Broad Agency Announcement
Building Resource Adaptive Software Systems (BRASS)
DARPA-BAA-15-36
April 07, 2015
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PART I: OVERVIEW

- **Federal Agency Name:** Defense Advanced Research Projects Agency (DARPA), Information Innovation Office (I2O)

- **Funding Opportunity Title:** Building Resource Adaptive Software Systems (BRASS)

- **Announcement Type:** Initial Announcement

- **Funding Opportunity Number:** DARPA-BAA-15-36

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

- **Dates**
  - Posting Date: April 7, 2015
  - Proposal Due Date: May 22, 2015, 12:00 noon (EDT)
  - BAA Closing Date: May 22, 2015, 12:00 noon (EDT)
  - Proposers’ Day: April 8, 2015

- **Anticipated Individual Awards:** DARPA anticipates multiple awards in Technical Areas 1, 2, and 3.

- **Total Funding Available for Award:** The anticipated award amount for an integrated TA1, TA2, and TA3 effort will range between $8M-$10M.

- **Types of Instruments that May be Awarded:** Procurement contracts, cooperative agreements or other transactions.

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- **I2O Solicitation Website:**
PART II: FULL TEXT OF ANNOUNCEMENT

I. FUNDING OPPORTUNITY DESCRIPTION

DARPA is soliciting innovative research proposals in the areas of formal methods, program analysis, compiler design, and runtime and virtual machine implementation to realize tools for the construction of long-lived, survivable, and scalable adaptive software systems. Proposed research should investigate innovative approaches that enable revolutionary advances in science, devices, or systems. Specifically excluded is research that primarily results in evolutionary improvements to the existing state of practice.

This broad agency announcement (BAA) is being issued, and any resultant selection will be made, using procedures under Federal Acquisition Regulation (FAR) 35.016. Any negotiations and/or awards will use procedures under FAR 15.4 (or 32 CFR 22 for cooperative agreements). 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 (FBO) website (http://www.fbo.gov/) and, as applicable, the Grants.gov website (http://www.grants.gov/).

The following information is for those wishing to respond to this BAA.

Introduction

Modern-day software systems, even those that presumably function correctly, have a useful and effective shelf life orders of magnitude less than other engineering artifacts. While an application's lifetime typically cannot be predicted with any degree of accuracy, it is likely to be strongly inversely correlated with the rate and magnitude of change of the ecosystem in which it executes. This ecosystem typically comprises the clients of the application itself, along with a myriad of sophisticated libraries and middleware, managed services, protocols, models, drivers, etc. that, in turn, interact with the outside world using other complex artifacts like browsers, databases, storage systems, etc. Access to system components and the interfaces between clients and their applications, however, are mediated via a number of often unrelated mechanisms, including informally documented application programming interfaces (APIs), idiosyncratic foreign function interfaces, complex ill-understood model definitions, or ad hoc data formats. These mechanisms usually provide only partial and incomplete understanding of the semantics of the components themselves. In the presence of such complexity, it is not surprising that applications typically bake-in many assumptions about the expected behavior of the ecosystem they interact with.

However, these assumptions may fail to hold as inevitable changes to the ecosystem occur. Advances in technology result in platform upgrades with new processors and devices, defined in terms of significantly different data formats, programming paradigms, and object, programming, or memory models. Vulnerabilities or deficiencies in system and library code (security, logical, or performance related) can result in substantial modification to, and refactoring of, existing scripts, APIs, data representations, and protocols. The structure of
application inputs may vary over time, exercising parts of the ecosystem that were previously not considered, or exercising previously studied components in new and unexpected ways. Long-lived mission-critical systems operate using reconfigurable system resources in which availability constraints are dictated by dynamically varying mission-parameter demands.

Ensuring applications can continue to function as expected and efficiently in the face of a changing operational environment is thus a formidable challenge. Failure to effectively and timely respond to these changes can result in technically inferior and potentially vulnerable systems; but, the lack of automated upgrade mechanisms to restructure and transform applications when changes do happen, leads to high software maintenance costs and premature obsolescence of otherwise functionally sound systems. Consequently, the inability to seamlessly adapt to new operating conditions negatively impacts economic productivity, hampers the development of resilient and secure cyber-infrastructure, raises the long-term risk that access to important digital content will be lost as the software that generates and interprets that content becomes outdated, and complicates the construction of autonomous mission-critical programs.

Precisely understanding application intent, a characterization of an application that extends beyond just its functional specification, but additionally subsumes various intensional and algorithmic characteristics such as the shape and structure of its inputs, notions of performance and efficiency, reliability, fault-tolerance, choice of data representations and schemas, cost models, security policies, etc., is fundamental to addressing this challenge. While implementations often closely interact with their environment during development to ensure that desired intent is preserved, whatever guarantees are derived during that process often do not hold in the face of arbitrary (continuous or discrete) ecosystem evolution, which can manifest in a number of different ways:

- **Restricted functionality.** As ecosystems evolve, they may limit how resources such as memory, communication bandwidth, energy, and processing power are apportioned and leveraged to reflect specific characteristics of new hardware, new programming paradigms, or new end-user requirements. In this context, effective adaptation may entail application restructuring that soundly trades off reliance on the availability of some resources in favor of others.
- **Enhanced functionality.** The set of protocols and services provided by an ecosystem may change over time to include additional features and functionality not originally available. Exploiting such functionality may involve offloading computation from an application to a new service now provided by the ecosystem, transparently leveraging additional physical resources, or eliminating functionality from the application altogether if it now becomes subsumed by more efficient underlying services. Evolution in this context can thus lead to simpler and more performant systems.
- **Altered functionality.** Changes in data formats, protocols, input characteristics, and models (e.g., programming or memory) of components in a software ecosystem may violate or undermine various (often implicit) application assumptions. Enabling applications to continue operation in the presence of these changes may require deployment of new algorithms and implementations to replace existing ones whose assumptions on ecosystem component behavior may no longer hold.
Adapting applications to effectively operate within an evolving ecosystem thus necessitates the ability to infer and discover the impact of environment changes on application behavior and performance, and transform applications to beneficially and safely exploit these changes, with the expectation that any transformations performed (even if they change intent) still guarantee high fidelity of the transformed application with respect to the functional characteristics of the original.

