustrating the exploration of the design space across multiple ML architectures

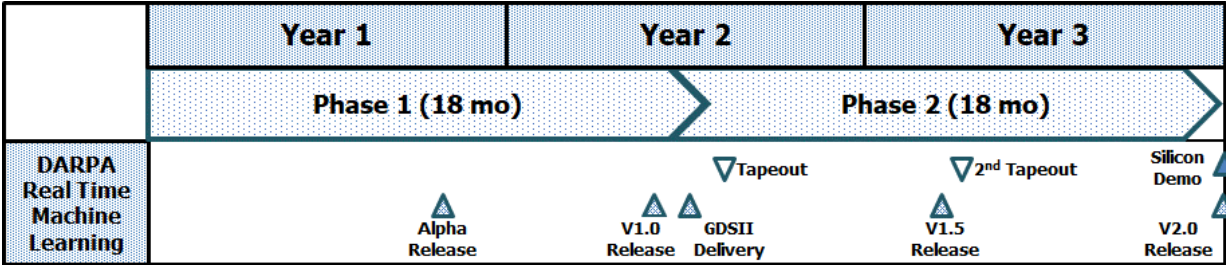


Figure 2. An illustration of the RTML program schedule highlighting critical program events and milestones.

6. Program Deliverables and/or Work Products

The RTML program deliverables are summarized in Table 3.

Table 3. Summary of RTML program deliverables and/or work products (as appropriate) by phase.

Phase	RTML
1	<ul style="list-style-type: none"> • All RTML hardware generator software and any required licenses • Essential training data and frameworks • Documentation • GDSII database and associated Verilog code • Size, weight, power, performance analysis based on GDSII layout • Reports as defined below
2	<ul style="list-style-type: none"> • All RTML hardware generator software and any required licenses • Essential training data and frameworks • Documentation • GDSII database and associated Verilog code • Size, weight, power, performance analysis based on fabricated chips • Fabricated chips • Reports as defined below

1. Software/Hardware

Performers are required to release all prototype software, hardware descriptions and netlists, and accompanying documentation developed under RTML. At the end of Phase 1, performers are required to release versions of the hardware generators consistent with the proposed license (open source license preferred). In Phase 2, performers are expected to release updated versions of the hardware generators consistent with the proposed license (open source license preferred), tape out test-chips, and demonstrate real time operation of functional hardware.

2. Technical Reports

Technical reports shall be submitted as text documents on a quarterly basis beginning two weeks after the kick-off meeting. Submission of technical presentation materials will be required two working days prior to a scheduled program event, such as a joint workshop or technical interchange meeting. All reports and presentations should include a technical and management work plan that documents the project schedule including milestones. Technical interchanges to discuss software progress as needed. Participation in 4 joint NSF-DARPA workshops is required. Proposed travel costs should support travel to these events.

3. Monthly Financial Reports

The financial report shall describe resources expended, resources available, any deviation from planned expenditures and any potential issues requiring the attention of the Government team. This report shall be provided within 10 days from the end of each month.

4. Final Report

After the end of each phase, a report shall summarize the effort in a comprehensive document.

7. Government Furnished Information

- The government will provide the I/O specifications and reference circuits needed to create DARPA-CHIPS chiplets [<https://www.darpa.mil/program/common-heterogeneous-integration-and-ip-reuse-strategies>]. Additional information about the physical interface can be found here: <https://github.com/intel/aib-phy-hardware>.
- The government will provide access to a leading edge foundry node (14/16nm or equivalent) for chosen Phase 2 tapeouts. It is expected performers will establish any necessary standard commercial agreements, such as non-disclosure agreements (NDAs), with the foundry at the inception of the program. In all cases, the Government is not a party to such agreements.
- The government will provide supplementary information required to locate open source IDEA layout platform code releases to facilitate integration of the RTML hardware generator within an RTML compiler flow.
- New techniques and results produced by NSF RTML performers during their first 18 months.

II. Award Information

A. General Award Information

Multiple awards are anticipated. The amount of resources made available under this BAA will depend on the quality of the proposals received and the availability of funds.

The Government reserves the right to select for negotiation all, some, one, or none of the proposals received in response to this solicitation, and to make awards without discussions with proposers. The Government also reserves the right to conduct discussions if it is later determined

to be necessary. If warranted, portions of resulting awards may be segregated into pre-priced options. Additionally, DARPA reserves the right to accept proposals in their entirety or to select only portions of proposals for award. In the event that DARPA desires to award only portions of a proposal, negotiations may be opened with that proposer. The Government reserves the right to fund proposals in phases with options for continued work at the end of one or more of the phases, as applicable.

Awards under this BAA will be made to proposers on the basis of the evaluation criteria listed below (see section labeled “Application Review Information,” Sec. V.), and program balance to provide overall value to the Government. The Government reserves the right to request any additional, necessary documentation once it makes the award instrument determination. Such additional information may include but is not limited to Representations and Certifications (see Section VI.B.4., “Representations and Certifications”). The Government reserves the right to remove proposers from award consideration should the parties fail to reach agreement on award terms, conditions and cost/price within a reasonable time or the proposer fails to timely provide requested additional information. Proposals identified for negotiation may result in a procurement contract, cooperative agreement, or other transaction, depending upon the nature of the work proposed, the required degree of interaction between parties, whether or not the research is classified as Fundamental Research, and other factors.

Proposers looking for innovative, commercial-like contractual arrangements are encouraged to consider requesting Other Transactions. To understand the flexibility and options associated with Other Transactions, consult <http://www.darpa.mil/work-with-us/contract-management#OtherTransactions>.

In accordance with 10 U.S.C. § 2371b(f), the Government may award a follow-on production contract or Other Transaction (OT) for any OT awarded under this BAA if: (1) that participant in the OT, or a recognized successor in interest to the OT, successfully completed the entire prototype project provided for in the OT, as modified; and (2) the OT provides for the award of a follow-on production contract or OT to the participant, or a recognized successor in interest to the OT.

In all cases, the Government contracting officer shall have sole discretion to select award instrument type, regardless of instrument type proposed, and to negotiate all instrument terms and conditions with selectees. DARPA will apply publication or other restrictions, as necessary, if it determines that the research resulting from the proposed effort will present a high likelihood of disclosing performance characteristics of military systems or manufacturing technologies that are unique and critical to defense. Any award resulting from such a determination will include a requirement for DARPA permission before publishing any information or results on the program. For more information on publication restrictions, see the section below on Fundamental Research.