There are a number of existing, albeit superficially disparate, approaches that can be brought to bear to achieve these goals. These include: (a) the ability to extract whole-system specifications and models over the entire software stack that collectively define resource-centric application-specific descriptions of an ecosystem; (b) the use of DSLs (domain-specific languages), continuous JIT compilation methodologies, middleware architectures, testing frameworks, and metaprogramming facilities to help define specifications, correlate application intent with relevant ecosystem changes, and express intent-preserving transformations; (c) leveraging program analysis, testing frameworks, autotuning strategies, and learning techniques applied over symbolic and concrete inputs to aid in intent discovery and optimize transformation selection; (c) defining programming abstractions that equip applications with functionality to automatically respond to resource changes; and, (d) deploying new runtime systems and virtual machine (VM) implementations structured to facilitate and enable fine-grained adaptive transformations.

The goal of the BRASS program is to realize foundational advances in the design and implementation of survivable, long-lived complex software systems that are robust to changes in the resources (logical or physical) provided by their operational environment. As described above, these advances will necessitate integration of new linguistic abstractions, scalable and compositional formal methods, and resource-aware program analyses to discover and specify application intent; program transformations triggered to adapt applications to salient resource changes; and, new systems designs to monitor ecosystem behavior. Towards this end, BRASS seeks new approaches to enable automated discovery of relationships between computations and the resources they utilize, along with techniques to safely and dynamically incorporate optimized, tailored algorithms and implementations constructed in response to ecosystem changes.

**Background**

Today's applications execute on a software stack comprised of many different layers of abstraction, providing various services and structures. These include: ISA definitions, drivers, kernels, managed runtimes, sophisticated middleware frameworks, protocols, hypervisors, libraries, and various kinds of servers. Access to these layers is mediated through different kinds of interfaces, all typically specified informally as ancillary documentation supplied along with the abstraction's API. These specifications can not only define the expected shape and type of arguments that should be supplied to the different methods comprising a service, and the form of the results returned by the service, but also often highlight various properties related to resource usage (e.g., computation or memory), as well as intended use cases, characterization of exceptional conditions, algorithmic complexity, data format interpretation,
among others. Because these properties are expressed informally, it is challenging to precisely relate them to specifications provided by (or inferred from) the application.

The dichotomy between the rigorous specification of applications and the informal definition of the complex system that sits underneath (and the clients which sit above) directly impacts an application’s ability to transparently respond to evolution of its surrounding ecosystem. Evolution is an inevitable consequence of technology trends, the emergence of new computational paradigms, the discovery or incorporation of new algorithms that lead to simpler and more efficient implementations, and a by-product of remediating vulnerabilities. When systems do evolve, they may do so by changing their interfaces and/or their underlying implementation. While it is conceivable that whole-system analyses can be employed to discover properties of ecosystem components and broadly identify the consequence of such evolution, tailoring such analyses to precisely reveal the impact of system changes on any given application involves substantial manual effort and reasoning. Moreover, discovering how system changes affect the behavior of one program reveals little about how those changes affect others, complicating the process of automatically tracking and responding to system updates.

Rather than allowing ecosystems to change in arbitrary ways, we can limit the scope of allowed changes by hardening (or virtualizing) interfaces between applications, their clients, and the system they execute on, effectively preventing internal change to ecosystem component implementations from being externally visible. Such techniques can be effective when the underlying platforms and architectures change slowly (if at all), and can parameterize over certain kinds of resources (e.g., the number of processors in a multicore system) cleanly; they are less likely to be successful when changes are more foundational (e.g., the incorporation of a new programming or memory model, or new client requirements that dramatically change the kind of inputs provided and responses demanded). In general, using virtualization exclusively as a means to handle system evolution is unlikely to deal resiliently and at scale with refinements over more than a small number of generations.

These observations lead us to conclude that a new approach towards software composition, evolution, and adaptation is required. This approach should enable the expression and discovery of new kinds of specifications that capture the relationship between computations and the resources they utilize, and algorithmic transformations that enable applications to adapt to ecosystem and client changes in efficient, provably sound and secure ways, without the need for extensive programmer involvement. The realization of this vision will lead to significant improvements in software resilience, correctness, and maintainability.

Conceptually, we can envision the construction of families of programs, all generally preserving the same high-level functional invariants, but with different implementations that exercise different resources, and expose different cost metrics on the use of these resources. The BRASS discovery component is responsible for providing an enumeration procedure or model for describing the elements in the family. Changes in the underlying ecosystem trigger a search for a path, represented as sequence of transformations, from the original program to an element in this family optimized for the resources manifest in the new system. The BRASS transformation component is responsible for constructing these paths.
Achieving this goal requires mechanisms to derive composable, whole-system specifications that reflect interesting properties of software artifacts amenable to adaptation. Discovery of these specifications can draw from a variety of sources including scalable program analyses (both static and dynamic), tests and profiling, model checking, behavioral contracts, resource-aware program logics (e.g., various flavors of separation logic), theorem provers, simulation environments, natural language processing analysis of comments and documentation, software repository mining, machine learning approaches for invariant discovery, AI planning, introspection, and autonomy mechanisms, programming abstractions for manipulating and reasoning about ad hoc data formats, etc. Specifications may be expressed in a language that highlights specific properties of the platform or domain appropriate to the application to simplify how program properties are characterized.

As systems and clients evolve, transformations over applications that consider alternative implementations, algorithms, and resource tradeoffs can be taken and refined. These decisions can be made using the model previously discovered, with possible transformation and composition strategies tailored for a specific target platform. The actual realization of the transformations themselves may be embedded within just-in-time compilers, managed runtime systems, operating system services, and virtual machines. Notions of cost, complexity, and optimality drive the specific transformations chosen, and validation techniques (either performed statically or at runtime) can be used to justify the choices made. Clean-slate solutions may define new adaptive programming languages, program analyses, compilers, runtime and operating systems, and architectures sensitive to evolution and reconfigurability.

Research breakthroughs in several areas are necessary to realize this vision. On the "discovery" side (i.e., the portion of the system responsible for identifying application intent), these challenges may include answering the following questions:

1. What kinds of programming abstractions accurately capture resource-sensitive properties related to physical resources?
2. How do we define new type systems, program analyses, model checkers, verification tools, etc., to be sensitive to fine-grained resource usage?
3. Are there general language abstractions and compilation techniques that enable automated selection, transformation, and tuning of algorithms and implementations in response to different input structure and platform features over a variety of domains?
4. How do we define precise interfaces among the different semantic styles and specification formulations that are likely warranted at different layers in a complex ecosystem?
5. How do we express notions of cost (e.g., time, space, and communication) in the language definitions in which applications are written? How can we use such notions to better understand and inform application intent?
6. What are appropriate techniques to realize precise and modular analyses that scale over whole-system environments? How do we transmit specifications and analysis outputs over different languages and abstraction layers, in the presence of complex linking and compilation mechanisms?
7. How do we capture application intent at different resolution scales to enable tractable reasoning given the complexity of the entire ecosystem over which specifications are derived?
8. How do we efficiently track and identify change and refactoring in ecosystem interfaces and implementations; how do we relate the impact of these changes to application execution?
9. Can we define DSLs or related technologies to specify resource properties, protocols, and analyses with respect to a given domain or platform?
10. Can we leverage machine learning or software mining techniques to infer common resource-based invariants and specifications at scale on collections of programs executing within a given ecosystem?
11. How do we develop testing methodologies capable of discovering useful semantic features of applications relevant to system evolution?
12. Are there useful notions of provenance that can be used to help track and identify interesting changes in an application's ecosystem?
13. How do we relate change in inputs and input structure to changes in intent?
14. What is the relationship between application intent and policies related to security, fault-tolerance, performance, etc.?
15. How do we specify mechanisms to integrate external information sources and data schemas into an application?
16. Are there language level notions of resilience and robustness that can be used to express application intent?

On the "analytics" side (i.e., the portion of the system responsible for monitoring changes to the ecosystem, and implementing application transformations in response), these challenges may include answering the following questions:

1. How do we identify the salient components in an ecosystem that need to be monitored with respect to a given application?
2. How do we structure compilers and managed runtimes to be sensitive to adaptive restructuring in response to underlying environment alterations?
3. Are there opportunities to define new kinds of operating systems, virtual machines, and system services structured with application-level adaptation in mind?
4. Is there a role for high-fidelity replay, or arbitrary versioning of applications and system components as possible adaptation mechanisms?
5. How do we implement scalable and lightweight profiling and instrumentation mechanisms tailored for adaptive transformations in mind?
6. Are there efficient runtime verification techniques that can identify salient environment changes, and guide transformations based on a characterization of these changes?
7. Can testing approaches be used to proactively induce changes in ecosystem behavior as a means to identify impact on application robustness and intent?
8. What is a scalable architecture capable of specifying, indexing, and discovering functionally equivalent implementations of application components that nonetheless exhibit different algorithmic complexity traits, suitable for different ecosystem instantiations?
9. How do we define cost and error metrics to guide adaptive refinement strategies?
10. What kind of online refinement strategies can be applied to guide transformations?
11. How do we integrate dynamic software update mechanisms to install adaptive refinements discovered in response to ecosystem change?
12. Complex systems have multiple layers of abstraction, each of which operates within their own particular ecosystem; how do we build adaptive frameworks that yield globally consistent and sensible transformations within such architectures?
13. What mechanisms should be employed to communicate platform or domain specific features in order to guide transformation discovery and monitoring strategies?
14. What is the sensitivity of applications and the impact on adaptability to tunable configuration parameters in the underlying ecosystem?
15. Can we apply AI planning, autonomous reasoning, or control theoretic techniques to implement transformation selection strategies?
16. Are there concepts from information theory, error correcting codes, and related disciplines that aid in the definition of these transformations?

The BRASS architecture is depicted below in Figure 1:

![Figure 1. BRASS Architecture](image_url)
Program Description and Structure

The BRASS program has four technical areas (TAs), depicted in Figure 2 below.

- TA1. Platform
- TA2. Analytics
- TA3. Discovery
- TA4. Evaluator

Proposers may address any (or all) of the first three TAs, which are discussed further in the BAA document. The performer for TA4 (Evaluator) will be provided by the Government and DARPA is not soliciting proposals for this area under this announcement. The decision as to which technical area(s), if any, to consider for award is at the discretion of the Government. See Section III.D for additional information.

Program success will require a close and continued collaboration from a range of fields, including but not limited to: language definition and semantics, program analysis, compiler design, machine learning, artificial intelligence planning, autonomy, control theory, runtime and operating system design, and a multitude of application domains. All performers under the BRASS program will be expected to work cooperatively with one another to develop, integrate, implement, and validate BRASS capabilities. Therefore, proposers should carefully review the expectations of all three TAs to fully understand the context of any TA(s) for which they will submit proposals. To facilitate the open exchange of information, performers may have an Associate Contractor Agreement (ACA) clause included in their award. Performers should execute the ACAs prior to the program kick-off. This clause is intended to ensure appropriate coordination and integration of work by BRASS performers, while maximizing commonality and
preventing unnecessary duplication of effort.

The BRASS program will be divided into three 16-month phases. A Platform Demonstration Workshop will signal the end of each phase, and will provide an opportunity to evaluate the objectives of the program. BRASS has several quantifiable objectives, among which are:

1. Reduce the time to repair vulnerabilities and port useful functionality in complex systems from human time to machine time;
2. Allow various syntactic and semantic forms of adaptation to be applied over large code bases;
3. Enable adaptation to be generally applicable for a significant fraction of the code base comprising an application and the underlying ecosystem; and
4. Sufficiently reduce analytics and runtime monitoring overhead to enable adaptive solutions to be effective in continuously operational, deployed environments.

Early in Phase 1, performers in TA1, TA2, and TA3 will be grouped into a design team, each led by a TA1 performer. Each such team will be responsible for producing before each Platform Demonstration Workshop, a complete Discovery and Analytics System (DAS). This system should be amenable for evaluation by the Evaluator. Thus, close collaboration between TA1, TA2 and TA3 performers is expected.

The BRASS program will emphasize creating and leveraging open architecture technology. Intellectual property rights asserted by proposers are strongly encouraged to be aligned with open source regimes. See Section VI.B.1 for more details on intellectual property. Proposals should specifically list anticipated technical and programmatic risks and describe associated mitigation strategies. See Section IV.B.1.a.

Small independent proposers are encouraged to propose to the BAA, as are agile teams from larger firms working along or composed of industry-leading, special purpose, and (perhaps) short-duration sub-contractors. Non-traditional government providers are encouraged to propose to this BAA, either on their own or in a teaming partnership with a firm who has experience in government contracting.

**TA1: Platform**

The goal of this technical area is to explore the applicability of adaptive and transformation analysis techniques to the development of resource adaptive systems, using the proposed platforms selected for case studies.