B. Fundamental Research

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

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

As of the date of publication of this BAA, the Government expects that program goals as described herein may be met by proposed efforts for fundamental research and non-fundamental research. Some proposed research may present a high likelihood of disclosing performance characteristics of military systems or manufacturing technologies that are unique and critical to defense. Based on the anticipated type of proposer (e.g., university or industry) and the nature of the solicited work, the Government expects that some awards will include restrictions on the resultant research that will require the awardee to seek DARPA permission before publishing any information or results relative to the program.

Proposers should indicate in their proposal whether they believe the scope of the research included in their proposal is fundamental or not. While proposers should clearly explain the intended results of their research, the Government shall have sole discretion to determine whether the proposed research shall be considered fundamental and to select the award instrument type. Appropriate language will be included in resultant awards for non-fundamental research to prescribe publication requirements and other restrictions, as appropriate. This language can be found at <http://www.darpa.mil/work-with-us/additional-baa>.

For certain research projects, it may be possible that although the research to be performed by a potential awardee is non-fundamental research, its proposed subawardee’s effort may be fundamental research. It is also possible that the research performed by a potential awardee is fundamental research while its proposed subawardee’s effort may be non-fundamental research. In all cases, it is the potential awardee’s responsibility to explain in its proposal which proposed efforts are fundamental research and why the proposed efforts should be considered fundamental research.

III. Eligibility Information

A. Eligible Applicants

All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA.

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

a) FFRDCs

FFRDCs are subject to applicable direct competition limitations and cannot propose to this BAA in any capacity unless they meet the following conditions: (1) FFRDCs must clearly demonstrate that the proposed work is not otherwise available from the private sector. (2) FFRDCs must provide a letter on official letterhead from their sponsoring organization citing the specific authority establishing their eligibility to propose to Government solicitations and compete with industry, and their compliance with the associated FFRDC sponsor agreement's terms and conditions. This information is required for FFRDCs proposing to be awardees or subawardees.

b) Government Entities

Government Entities (e.g., Government/National laboratories, military educational institutions, etc.) are subject to applicable direct competition limitations. Government entities must clearly demonstrate that the work is not otherwise available from the private sector and provide written documentation citing the specific statutory authority and contractual authority, if relevant, establishing their ability to propose to Government solicitations. This information is required for Government Entities proposing to be awardees or subawardees.

c) Authority and Eligibility

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

(1) Non-U.S. organizations and/or individuals may participate to the extent that such participants comply with any necessary nondisclosure agreements, security regulations, export control laws, and other governing statutes applicable under the circumstances.

(2) For classified proposals, applicants will ensure all industrial, personnel, and information systems processing security requirements are in place and at the appropriate level (e.g., Facility Clearance Level (FCL), Automated Information Security (AIS), Certification and Accreditation (C&A), and any Foreign Ownership Control and Influence (FOCI) issues are mitigated prior to submission. Additional information on these subjects can be found at <http://www.dss.mil>.

B. Organizational Conflicts of Interest

FAR 9.5 Requirements

In accordance with FAR 9.5, proposers are required to identify and disclose all facts relevant to potential OCIs involving the proposer's organization and *any* proposed team member (subawardee, consultant). Under this Section, the proposer is responsible for providing this disclosure with each proposal submitted to the BAA. The disclosure must include the

proposer's, and as applicable, proposed team member's OCI mitigation plan. The OCI mitigation plan must include a description of the actions the proposer has taken, or intends to take, to prevent the existence of conflicting roles that might bias the proposer's judgment and to prevent the proposer from having unfair competitive advantage. The OCI mitigation plan will specifically discuss the disclosed OCI in the context of each of the OCI limitations outlined in FAR 9.505-1 through FAR 9.505-4.

Agency Supplemental OCI Policy

In addition, DARPA has a supplemental OCI policy that prohibits contractors/performers from concurrently providing Scientific Engineering Technical Assistance (SETA), Advisory and Assistance Services (A&AS) or similar support services and being a technical performer. Therefore, as part of the FAR 9.5 disclosure requirement above, a proposer must affirm whether the proposer or *any* proposed team member (subawardee, consultant) is providing SETA, A&AS, or similar support to any DARPA office(s) under: (a) a current award or subaward; or (b) a past award or subaward that ended within one calendar year prior to the proposal's submission date.

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

- The name of the DARPA office receiving the support;
- The prime contract number;
- Identification of proposed team member (subawardee, consultant) providing the support; and
- An OCI mitigation plan in accordance with FAR 9.5.

Government Procedures

In accordance with FAR 9.503, 9.504 and 9.506, the Government will evaluate OCI mitigation plans to avoid, neutralize or mitigate potential OCI issues before award and to determine whether it is in the Government's interest to grant a waiver. The Government will only evaluate OCI mitigation plans for proposals that are determined selectable under the BAA evaluation criteria and funding availability.

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

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

C. Cost Sharing/Matching

Cost sharing is not required; however, it will be carefully considered where there is an applicable statutory condition relating to the selected funding instrument. Cost sharing is encouraged where there is a reasonable probability of a potential commercial application related to the proposed research and development effort.

For more information on potential cost sharing requirements for Other Transactions, see <http://www.darpa.mil/work-with-us/contract-management#OtherTransactions>.

D. Other Eligibility Criteria

1. Collaborative Efforts

Collaborative efforts/teaming are encouraged. After proposal selections, the Government reserves the right to seek contractual arrangements, such as Associate Contractor Agreements (ACAs), between separate performers if doing so benefits the overall program/project goals and objectives and mutual interests of the parties.

IV. Application and Submission Information

PROPOSERS ARE CAUTIONED THAT EVALUATION RATINGS MAY BE LOWERED AND/OR PROPOSALS REJECTED IF PROPOSAL PREPARATION (PROPOSAL FORMAT, CONTENT, ETC.) AND/OR SUBMITTAL INSTRUCTIONS ARE NOT FOLLOWED.

A. Address to Request Application Package

This announcement, any attachments, and any references to external websites herein constitute the total solicitation. If proposers cannot access the referenced material posted in the announcement found at www.darpa.mil, contact the administrative contact listed herein.