Each Platform performer will produce a DAS using adaptive techniques developed by their TA2 and TA3 design team performers. To facilitate this goal, TA1 performers will work closely with the Evaluator and TA2 and TA3 design team performers, educating them about the technical challenges in producing resource adaptive versions of the platform, developing unrestricted and unclassified “challenge problems” that abstract the key technical contributions of their TA2 and TA3 design team performers, and applying the research results from them to the development of the DAS.
Exemplar platforms include, but are not limited to:

- Autonomous and robotic systems that can expose varying changes to mission parameters and which operate with incomplete knowledge of the input space;
- Embedded systems (e.g., Internet of Things) that exhibit frequent changes to topology, availability, and bandwidth resulting in the need for adaptive protocols;
- Geo-distributed systems that have complex failure, consistency, and visibility semantics;
- Heterogeneous scalable multiprocessors that support a variety of computation and memory models;
- Cloud infrastructure in which SLAs (service level agreements) impose execution constraints highly dependent on resource availability;
- Mobile platforms that exhibit high variance in application and library functionality driven by underlying resource changes;
- High-assurance systems in which security guarantees and policies are validated against a specific set of assumptions on ecosystem behavior;
- Coordinated platform ensembles in which components may have different, dynamically changing, ecosystem configurations;
- Storage and file systems in which data representation, layout, metadata, and general functionality are optimized for specific workloads and expected client access patterns; and
- Diverse hardware infrastructures (e.g., FPGA, SoC) that have idiosyncratic computation models and a large adaptability surface.

Each TA1 performer will be responsible for leading a DAS design team, which will include one TA2 performer and one or more TA3 performers. The goal of this team will be the realization of a working end-to-end DAS system in advance of each Platform Demonstration Workshop meeting. In this capacity, each TA1 performer is responsible for ensuring that the team completes a number of tasks, including:

1. Proposing two Platform-Specific Challenge Problems two months after the program kick-off and three Platform-Specific Challenge Problems two months after the start of Phase 2 and Phase 3;
2. Coordinating and finalizing definitions of APIs, interfaces, representations, internal DSLs, and other technologies necessary to enable interaction among performers in the team, as well as the Evaluator;
3. Producing a working version of the integrated system two weeks before the Platform Demonstration Workshop, delivering the system to the Evaluator for evaluation;
4. Demonstrating the system applied to the Platform-Specific Challenge Problems at the Platform Demonstration Workshop; and
5. Serving as the primary point of contact for technical support to the Evaluator during the evaluation of the system on Platform-Specific Challenge Problems.

Furthermore, each TA1 performer will be responsible for working with the Evaluator to define
an interface (i.e., API) between their DAS and the Evaluator’s evaluation framework. This API should contain two types of methods:

1. Methods that correspond to perturbations that can be affected within the software stack. These perturbations could include changes in libraries, resources, protocols, data formats, kernel variables and services, etc.; and
2. Methods to request, collect, and aggregate various software stack, execution, and application data. This data will be used to measure the correctness and performance of the application as well as the performance and stability of the entire software stack.

As an example, suppose the Evaluator is altering the software stack by dynamically changing a core library version. The API would include a method to change the current version of the library. Further, the API would enable the transfer of output results of the application under test back to the evaluation framework to evaluate the correctness of the application under test. Similarly, the API would provide methods to receive application timing results, relinking latency results, offline analysis timing results, resource utilization results, etc., back to the evaluation framework. For Phase 1, the API will be instantiated through one or more agreed-upon socket interfaces. As the modifications in Phases 2 and 3 become more complex and dynamic, the API will likely be migrated to work through a hypervisor or a combination of hypervisor and socket interface.

To the extent consistent with other program goals, it is strongly preferred that the identified platforms, including sensors, computing hardware, and software, are unclassified.

**TA2: Analytics**

The TA2 performer will be responsible for monitoring system behavior with respect to a given application or set of applications, identifying salient changes (logical or physical) to the underlying system that may affect application intent, selecting transformations based on analyses provided by TA3 activities, and incorporating program transformations and restructuring techniques to evolve applications to operate effectively within the context of a new ecosystem. The scope and extent of these transformations very much depends upon the accuracy and sophistication of the TA3 analyses, the ability of compilation and runtime systems to perform updates efficiently, and an understanding of the platform in which the ecosystem resides.

Platform-specific characteristics and specifications of ecosystem components, along with analysis outputs from TA3, collectively inform the kind of monitoring techniques employed, and the transformations adopted. Monitoring can be injected into applications as part of a compile-time instrumentation facility, through runtime/VM mechanisms that track application resource usage, or specialized architecture support. Monitored resources need not only be associated with physical units such as energy, memory, or bandwidth; logical resources include data structures, protocols, memory and object models. In both cases, ecosystem changes can affect a variety of application assumptions, and can thus impact application intent.
The monitoring component of the TA2 effort must guide transformation and selection strategies that propose alternative implementations for affected parts of an application. Among others, these implementations can be: (a) captured by different versions of an application component in e.g., a GIT-style versioned repository, (b) composed of different algorithmic variants that all share the same interface signatures, but have different underlying instantiations and complexity, tailored for different resource characteristics and inputs, or (c) discovered via relationships and ontologies built in a software mining repository.

Regardless of the mechanisms used to identify suitable variants, the transformation component of this effort must stitch the chosen variant into the application, ensuring type correctness and safety of the resulting artifact. A validation step that provides assurance in the form of comprehensive test diagnostics or proof certificates is also expected. The goal is to provide evidence that the chosen transformations satisfy functional invariants with high fidelity, along with a precise description of the transformed application’s (possibly altered) intent in the context of this new ecosystem. The determination of when transformations are injected (offline or online) depends upon the specific characteristics of the application and platform.

The kinds of transformation performed within this technical area can be broadly categorized into two categories:

1. **Intent preservation.** Sometimes ecosystem changes can affect application behavior without compromising intent. Alteration to data formats, changing object and file locations, and storage layout modifications, can cause existing scripts and previously correct protocols to break. The introduction of features like concurrency may introduce unintended racy behavior in thread libraries invoked by applications. In these cases, the transformations necessary to ensure applications continue to operate correctly involve relatively “shallow” transformations (e.g., changing environment variables in scripts, modifying data accessors, introducing appropriate synchronization, etc.) that are unlikely to visibly affect how an application interacts with its ecosystem.

2. **Functionality preservation.** Ecosystem evolution can be more invasive, however. Resources may be removed, added, or altered in ways that affect application intent. When attributes of low-level physical resources like processing power, memory, communication bandwidth, and storage change, application behavior can be affected in ways that dictate incorporating new implementations of alternative algorithms tailored for this new resource configuration. Similarly, logical characteristics of the ecosystem expressed in the form of protocols (e.g., consistency or cryptographic) and policies (e.g., security) can also evolve. Such evolution may be instigated by new domains on which the ecosystem is deployed (e.g., consider the evolution of a system from a highly-reliable shared-memory platform to a distributed memory environment that provides weaker fault tolerant and consistency guarantees), or by new client requirements on expectations of the application (e.g., scaling applications to operate from small in-memory data sets to streaming big data). In these instances, “deep” transformations to application structure that go beyond merely conforming to new interfaces and signatures in the underlying system are required.
Anticipated research challenges in this area include, but are not limited to:

1. Development of new managed runtimes and language-based VM extensions that facilitate monitoring and profiling of application-relevant resource changes.
2. Runtime introspection mechanisms to allow applications to direct code specialization strategies based on TA3 generated artifacts.
3. Suitable apparatus for enabling adaptation in dynamic languages not amenable to whole-program analysis.
4. Unobtrusive monitoring and transformations for binaries, type-unsafe languages, and legacy applications.
5. Techniques for understanding and responding to resource changes that impact heap-allocated data structures, and persistent objects such as files and database-managed records.
6. Autotuning assessment techniques (including machine learning approaches) that quantify optimality, cost, and error metrics of proposed transformations.
7. Indexing mechanisms to enable access and search of a database of potential transformations each specialized with respect to specific resource characteristics.
8. Methodologies that derive suitable transformations optimized with respect to desired or predicted resource properties.
9. Mechanisms to preserve and identify the contexts in which data should be interpreted and manipulated.
10. Techniques to facilitate globally consistent adaptive transformations in complex, multi-component and multi-process distributed or parallel environments.
11. Adaptation mechanisms for dealing with complex data format changes.
12. Autonomic techniques to enable efficient response to unanticipated faults and failures.
13. Proof engineering and verification techniques to facilitate compositional reasoning of proposed transformations.
14. System architectures that support incremental computation of varying inputs at scale.

Individual TA2 proposals need not address any or all of these challenges.

Each TA2 performer will be part of a DAS team, which will include a TA1 lead and one or more TA3 performers. TA2 proposals that are not part of a collaborative TA1 effort must nonetheless clearly justify the utility of their approach in the framework of a potential platform.

**TA3: Discovery**

The TA3 performer will be responsible for specifying, and inferring within a compiler framework, program properties that identify potential program dependencies on ecosystem changes. These properties may be defined, discovered, and validated though the use of program annotations and explicit specifications, program analysis, type systems, contract systems, aspect-oriented programming abstractions, test mechanisms, abstract interpretation, model checking, termination analysis, shape and heap analysis, worst-case execution time analysis (WCET), etc. In addition, machine-learning approaches that discover and predict properties relating program behavior to ecosystem resources may also be applicable. The
outputs of executable language models, language or systems-based provenance extraction, documentation analysis (e.g., natural language interpretation of source-code comments), and other less traditional mechanisms for deriving program properties are also valid avenues of study within this area. Although the focus of this effort is primarily on source code analysis, techniques that extract useful resource usage properties of binaries are also in scope.

The end goal of this technical area effort is to provide a detailed understanding of programs with respect to the resources they depend on in their underlying ecosystems, sufficiently precise to enable subsequent transformation and adaptation. In this regard, TA3 performers will work closely with TA2 performers to establish interfaces and representations suitable for communicating and identifying salient ecosystem changes, enabling TA2 tools to safely respond to them. The kinds of analyses and discovery mechanisms considered will also be influenced by the particular features of the platform defined by TA1 performers and by the kind of analytics that track ecosystem changes monitored by TA2 tools.

Anticipated research challenges in this area include, but are not limited to:

1. The development of new programming abstractions to identify relationships between code and ecosystem-managed resources.
2. The development of DSLs to specify resource properties, and guide program analyses.
3. Linguistic mechanisms, annotations, and specification languages that facilitate resource usage, broadly construed to include resource-centric protocols.
5. Program analyses capable of deriving symbolic and concrete bounds on stack and heap usage, termination, etc.
6. Analysis and verification of quantitative properties of programs that relate the impact of perturbation and change in inputs to the effect on outputs.
7. A principled framework to relate algorithmic notions of cost and complexity to language semantics.
8. Change and impact analysis techniques that identify semantic differences across versions of ecosystem components.
9. The calibration of resource analyses developed at different abstraction levels in a software stack, expressed in the context of different semantic formalisms.
10. The capture of “higher-levels” of resource usage protocols (e.g., those that deal with liveness, failure, consensus, security, etc.) and their relation to application intent.
11. Discovery of resource properties in the presence of ad hoc data description languages, scripts, build tools, and dynamically linked components.
12. Characterization of policies (e.g., security) and models (e.g., object or memory) with respect to overall system evolution.
13. Devising language abstractions and compiler techniques to express and manipulate information theoretic notions of resilience and robustness.
14. The development of program abstractions and analyses that facilitate autonomous decision-making in response to environment changes.

Individual TA3 proposals need not address any or all of these challenges.
Each TA3 performer will be part of a DAS team, which will include a TA1 lead and a TA2 performer. TA3 proposals that are not part of a collaborative TA1 effort must nonetheless clearly justify the utility of their approach in the framework of a potential platform.

**Scheduling and Budgeting Information**

The schedule listed in Figure 3 contains notional estimates. Proposers should submit a detailed schedule that is consistent with the maturity of their approaches and the risk reduction required for their concepts. These schedules will be synchronized across performers, as required, and monitored and reviewed as necessary throughout the BRASS program’s period of performance. For budgeting purposes, please use October 1, 2015, as an estimated start date for all technical areas.

![Figure 3. Program Schedule](image)

The Government will specify the locations for program reviews, Principal Investigator (PI) meetings, Platform Demonstration Workshops, and other events. In general, for budgeting travel, assume that program reviews will be held either in Washington, D.C., or at the performer’s location once a year. It is currently anticipated that the program kick-off meeting will occur in early-to mid-October 2015, after contract signing. It is strongly encouraged that all subcontracts are signed within one month of award of the prime contract.