B. Content and Form of Application Submission

1. Full Proposal Format

All full proposals must be in the format given below. Proposals shall consist of two volumes: Volume I – Technical and Management Proposal (3 sections), and Volume II – Cost Proposal (4 sections). All pages shall be printed on 8-1/2 by 11 inch paper with type not smaller than 12 point. Smaller font may be used for figures, tables and charts. The page limitation for full proposals includes all figures, tables, and charts. The submission of other supporting materials along with the proposals is strongly discouraged and will not be considered for review. Section II of Volume I, Technical and Management Proposal, shall not exceed 15 pages. There is no page limit for Volume II, Cost Proposal. All full proposals must be written in English.

A summary slide of the proposed effort, in PowerPoint format, should be submitted with the proposal. A template slide is provided as Attachment 2 to the BAA. Submit this PowerPoint file in addition to Volumes I and II of your full proposal. This summary slide does not count towards the total page count.

a. Volume I, Technical and Management Proposal

Section I. Administrative

A. Cover sheet to include:

- (1) BAA number (HR001119S0037);
- (2) Program Name;
- (3) Lead Organization submitting proposal;
- (4) Type of organization, selected among the following categories:
Large Organization, Small Disadvantaged Organization, Other Small Organization, HBCU, MI, Other Educational, Other Nonprofit;
- (5) Proposer's internal reference number (if any);
- (6) Other team members (if applicable) and type of organization for each;
- (7) Proposal title;
- (8) Technical point of contact to include:
Salutation, last name, first name, street address, city, state, zip code (+4), telephone, fax (if available), electronic mail;
- (9) Administrative point of contact to include:
Salutation, last name, first name, street address, city, state, zip code (+4), telephone, fax (if available), electronic mail;
- (10) Total funds requested from DARPA, and the amount of cost share (if any); AND
- (11) Date proposal was submitted.

B. Official transmittal letter.

The transmittal letter should identify the BAA number with specific program listed, the proposal by name, and the proposal reference number (if any), and should be signed by an individual who is authorized to submit proposals to the Government.

Section II. Detailed Proposal Information**A. Statement of Work (SOW)**

In plain English, clearly define the technical tasks to be performed, their durations, and dependencies among them. The page length for the SOW will be dependent on the amount of the effort. For each task, provide:

1. A general description of the objective (for each defined task/activity);
2. A detailed description of the approach to be taken to accomplish each defined task/activity;
3. Identification of the primary organization responsible for task execution (prime, sub, team member, by name, etc.);
4. The completion criteria for each task/activity - a product, event or milestone that defines its completion.
5. Define all deliverables (reporting, data, reports, software, hardware, etc.) to be provided to the Government in support of the proposed research tasks/activities; AND
6. Clearly identify any tasks/subtasks (prime or subcontracted) that will be accomplished on-campus at a university, if applicable.

*Note: Each Phase and subtask, as applicable, of the program must be separately defined in the SOW. Include a SOW for each subcontractor and/or consultant in the **Cost Proposal Volume**. Do not include any proprietary information in the SOW(s).*

B. Technical Approach

This section is the centerpiece of the proposal and should succinctly summarize the innovative claims for the proposed research and clearly describe the proposed approach without using any jargon. This section should demonstrate that the proposer has a clear understanding of the state-of-the-art and should provide sufficient justification for the feasibility of the proposed approach(es). This section should include a detailed technical rationale, technical approach, and constructive plan for accomplishment of technical goals in support of innovative claims and deliverable creation. This section should clearly identify the ML architectures that will be instantiated in hardware and the chosen RTML application. It should also include a description of RTML task(s) to be performed and the input and output relationship as it relates to the real time hardware, a description of any training data needed and the plan for curating the data, and discussion of the plan to achieve a fully automated tunable generator of GDSIs from a high level description of machine learning hardware.

C. Ongoing Research

Thoroughly and quantitatively describe the uniqueness and benefits of the proposed approach relative to the current state-of-art and alternate approaches. This section should include a comparison of the proposed effort with ongoing research, indicating the advantages and disadvantages of the proposed approach.

D. Risk Analysis and Mitigation Plan

Identify the major technical and programmatic risks in the program. Include a risk matrix. For each risk, assign a probability of occurrence on a scale of 1-10, where 10 indicates a high likelihood that the risk will impact program success, as well as an assessment of impact, also on a scale of 1-10, where 10 indicates that this risk would maximally limit the program from delivering software on schedule or meeting performance objectives. For each item with total risk (likelihood \times impact) exceeding 40, include a plan for mitigating the risk and assessing risk reduction.

E. Proposer Accomplishments

This section should include a discussion of proposer's previous accomplishments and work in closely related research areas.

F. National Security Impact Statement

To reduce the potential for unintended foreign access to critical U.S. national security technologies developed under this effort, proposals shall describe:

- How the proposed work contributes to U.S. national security and U.S. technological capabilities. The proposer may also summarize previous work that contributed to U.S. national security and U.S. technological capabilities.
- Plans and capabilities to transition technologies developed under this effort to U.S. national security applications and/or to U.S. industry. The proposer may also discuss previous technology transitions to the benefit of U.S. interests.

- Any plans to transition technologies developed under this effort to foreign governments or to companies that are foreign owned, controlled or influenced. The proposer may also discuss previous technology transition to these groups.
- How the proposer will assist its employees and agents performing work under this effort to be eligible to participate in the U.S. national security environment.

G. Teaming

Describe the formal teaming arrangements that will be used to execute this effort. Describe the programmatic relationship between investigators and the rationale for choosing this teaming strategy. Present a coherent organization chart and integrated management strategy for the program team. For each person, indicate: (1) name, (2) affiliation, (3) abbreviated listing of all tasks they will work on with roles, responsibilities, and percent time indicated, (4) discussion of the proposers' previous accomplishments, relevant expertise and/or unique capabilities.

H. Schedules and measurable milestones

Schedules and measurable milestones for the proposed research. (Note: Measurable milestones should capture key development points in tasks and should be clearly articulated and defined in time relative to start of effort.) Where the effort consists of multiple portions which could reasonably be partitioned for purposes of funding, these should be identified as options. Additionally, proposals should clearly explain the technical approach(es) that will be employed to meet or exceed each program metric and provide ample justification as to why the approach(es) is/are feasible. See also Section III. Other Transaction Request, If Applicable.