There will be one PI meeting in Phase 1, held approximately 8 months after the kick-off meeting. There will be one PI meeting in both Phase 2 and Phase 3, held roughly 8 months from the beginning of each phase. PI meeting locations are likely to be split between performer locations. The goals of the PI meetings will be to primarily present new research findings and accomplishments, review plans for the next period, discuss implementation milestones, and raise any programmatic, budgeting, or logistics issues. Platform Demonstration Workshops will
be held at the end of each phase. The kick-off meeting and each subsequent PI meeting and Platform Demonstration Workshop will have a registration fee that is currently estimated to be $300 per person, in addition to travel and lodging costs.

In addition to site visits, monthly teleconference meetings will be held with each PI to enhance communications with the Government Team. Should important issues arise between program reviews; the Government Team will be available to support informal interim technical interchange meetings.

**Milestones**

Two months after program kick-off, each DAS design team will propose Platform-Specific Challenge Problems (two in Phase 1, 3 in Phase 2 and 3 in Phase 3) that they will be expected to develop their systems against, and present at the Platform Demonstration Workshops, which will be held at the end of each phase. These Challenge Problems will be finalized by the PI meeting (8 months from program kick-off) in consultation with the Evaluator. Two weeks prior to the workshop, each DAS design team will provide their system to the Evaluator for evaluation. During the workshop, each DAS design team will demonstrate their system on Challenge Problems developed for that phase and initiate discussions with the Evaluator on proposed Platform-Specific Challenge Problems for the following phase. A written report on the outcome of the workshop and the success of the phase will be made available to all DAS design teams by the Evaluator one month after the start of the next phase.

**Deliverables**

TA1 performers will deliver a working version of their team’s DAS and associated documentation to the Evaluator two weeks before the Platform Demonstration Workshop. TA2 and TA3 performers will deliver appropriate code and documentation to their partnered TA1 performer at regular intervals, and on a schedule consistent with the delivery of a working DAS three weeks before each Demonstration Workshop. It is expected that the TA1 performers will be in close collaboration with the Evaluator at least one month before each Platform Demonstration Workshop to ensure program deliverables are met.

In addition, all performers will be required to provide the following deliverables:

- Technical papers covering work funded by BRASS;
- Source code, other necessary data, and accompanying documentation for all software developed under this program;
- Slide Presentations. Annotated slide presentations shall be submitted within one month after the program kick-off meeting and after each program event (program reviews, PI meetings, and technical interchange meetings);
- Quarterly Progress Reports. A quarterly progress report describing technical progress made, resources expended, major risks, planned activities, trip summaries, changes to key personnel, and any potential issues or problem areas that require the attention of the Government Team shall be provided within 10 days after the end of each quarter;
- Monthly financial status reports; and
• Final Report after each program phase. The final report shall concisely summarize the effort conducted.

**Intellectual Property**

As mentioned earlier, BRASS will emphasize creating and leveraging open architecture technology. Intellectual property rights asserted by proposers are strongly encouraged to be aligned with open architecture regimes. See Section VI.B.1 for more details.
II. AWARD INFORMATION

A. Awards

Multiple awards are anticipated. The level of funding for individual awards made under this solicitation has not been predetermined and will depend on the quality of the proposals received and the availability of funds. Awards will be made to proposers whose proposals are determined to be the most advantageous and provide the best value to the Government, all factors considered, including the potential contributions of the proposed work, overall funding strategy, and availability of funding. See Section V for further information.

The Government reserves the right to:

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

Proposals selected for award negotiation may result in a procurement contract, cooperative agreement, or other transaction (OT) depending upon the nature of the work proposed, the required degree of interaction between parties, and other factors. In all cases, the Government contracting officer shall have sole discretion to select award instrument type and to negotiate all instrument terms and conditions with selectees. Proposers are advised that, if they propose cooperative agreements, the Government contracting officer may select other award instruments, as appropriate. Publication or other restrictions will be applied, as necessary, if DARPA 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 below.

B. Fundamental Research

It is Department of Defense (DoD) policy that the publication of products of fundamental research will remain unrestricted to the maximum extent possible. National Security Decision Directive (NSDD) 189 established the national policy for controlling the flow of scientific,
technical, and engineering information produced in federally funded fundamental research at colleges, universities, and laboratories. 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 proposers intending to perform fundamental research. The Government does not anticipate applying publication restrictions of any kind to individual awards for fundamental research that may result from this BAA. Notwithstanding this statement of expectation, the Government is not prohibited from considering and selecting research proposals that, while perhaps not qualifying as fundamental research under the foregoing definition, still meet the BAA criteria for submissions. If proposals are selected for award that offer other than a fundamental research solution, the Government will either work with the proposer to modify the proposed statement of work to bring the research back into line with fundamental research or else the proposer will agree to restrictions in order to receive an award.

Proposers should indicate in their proposal whether they believe the scope of the proposed research is fundamental. For certain research projects, it may be possible that although the research to be performed by the prime proposer is non-fundamental, a subcontractor’s tasks may be considered fundamental research. In those cases, it is the prime proposer’s responsibility to explain in their proposal why its subcontractor’s effort is fundamental research. While proposers should clearly explain the intended results of their research, DARPA shall have sole discretion to determine whether the project is considered fundamental research. Awards for non-fundamental research will include the following statement or similar provision:

There shall be no dissemination or publication, except within and between the contractor and any subcontractors, of information developed under this contract or contained in the reports to be furnished pursuant to this contract without prior written approval of DARPA’s Public Release Center (DARPA/PRC). All technical reports will be given proper review by appropriate authority to determine which Distribution Statement is to be applied prior to the initial distribution of these reports by the contractor. With regard to subcontractor proposals for Contracted Fundamental Research, papers resulting from unclassified contracted fundamental research are exempt from prepublication controls and this review requirement, pursuant to DoD Instruction 5230.27 dated October 6, 1987.