Section III. Additional Information

Information in this section may include an attached bibliography of relevant technical papers or research notes (published and unpublished) which document the technical ideas and approach upon which the proposal is based. Copies of not more than three (3) prior relevant papers may be included with the submission. The bibliography and attached papers are not included in the page counts given.

b. Volume II, Cost Proposal – {No Page Limit}

All proposers, including FFRDCs, must submit the following:

Section I. Administrative

Cover sheet to include:

- (1) BAA number (HR001119S0037);
- (2) Program Name;
- (3) Lead Organization submitting proposal;
- (4) Type of organization, selected among the following categories:
Large Organization, Small Disadvantaged Organization, Other Small Organization, HBCU, MI, Other Educational, Other Nonprofit;

- (5) Proposer's internal reference number (if any);
- (6) Other team members (if applicable) and type of organization for each;
- (7) Proposal title;
- (8) Technical point of contact to include:
Salutation, last name, first name, street address, city, state, zip code (+4), telephone, fax (if available), electronic mail (if available);
- (9) Administrative point of contact to include:
Salutation, last name, first name, street address, city, state, zip code (+4), telephone, fax (if available), and electronic mail (if available);
- (10) Award instrument requested:
Cost-Plus-Fixed Fee (CPFF), Cost-contract—no fee, cost sharing contract—no fee, or other type of procurement contract (*specify*), Cooperative Agreement, or Other Transaction;
- (11) Place(s) and period(s) of performance;
- (12) Total proposed cost separated by basic award and option(s), if any, by calendar year and by government fiscal year;
- (13) Name, address, and telephone number of the proposer's cognizant Defense Contract Management Agency (DCMA) administration office (*if known*);
- (14) Name, address, and telephone number of the proposer's cognizant Defense Contract Audit Agency (DCAA) audit office (*if known*);
- (15) Date proposal was prepared;
- (16) DUNS number;
- (17) TIN number;
- (18) CAGE Code;
- (19) Subcontractor Information;
- (20) Proposal validity period (120 days is recommended); AND
- (21) Any Forward Pricing Rate Agreement, other such approved rate information, or such documentation that may assist in expediting negotiations (if available).

Attachment 1, the Cost Volume Proposer Checklist, must be included with the coversheet of the Cost Proposal.

Section II. Detailed Cost Information (Prime and Subcontractors)

The proposers', to include eligible FFRDCs', cost volume shall provide cost and pricing information (See Note 1), or other than cost or pricing information if the total price is under the referenced threshold, in sufficient detail to substantiate the program price proposed (e.g., realism and reasonableness). In doing so, the proposer shall provide, **for both the prime and each subcontractor**, a "Summary Cost Breakdown" by phase and performer fiscal year, and a "Detailed Cost Breakdown" by phase, technical task/sub-task, and month. The breakdown/s shall include, at a minimum, the following major cost items along with associated backup documentation:

Total program cost broken down by major cost items:

A. Direct Labor

A breakout clearly identifying the individual labor categories with associated labor hours and direct labor rates, as well as a detailed Basis-of-Estimate (BOE) narrative description of the methods used to estimate labor costs;

B. Indirect Costs

Including Fringe Benefits, Overhead, General and Administrative Expense, Cost of Money, Fee, etc. (must show base amount and rate);

C. Travel

Provide the purpose of the trip, number of trips, number of days per trip, departure and arrival destinations, number of people, etc.;

D. Other Direct Costs

Itemized with costs; back-up documentation is to be submitted to support proposed costs;

E. Material/Equipment

(i) For IT and equipment purchases, include a letter stating why the proposer cannot provide the requested resources from its own funding.

(ii) A priced Bill-of-Material (BOM) clearly identifying, for each item proposed, the quantity, unit price, the source of the unit price (i.e., vendor quote, engineering estimate, etc.), the type of property (i.e., material, equipment, special test equipment, information technology, etc.), and a cross-reference to the Statement of Work (SOW) task/s that require the item/s. At time of proposal submission, any item that exceeds \$2,000 must be supported with basis-of-estimate (BOE) documentation such as a copy of catalog price lists, vendor quotes or a written engineering estimate (additional documentation may be required during negotiations, if selected).

(iii) If seeking a procurement contract and items of Contractor Acquired Property are proposed, exclusive of material, the proposer shall clearly demonstrate that the inclusion of such items as Government Property is in keeping with the requirements of FAR Part 45.102. In accordance with FAR 35.014, "Government property and title," it is the Government's intent that title to all equipment purchased with funds available for research under any resulting contract will vest in the acquiring nonprofit institution (e.g., Nonprofit Institutions of Higher Education and Nonprofit Organizations whose primary purpose is the conduct of scientific research) upon acquisition without further obligation to the Government. Any such equipment shall be used for the conduct of basic and applied scientific research. The above transfer of title to all equipment purchased with funds available for research under any resulting contract is not allowable when the acquiring entity is a for-profit organization; however, such organizations can, in accordance with FAR 52.245-1(j), be given priority to acquire such property at its full acquisition cost.

F. Consultants

If consultants are to be used, proposer must provide a copy of the consultant's proposed SOW as well as a signed consultant agreement or other document which verifies the proposed loaded daily / hourly rate and any other proposed consultant costs (e.g. travel);

G. Subcontracts

Itemization of all subcontracts. Additionally, the prime contractor is responsible for compiling and providing, as part of its proposal submission to the Government, subcontractor proposals prepared at the same level of detail as that required by the prime. Subcontractor proposals include Interdivisional Work Transfer Agreements (ITWA) or similar arrangements. If seeking a procurement contract, the prime contractor shall provide a cost reasonableness analysis of all proposed subcontractor costs/prices. Such analysis shall indicate the extent to which the prime contractor has negotiated subcontract costs/prices and whether any such subcontracts are to be placed on a sole-source basis.

All proprietary subcontractor proposal documentation, prepared at the same level of detail as that required of the prime, which cannot be uploaded to the DARPA BAA website (<https://baa.darpa.mil>, BAAT) or Grants.gov as part of the proposer's submission, shall be made immediately available to the Government, upon request, under separate cover (i.e., mail, electronic/email, etc.), either by the proposer or by the subcontractor organization. This does not relieve the proposer from the requirement to include, as part of their submission (via BAAT or Grants.gov, as applicable), subcontract proposals that do not include proprietary pricing information (rates, factors, etc.).

A Rough Order of Magnitude (ROM), or similar budgetary estimate, is not considered a fully qualified subcontract cost proposal submission. Inclusion of a ROM, or similar budgetary estimate, may result in the full proposal being deemed non-compliant or evaluation ratings may be lowered;

H. Cost-Sharing

The amount of any industry cost-sharing (the source and nature of any proposed cost-sharing should be discussed in the narrative portion of the cost volume); AND

I. Fundamental Research

Written justification required per Section II.B, "Fundamental Research," pertaining to prime and/or subcontracted effort being considered Contracted Fundamental Research.

Note 1:

(a) "Cost or Pricing Data" as defined in FAR 15.403-4 shall be required if the proposer is seeking a procurement contract per the referenced threshold, unless the proposer requests and is granted an exception from the requirement to submit cost or pricing data. Per DoD Class Deviation 2018-O0012, dated 13 April 2018, the threshold for obtaining certified cost and pricing data is \$2,000,000. Per DFARS 215.408(5), DFARS 252.215-7009, Proposal Adequacy Checklist, applies to all proposers/proposals seeking a FAR-based award (contract).

(b) In accordance with DFARS 215.403-1(4)(D), DoD has waived cost or pricing data requirements for nonprofit organizations (including educational institutions) on cost-reimbursement-no-fee contracts. In such instances where the waiver stipulated at DFARS 215.403-1(4)(D) applies, proposers shall submit information other than cost or pricing data to the extent necessary for the Government to determine price reasonableness and cost realism; and cost or pricing data from subcontractors that are not nonprofit organizations when the subcontractor's proposal exceeds the cost and pricing data threshold at FAR 15.403-4(a)(1).

(c) Per Section 873 of the FY2016 National Defense Authorization Act (Pub L. 114-92), “Pilot Program For Streamlining Awards For Innovative Technology Projects,” small businesses and nontraditional defense contractors (as defined therein) are alleviated from submission of certified cost and pricing data for new contract awards valued at less than \$7,500,000. In such instances where this “waiver” applies, proposers seeking a FAR-based contract shall submit information other than certified cost or pricing data to the extent necessary for the Government to determine price reasonableness and cost realism; and certified cost or pricing data from subcontractors that are not small businesses or nontraditional defense contractors when such subcontract proposals exceed the cost and pricing data threshold at FAR 15.403-4(a)(1).

(d) “Cost or pricing data” are not required if the proposer proposes an award instrument other than a procurement contract (i.e., cooperative agreement or other transaction).

Note 2:

Proposers are required to provide the aforementioned cost breakdown as an editable MS Excel spreadsheet, inclusive of calculations formulae, with tabs (material, travel, ODC’s) provided as necessary. The Government also requests that the Cost Proposal include MS Excel file(s) that provide traceability between the Bases of Estimate (BOEs) and the proposed costs across all elements and phases. This includes the calculations and adjustments that are utilized to generate the Summary Costs from the source labor hours, labor costs, material costs, etc. input data. It is requested that the costs and Subcontractor proposals be readily traceable to the Prime Cost Proposal in the provided MS Excel file(s) – although this is not a requirement, providing information in this manner will assist the Government in understanding what is being proposed both technically and in terms of cost realism. NOTE: If the PDF submission differs from the Excel submission, the PDF will take precedence.

Section III. Other Transaction Request, if applicable

All proposers requesting an Other Transaction (OT) must include a detailed list of payment milestones (Milestone Plan). Each milestone must include the following:

- Milestone description
- Completion/Exit criteria (to include identifying all associated data deliverables excluding those specifically providing project status)
- Due date
- Payment/funding schedule (to include, if cost share is proposed, awardee and Government share amounts)
- For each data deliverable, identify the proposed Government data rights (keeping in mind the how each data deliverable will need to be used by the Government given the goals and objectives of the proposed project)
- Milestones must not include proprietary information.

It is noted that, at a minimum, milestones should relate directly to accomplishment of program technical metrics as defined in the BAA and/or the proposer’s proposal. Agreement type, expenditure or fixed-price based, will be subject to negotiation by the Agreements Officer. Do not include proprietary data.

Section IV. Other Cost Information

Where the effort consists of multiple portions which could reasonably be partitioned for purposes of funding, these should be identified as options with separate cost estimates.

The cost proposal should include identification of pricing assumptions of which may require incorporation into the resulting award instrument (i.e., use of Government Furnished Property/Facilities/Information, access to Government Subject Matter Experts, etc.).

The proposer should include supporting cost and pricing information in sufficient detail to substantiate the summary cost estimates and should include a description of the method used to estimate costs and supporting documentation.

Cost proposals submitted by FFRDC's (prime or subcontractor) will be forwarded, if selected for negotiation, to their sponsoring organization contracting officer for review to confirm that all required forward pricing rates and factors have been used.

2. Proprietary Information

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

3. Security Information

a. Program Security Information

Proposers should include with their proposal any proposed solution(s) to program security requirements unique to this program. Common program security requirements include but are not limited to: operational security (OPSEC) contracting/sub-contracting plans; foreign participation or materials utilization plans; program protection plans (which may entail the following) manufacturing and integration plans; range utilization and support plans (air, sea, land, space, and cyber); data dissemination plans; asset transportation plans; classified test activity plans; disaster recovery plans; classified material / asset disposition plans and public affairs / communications plans.

b. Unclassified Submissions

DARPA anticipates that submissions received under this BAA will be unclassified. No classified proposals will be accepted.

4. Disclosure of Information and Compliance with Safeguarding Covered Defense Information Controls

The following provisions and clause apply to all solicitations and contracts; however, the definition of “controlled technical information” clearly exempts work considered fundamental research and therefore, even though included in the contract, will not apply if the work is fundamental research.

DFARS 252.204-7000, “Disclosure of Information”

DFARS 252.204-7008, “Compliance with Safeguarding Covered Defense Information Controls”

DFARS 252.204-7012, “Safeguarding Covered Defense Information and Cyber Incident Reporting”

The full text of the above solicitation provision and contract clauses can be found at <http://www.darpa.mil/work-with-us/additional-baa#NPRPAC>.

Compliance with the above requirements includes the mandate for proposers to implement the security requirements specified by National Institute of Standards and Technology (NIST) Special Publication (SP) 800-171, “Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations” (see <https://doi.org/10.6028/NIST.SP.800-171r1>) that are in effect at the time the BAA is issued.

For awards where the work is considered fundamental research, the contractor will not have to implement the aforementioned requirements and safeguards; however, should the nature of the work change during performance of the award, work not considered fundamental research will be subject to these requirements.