When submitting material for written approval for open publication, the contractor/awardee must submit a request for public release to the PRC and include the following information: 1) Document Information: title, author, short plain-language description of technology discussed in the material (approx. 30 words), number of pages (or minutes of video) and type (e.g., briefing, report, abstract, article, or paper); 2) Event
Information: type (e.g., conference, principal investigator meeting, article or paper), date, desired date for DARPA’s approval; 3) DARPA Sponsor: DARPA Program Manager, DARPA office, and contract number; and 4) Contractor/Awardee’s Information: POC name, e-mail address and phone number. Allow four weeks for processing; due dates under four weeks require a justification. Unusual electronic file formats may require additional processing time. Requests may be sent either to prc@darpa.mil or 675 North Randolph Street, Arlington VA 22203-2114, telephone (571) 218-4235. See http://www.darpa.mil/NewsEvents/Public_Release_Center/Public_Release_Center.aspx for further information about DARPA’s public release process.
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

FFRDCs and Government entities (e.g., Government/National laboratories, military educational institutions, etc.) are subject to applicable direct competition limitations and cannot propose to this solicitation in any capacity unless the following conditions are met.

- FFRDCs must clearly demonstrate that the proposed work is not otherwise available from the private sector and must provide a letter on official letterhead from their sponsoring organization citing the specific authority establishing the FFRDC’s eligibility to propose to Government solicitations and compete with industry, and compliance with the terms and conditions in the associated FFRDC sponsor agreement. This information is required for FFRDCs proposing as either prime contractors or subcontractors.

- Government entities must clearly demonstrate that the proposed work is not otherwise available from the private sector and provide documentation citing the specific statutory authority (and contractual authority, if relevant) establishing their eligibility to propose to Government solicitations.

At the present time, DARPA does not consider 15 U.S.C. § 3710a to be sufficient legal authority to show eligibility. For some entities, 10 U.S.C. § 2539b may be the appropriate statutory starting point; however, specific supporting regulatory guidance, together with evidence of agency approval, will still be required to fully establish eligibility.

DARPA will consider eligibility submissions on a case-by-case basis; however, the burden to prove eligibility for all team members rests solely with the proposer.

2. Foreign Participation

Non-U.S. organizations 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.

B. Procurement Integrity, Standards of Conduct, Ethical Considerations and Organizational Conflicts of Interest (OCIs)

Current Federal employees are prohibited from participating in particular matters involving conflicting financial, employment, and representational interests (18 U.S.C. §§ 203, 205, and 208). Prior to the start of proposal evaluation, the Government will assess potential COIs and will promptly notify the proposer if any appear to exist. The Government assessment does not
affect, offset, or mitigate the proposer’s responsibility to give full notice and planned mitigation for all potential organizational conflicts, as discussed below.

In accordance with FAR 9.5 and without prior approval or a waiver from the DARPA Director, a contractor cannot simultaneously provide scientific, engineering, and technical assistance (SETA) or similar support and be a technical performer. As part of the proposal submission, all members of a proposed team (prime proposers, proposed subcontractors and consultants) must affirm whether they (individuals and organizations) are providing SETA or similar support to any DARPA technical office(s) through an active contract or subcontract. Affirmations must state which office(s) the proposer and/or proposed subcontractor/consultant supports and must provide prime contract number(s). All facts relevant to the existence or potential existence of OCIs must be disclosed. The disclosure shall include a description of the action the proposer has taken or proposes to take to avoid, neutralize, or mitigate such conflict. If, in the sole opinion of the Government after full consideration of the circumstances, a proposal fails to fully disclose potential conflicts of interest and/or any identified conflict situation cannot be effectively mitigated, the proposal will be rejected without technical evaluation and withdrawn from further consideration for award.

If a prospective proposer believes a conflict of interest exists or may exist (whether organizational or otherwise) or has a question as to what constitutes a conflict, a summary of the potential conflict should be sent to BRASS@darpa.mil before preparing a proposal and mitigation plan.

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 (e.g., OTs under the authority of 10 U.S.C. § 2371).

D. Other Eligibility Requirements

1. Ability to Receive Awards in Multiple Technical Areas - Conflicts of Interest

Proposers should not submit multiple proposals as a prime contractor for the same TA. However, proposers may submit a single proposal as a prime contractor that addresses TA1-TA3 (or some subset thereof). For the BRASS program, separate research groups inside a large business represent separate entities and, thus, each such research group is allowed to submit a proposal as a prime towards TAs 1-3. If a proposal is submitted for more than one technical area, the decision as to which technical area(s), if any, to consider for award is at the discretion of the Government.

2. Ability to Support Classified Development

No classified development is anticipated. BRASS is a fundamental research program.
IV. APPLICATION AND SUBMISSION INFORMATION

A. Address to Request Application Package

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

B. Content and Form of Application Submission

1. Proposals

Proposals consist of Volume 1: Technical and Management Proposal (including mandatory Appendix A and optional Appendix B) and Volume 2: Cost Proposal.

All pages shall be formatted for printing on 8-1/2 by 11-inch paper with 1-inch margins, single-line spacing, and a font size not smaller than 12 point. Font sizes of 8 or 10 point may be used for figures, tables, and charts. Document files must be in .pdf, .odx, .doc, .docx, .xls, or .xlsx formats. Submissions must be written in English.

Proposals not meeting the format prescribed herein may not be reviewed.

a. Volume 1: Technical and Management Proposal

If a proposer submits a proposal for one TA, the maximum count for Volume 1 (technical and management proposal) should not exceed a total of 25 pages, including all figures, tables and charts, but not including the cover sheet, table of contents or appendices. Specifically, the breakdown should be as follows: no more than 2 pages for the executive summary; no more than 2 pages for the goals and impacts; no more than 13 pages for the technical plan; no more than 2 pages for the management plan; no more than 1 page for the capabilities; no more than 2 pages for the statement of work (SOW); no more than 2 page for the schedule and milestones; and no more than 1 page for the cost summary.

If a proposer submits a proposal for more than one TA (i.e., two TAs or three TAs), the maximum count for Volume 1 (technical and management proposal) should not exceed a total of 35 pages, including all figures, tables and charts, but not including the cover sheet, table of contents or appendices. Specifically, the breakdown should be as follows: no more than 4 pages for the executive summary; no more than 2 page for the goals and impacts; no more than 18 pages for the technical plan; no more than 2 pages for the management plan; no more than 1 page for the capabilities; no more than 2 pages for the statement of work (SOW); no more than 3 pages for the schedule and milestones; and no more than 1 page for the cost summary.

These page limits will be STRICTLY enforced. A submission letter is optional and is not
included in the page count. Appendix A does not count against the page limit and is mandatory. Appendix B does not count against the page limit and is optional. Additional information not explicitly called for here must not be submitted with the proposal, but may be included as links in the bibliography in Appendix B. Such materials will be considered for the reviewers’ convenience only and not evaluated as part of the proposal.