5. Human Subjects Research (HSR)/Animal Use

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

6. Approved Cost Accounting System Documentation

Proposers that do not have a Cost Accounting Standards (CAS) compliant accounting system considered adequate for determining accurate costs that are negotiating a cost- type procurement contract must complete an SF 1408. For more information on CAS compliance, see <http://www.dcaa.mil/cas.html>. To facilitate this process, proposers should complete the SF 1408 found at <http://www.gsa.gov/portal/forms/download/115778> and submit the completed form with the proposal. To complete the form, check the boxes on the second page, then provide a narrative explanation of your accounting system to supplement the checklist on page one. For more information, see (http://www.dcaa.mil/preaward_accounting_system_adequacy_checklist.html).

7. Section 508 of the Rehabilitation Act (29 U.S.C. § 749d)/FAR 39.2

All electronic and information technology acquired or created through this BAA must satisfy the accessibility requirements of Section 508 of the Rehabilitation Act (29 U.S.C § 794d)/FAR 39.2.

8. Small Business Subcontracting Plan

Pursuant to Section 8(d) of the Small Business Act (15 U.S.C. § 637(d)) and FAR 19.702(a)(1), each proposer who is a small business concern and seeking a procurement contract that has subcontracting possibilities is required to submit a subcontracting plan with their proposal. The plan format is outlined in FAR 19.704. As of the date of publication of this BAA, per FAR 19.702, the threshold for submission of a small business subcontracting plan is \$700,000 (total contract amount including options).

9. Intellectual Property

All proposers must provide a good faith representation that the proposer either owns or possesses the appropriate licensing rights to all intellectual property that will be utilized under the proposed effort.

a. For Procurement Contracts

Proposers responding to this BAA requesting procurement contracts will need to complete the certifications at DFARS 252.227-7017. See www.darpa.mil/work-with-us/additional-baa for further information. If no restrictions are intended, the proposer should state “none.” The table below captures the requested information:

Technical Data Computer Software To be Furnished With Restrictions	Summary of Intended Use in the Conduct of the Research	Basis for Assertion	Asserted Rights Category	Name of Person Asserting Restrictions
(LIST)	(NARRATIVE)	(LIST)	(LIST)	(LIST)

b. For All Non-Procurement Contracts

Proposers responding to this BAA requesting a Cooperative Agreement, Technology Investment Agreement, or Other Transaction for Prototypes shall follow the applicable rules and regulations governing these various award instruments, but, in all cases, should appropriately identify any potential restrictions on the Government’s use of any Intellectual Property contemplated under the award instrument in question. This includes both Noncommercial Items and Commercial Items. Proposers are encouraged use a format similar to that described in Paragraph a. above. If no restrictions are intended, then the proposer should state “NONE.”

10. Patents

Include documentation proving your ownership of or possession of appropriate licensing rights to all patented inventions (or inventions for which a patent application has been filed) that will be utilized under your proposal for the DARPA program. If a patent application has been filed for an invention that your proposal utilizes, but the application has not yet been made publicly available and contains proprietary information, you may provide only the patent number, inventor name(s), assignee names (if any), filing date, filing date of any related provisional application, and a summary of the patent title, together with either: (1) a representation that you own the invention, or (2) proof of possession of appropriate licensing rights in the invention.

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

All proposers must be registered in SAM unless exempt per FAR 4.1102. FAR 52.204-7, “System for Award Management” and FAR 52.204-13, “System for Award Management Maintenance” are incorporated into this BAA. See <http://www.darpa.mil/work-with-us/additional-baa> for further information.

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

12. Funding Restrictions

There will be limitations on direct costs such as foreign travel or equipment purchases. Laboratory equipment should include only specialized equipment and tooling specific to the proposed program. Where equipment purchases are proposed, the proposal must include a narrative description for the application requirements.

Travel budgets should include allocation for the Principle Investigator, all Co-Principle Investigators, and critical research staff members to attend the program kick-off meeting and joint DARPA-NSF workshops. At an academic institution the proposal may include travel budget for graduate students conducting research under the program to attend the workshops. For budgetary purposes, assume that the workshops alternate between Washington, DC and San Francisco, CA. The proposal may include travel budget for the P.I. and two associates to present Program results at a maximum of one domestic and one foreign conference annually.

Preaward costs will not be reimbursed unless a preaward cost agreement is negotiated prior to award.

C. Submission Information

DARPA will acknowledge receipt of all submissions and assign an identifying control number that should be used in all further correspondence regarding the submission. DARPA intends to use electronic mail correspondence regarding HR001119S0037. Submissions may not be submitted by fax or e-mail; any so sent will be disregarded.

Submissions will not be returned. An electronic copy of each submission received will be retained at DARPA and all other non-required copies destroyed. A certification of destruction may be requested, provided the formal request is received by DARPA within 5 days after notification that a proposal was not selected.

All administrative correspondence and questions on this solicitation, including requests for clarifying information on how to submit a full proposal to this BAA should be directed to HR001119S0037@darpa.mil. DARPA intends to use electronic mail for correspondence regarding HR001119S0037. Proposals and abstracts may not be submitted by fax or e-mail; any so sent will be disregarded. DARPA encourages use of the Internet for retrieving the BAA and any other related information that may subsequently be provided.

1. Submission Dates and Times

a. Full Proposal Date

The full proposal must be submitted to DARPA/MTO on or before 1:00 PM, Eastern Time, May 1, 2019 in order to be considered during the single round of selections. Proposals received after this deadline will not be reviewed.

b. Frequently Asked Questions (FAQ)

DARPA will post a consolidated Question and Answer (FAQ) document on a regular basis. To access the posting go to: <http://www.darpa.mil/work-with-us/opportunities>. Under the HR001119S0037 summary will be a link to the FAQ. Submit your question/s by e-mail to HR001119S0037@darpa.mil. In order to receive a response sufficiently in advance of the proposal due date, send your question/s on or before 1:00 PM, Eastern Time, April 15, 2019.

2. Proposal Submission Information

The typical proposal should express a consolidated effort in support of one or more related technical concepts or ideas. Disjointed efforts should not be included into a single proposal. Proposals not meeting the format described in the BAA may not be reviewed.

a. For Proposers Requesting Cooperative Agreements:

Proposers requesting cooperative agreements must submit proposals through one of the following methods: (1) electronic upload per the instructions at <https://www.grants.gov/applicants/apply-for-grants.html>; or (2) hard-copy mailed directly to DARPA. If proposers intend to use Grants.gov as their means of submission, then they must submit their entire proposal through Grants.gov; applications cannot be submitted in part to Grants.gov and in part as a hard-copy. Proposers using Grants.gov do not submit hard-copy proposals in addition to the Grants.gov electronic submission.

Submissions: Proposers must submit the three forms listed below.

SF 424 Research and Related (R&R) Application for Federal Assistance, available on the Grants.gov website at https://apply07.grants.gov/apply/forms/sample/RR_SF424_2_0-V2.0.pdf. *This form must be completed and submitted.*

To evaluate compliance with Title IX of the Education Amendments of 1972 (20 U.S.C. A§ 1681 Et. Seq.), the Department of Defense is using the two forms below to collect certain demographic and career information to be able to assess the success rates of women who are proposed for key roles in applications in science, technology, engineering, or mathematics disciplines. Detailed instructions for each form are available on Grants.gov.

Research and Related Senior/Key Person Profile (Expanded), available on the Grants.gov website at https://apply07.grants.gov/apply/forms/sample/RR_KeyPersonExpanded_2_0-V2.0.pdf. *This form must be completed and submitted.*

Research and Related Personal Data, available on the Grants.gov website at https://apply07.grants.gov/apply/forms/sample/RR_PersonalData_1_2-V1.2.pdf. *Each applicant must complete the name field of this form, however, provision of the demographic information is voluntary. Regardless of whether the demographic fields are completed or not, this form must be submitted with at least the applicant's name completed.*

Grants.gov requires proposers to complete a one-time registration process before a proposal can be electronically submitted. If proposers have not previously registered, this process can take between three business days and four weeks. For more information about registering for Grants.gov, see www.darpa.mil/work-with-us/additional-baa. See the Grants.gov registration checklist at <http://www.grants.gov/web/grants/register.html> for registration requirements and instructions.

Once Grants.gov has received a proposal submission, Grants.gov will send two email messages to advise proposers as to whether or not their proposals have been validated or rejected by the system; IT MAY TAKE UP TO TWO DAYS TO RECEIVE THESE EMAILS. The first email will confirm receipt of the proposal by the Grants.gov system; this email only confirms receipt, not acceptance, of the proposal. The second will indicate that the application has been successfully validated by the system prior to transmission to the grantor agency or has been rejected due to errors. If the proposal is validated, then the proposer has successfully submitted their proposal. If the proposal is rejected, the proposed must be corrected and resubmitted before DARPA can retrieve it. If the solicitation is no longer open, the rejected proposal cannot be resubmitted. Once the proposal is retrieved by DARPA, the proposer will receive a third email from Grants.gov. To avoid missing deadlines, proposers should submit their proposals in advance of the final proposal due date with sufficient time to receive confirmations and correct any errors in the submission process through Grants.gov. For more information on submitting proposals to Grants.gov, visit the Grants.gov submissions page at:

<http://www.grants.gov/web/grants/applicants/apply-for-grants.html>.

Proposers electing to submit grant or cooperative agreement proposals as hard copies must complete the same forms as indicated above.

b. For Proposers Requesting Contracts or Other Transaction Agreements

Proposers requesting contracts or other transaction agreements must submit proposals via DARPA's BAA Website (<https://baa.darpa.mil>). Note: If an account has already been created for the DARPA BAA Website, this account may be reused. If no account currently exists for the DARPA BAA Website, visit the website to complete the two-step registration process. Submitters will need to register for an Extranet account (via the form at the URL listed above) and wait for two separate e-mails containing a username and temporary password. After accessing the Extranet, submitters may then create an account for the DARPA BAA website (via the "Register your Organization" link along the left side of the homepage), view submission instructions, and upload/finalize the proposal. Proposers using the DARPA BAA Website may encounter heavy traffic on the submission deadline date; it is highly advised that submission process be started as early as possible.

All unclassified full proposals submitted electronically through the DARPA BAA website must be uploaded as zip files (.zip or .zipx extension). The final zip file should not exceed 50 MB in size. Only one zip file will be accepted per submission and submissions not uploaded as zip files will be rejected by DARPA.

NOTE: YOU MUST CLICK THE 'FINALIZE FULL PROPOSAL' BUTTON AT THE BOTTOM OF THE CREATE FULL PROPOSAL PAGE. FAILURE TO DO SO WILL RESULT IN YOUR PROPOSAL NOT BEING OFFICIALLY SUBMITTED TO THIS BAA AND THEREFORE NOT BEING REVIEWED.

Classified submissions and proposals requesting assistance instruments (grants or cooperative agreements) should NOT be submitted through DARPA's BAA Website (<https://baa.darpa.mil>), though proposers will likely still need to visit <https://baa.darpa.mil> to register their organization (or verify an existing registration) to ensure the BAA office can verify and finalize their submission.

Please note that the DoD-issued certificate associated with the BAA website is not recognized by all commercial certificate authorities, resulting in untrusted connection errors/messages. You can either bypass the warning (possibly by adding <https://baa.darpa.mil> to your listed of trusted sites, or [darpa.mil](https://baa.darpa.mil) as a trusted domain), or visit DISA's site to download the Root Certificate Authority (CA): <http://dodpki.c3pki.chamb.disa.mil/rootca.html>.

Technical support for DARPA's BAA Website may be reached at BAAT_Support@darpa.mil, and is typically available during regular business hours (9:00 AM - 5:00 PM EST, Monday - Friday).

c. Classified Submission Information

See Section IV.B.4, “Security Information,” for guidance on submitting classified abstracts and proposals.

V. Application Review Information

A. Evaluation Criteria

1. Overall Scientific and Technical Merit

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

The proposal should be supported by a technical team with the expertise and experience to accomplish the proposed task. The proposer's prior experience in similar efforts should clearly demonstrate an ability to deliver products that meet the proposed technical performance. A clear and feasible plan for release of high quality software is provided.

Task descriptions and associated technical elements provided are complete and in a logical sequence with all proposed research clearly defined such that a final outcome that achieves the goal can be expected as a result of award. The proposal identifies major technical risks and planned mitigation efforts are clearly defined and feasible.

2. Potential Contribution and Relevance to the DARPA Mission of Supporting National Security

The potential contributions of the proposed effort are relevant to the national technology base. Specifically, DARPA’s mission is to make pivotal early technology investments that create or prevent strategic surprise for U.S. National Security.

The proposer clearly demonstrates its plans and capabilities to contribute to U.S. national security and U.S. technological capabilities. The evaluation will consider the proposer’s plans and capabilities to transition proposed technologies to U.S. national security applications and to U.S. industry. The evaluation may consider the proposer’s history of transitioning or plans to transition technologies to foreign governments or to companies that are foreign owned, controlled, or influenced. The evaluation will also consider the proposer’s plans and capabilities to assist its employees and agents to be eligible to participate in the U.S. national security environment.

3. Impact on Machine Learning Landscape

The proposed research is appropriate for pre-competitive, basic or applied DoD research funding. This research successfully illustrates how the proposed work can provide deliverables which address the program guidelines. The proposed research will successfully complete a fundamental exploration of the tradeoffs between system efficiency and performance for a number of ML

architectures. The proposed research significantly advanced the state of the art in machine learning hardware.

4. Cost Realism and Schedule Realism

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

It is expected that the effort will leverage all available relevant prior research in order to obtain the maximum benefit from the available funding. DARPA recognizes that undue emphasis on cost may motivate proposers to offer low-risk ideas with minimum uncertainty and to staff the effort with junior personnel in order to be in a more competitive posture. DARPA discourages such cost strategies.

The proposed schedule aggressively pursues performance metrics in the shortest timeframe and accurately accounts for that timeframe. The proposed schedule identifies and mitigates any potential schedule risk.

B. Review and Selection Process

1. Review Process

It is the policy of DARPA to ensure impartial, equitable, comprehensive proposal evaluations based on the evaluation criteria listed in Section V.A, and to select the source (or sources) whose offer meets the Government's technical, policy, and programmatic goals.

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

Award(s) will be made to proposers whose proposals are determined to be the most advantageous to the Government, all factors considered, including the potential contributions of the proposed work to the overall research program and the availability of funding for the effort.

It is the policy of DARPA to ensure impartial, equitable, comprehensive proposal evaluations based on the evaluation criteria listed above and to select the source (or sources) whose offer meets the Government's technical, policy, and programmatic goals. Pursuant to FAR 35.016, the

primary basis for selecting proposals for acceptance shall be technical, importance to agency programs, and fund availability. In order to provide the desired evaluation, qualified Government personnel will conduct reviews and (if necessary) convene panels of experts in the appropriate areas.

2. Handling of Source Selection Information

DARPA policy is to treat all submissions as source selection information (see FAR 2.101 and 3.104), and to disclose their contents only for the purpose of evaluation. Restrictive notices notwithstanding, during the evaluation process, submissions may be handled by support contractors for administrative purposes and/or to assist with technical evaluation. All DARPA support contractors performing this role are expressly prohibited from performing DARPA-sponsored technical research and are bound by appropriate nondisclosure agreements.

Subject to the restrictions set forth in FAR 37.203(d), input on technical aspects of the proposals may be solicited by DARPA from non-Government consultants/experts who are strictly bound by the appropriate non-disclosure requirements.

3. Federal Awardee Performance and Integrity Information (FAPIIS)

Per 41 U.S.C. 2313, as implemented by FAR 9.103 and 2 CFR § 200.205, prior to making an award above the simplified acquisition threshold, DARPA is required to review and consider any information available through the designated integrity and performance system (currently FAPIIS). Awardees have the opportunity to comment on any information about themselves entered in the database, and DARPA will consider any comments, along with other information in FAPIIS or other systems prior to making an award.

VI. Award Administration Information

A. Selection Notices

1. Proposals

As soon as the evaluation of a proposal is complete, the proposer will be notified that (1) the proposal has been selected for funding pending contract negotiations, in whole or in part, or (2) the proposal has not been selected. These official notifications will be sent via email to the Technical POC identified on the proposal coversheet.

B. Administrative and National Policy Requirements

1. Meeting and Travel Requirements

All key participants are required to attend the program kickoff meeting. Performers should also anticipate regular program-wide PI Meetings and periodic site visits at the Program Manager's discretion. Performers will be required to attend and participate in 4 joint NSF-DARPA RTML workshops.

2. FAR and DFARS Clauses

Solicitation clauses in the FAR and DFARS relevant to procurement contracts and FAR and DFARS clauses that may be included in any resultant procurement contracts are incorporated herein and can be found at www.darpa.mil/work-with-us/additional-baa.

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

Further information on Controlled Unclassified Information on Non-DoD Information Systems is incorporated herein can be found at www.darpa.mil/work-with-us/additional-baa.

4. Representations and Certifications

In accordance with FAR 4.1102 and 4.1201, proposers requesting a procurement contract must complete electronic annual representations and certifications at <https://www.sam.gov/>. In addition, resultant procurement contracts will require supplementary DARPA-specific representations and certifications. See <http://www.darpa.mil/work-with-us/additional-baa> for further information.

5. Terms and Conditions

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

C. Reporting

The number and types of reports will be specified in the award document, but will include as a minimum quarterly technical and monthly financial status reports. The reports shall be prepared and submitted in accordance with the procedures contained in the award document and mutually agreed on before award. Reports and briefing material will also be required as appropriate to document progress in accomplishing program metrics. A Final Report that summarizes the project and tasks will be required at the conclusion of the performance period for the award, notwithstanding the fact that the research may be continued under a follow-on vehicle.

D. Electronic Systems

1. Wide Area Work Flow (WAWF)

Unless using another means of invoicing, performers will be required to submit invoices for payment directly via to <https://wawf.eb.mil>. Registration in WAWF will be required prior to any award under this BAA.

2. i-Edison

The award document for each proposal selected for funding will contain a mandatory requirement for patent reports and notifications to be submitted electronically through i-Edison (<https://public.era.nih.gov/iedison>).

VII. Agency Contacts

Administrative, technical or contractual questions should be sent via e-mail to HR001119S0037@darpa.mil. All requests must include the name, email address, and phone number of a point of contact.

The technical POC for this effort is:
Mr. Andreas Olofsson
DARPA/MTO
ATTN: HR001119S0037
675 North Randolph Street
Arlington, VA 22203-2114

VIII. Other Information

A. Proposers Day

The RTML Proposer's Day will be held on April 2, 2019 in Arlington, VA. Advance registration is required for the physical meeting. See DARPA-SN-19-43 posted at www.fbo.gov for details on the RTML Proposers Days. Attendance at the RTML Proposers Day is not required to propose to this solicitation.

B. Protesting

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