Volume 1 must include the following components:

i. **Cover Sheet**: Include the following information.
   - Label: “Proposal: Volume 1”
   - BAA number (DARPA-BAA-14-36)
   - Technical Area
   - Proposal title
   - Lead organization (prime contractor) name
   - Type of organization, selected from the following categories: Large Business, Small Disadvantaged Business, Other Small Business, HBCU, MI, Other Educational, or Other Nonprofit
   - Technical point of contact (POC) including name, mailing address, telephone, and email
   - Administrative POC including name, mailing address, telephone number, and email address
   - Award instrument requested: procurement contract (specify type), cooperative agreement or OT.
   - Place(s) and period(s) of performance
   - Other team member (subcontractors and consultants) information (for each, include Technical POC name, organization, type of organization, mailing address, telephone number, and email address)
   - Proposal validity period (minimum 120 days)
   - Data Universal Numbering System (DUNS) number
   - Taxpayer identification number
   - Commercial and Government Entity (CAGE) code
   - Proposer’s reference number (if any)

ii. **Table of Contents**

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2 The DUNS number is used as the Government’s contractor identification code for all procurement-related activities. Go to [http://fedgov.db.com/webform/index.jsp](http://fedgov.db.com/webform/index.jsp) to request a DUNS number (may take at least one business day). See Section VI.B.8 for further information.

3 See [http://www.irs.gov/businesses/small/international/article/0, id=96696,00.html](http://www.irs.gov/businesses/small/international/article/0, id=96696,00.html) for information on requesting a TIN. Note, requests may take from 1 business day to 1 month depending on the method (online, fax, mail).

4 A CAGE Code identifies companies doing or wishing to do business with the Federal Government. See Section VI.B.8 for further information.
iii. Executive Summary: Taking the context of the BAA and target technical area as understood, the executive summary should address the following questions:

− What is the proposed work attempting to accomplish?
− What are the limitations with how it is done today?
− What key challenges need to be overcome?
− What technological approaches are being proposed to achieve the goal?
− What will be the consequences if the work is successful?
− How much will it cost, and how long will it take?

The executive summary should include a description of the key technical challenges, a concise review of the technologies proposed to overcome these challenges and achieve the project’s goal, and a clear statement of the novelty and uniqueness of the proposed work.

iv. Goals and Impact: Describe what the proposed team is trying to achieve and the difference it will make (qualitatively and quantitatively) if successful. Describe the innovative aspects of the project in the context of existing capabilities and approaches, clearly delineating the uniqueness and benefits of this project in the context of the state of the art, alternative approaches, and other projects from the past and present. Describe how the proposed project is revolutionary and how it significantly rises above the current state of the art.

Describe the deliverables associated with the proposed project and any plans to commercialize the technology, transition it to a customer, or further the work. Discuss the mitigation of any issues related to sustainment of the technology over its entire lifecycle, assuming the technology transition plan is successful.

v. Technical Plan: Outline and address technical challenges inherent in the approach and possible solutions for overcoming potential problems. Demonstrate a deep understanding of the technical challenges and present a credible (even if risky) plan to achieve the project’s goal. Discuss mitigation of technical risk. Provide appropriate measurable milestones (quantitative if possible) at intermediate stages of the project to demonstrate progress, and a plan for achieving the milestones.

vi. Management Plan: Provide a summary of expertise of the proposed team, including any subcontractors/consultants and key personnel who will be executing the work. Resumes count against the proposal page limit so proposers may wish to include them as links in Appendix B below. Identify a principal investigator (PI) for the project. Provide a clear description of the team’s organization including an organization chart that includes, as applicable, the relationship of team members; unique capabilities of team members; task responsibilities of team members; teaming strategy among the team members; and key personnel with the amount of effort to be expended by each person during the project. Provide a detailed plan for coordination including explicit guidelines for interaction among collaborators/subcontractors of the proposed project. Include risk management approaches. Describe any formal teaming agreements that
are required to execute this project. List Government-furnished materials or data assumed to be available.

vii. **Capabilities:** Describe organizational experience in relevant subject area(s), existing intellectual property, or specialized facilities. Discuss any work in closely related research areas and previous accomplishments.

viii. **Statement of Work (SOW):** The SOW must provide a detailed task breakdown, citing specific tasks and their connection to the interim milestones and metrics, as applicable. Each year of the project should be separately defined. The SOW must not include proprietary information. For each defined task/subtask, provide:

- A general description of the objective.
- A detailed description of the approach to be taken to accomplish each defined task/subtask.
- Identification of the primary organization responsible for task execution (prime contractor, subcontractor(s), consultant(s)), by name.
- A measurable milestone, (e.g., a deliverable, demonstration, or other event/activity that marks task completion).
- A definition of all deliverables (e.g., data, reports, software) to be provided to the Government in support of the proposed tasks/subtasks.

ix. **Schedule and Milestones:** Provide a detailed schedule showing tasks (task name, duration, work breakdown structure element as applicable, performing organization), milestones, and the interrelationships among tasks. The task structure must be consistent with that in the SOW. Measurable milestones should be clearly articulated and defined in time relative to the start of the project.

x. **Cost Summary:** Provide the cost summary as described in Section IV.B.2.b.ii.

xii. **Appendix A:** This section is mandatory and must include all of the following components. If a particular subsection is not applicable, state “NONE.”

(1). **Team Member Identification:** Provide a list of all team members including the prime, subcontractor(s), and consultant(s), as applicable. Identify specifically whether any are a non-US organization or individual, FFRDC and/or Government entity. Use the following format for this list:

<table>
<thead>
<tr>
<th>Individual Name</th>
<th>Role (Prime, Subcontractor or Consultant)</th>
<th>Organization</th>
<th>Non-US?</th>
<th>FFRDC or Govt?</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>
(2). **Government or FFRDC Team Member Proof of Eligibility to Propose:** If none of the team member organizations (prime or subcontractor) are a Government entity or FFRDC, state “NONE.”

If any of the team member organizations are a Government entity or FFRDC, provide documentation (per Section III.A.1) citing the specific authority that establishes the applicable team member’s eligibility to propose to Government solicitations to include: 1) statutory authority; 2) contractual authority; 3) supporting regulatory guidance; and 4) evidence of agency approval for applicable team member participation.

(3). **Government or FFRDC Team Member Statement of Unique Capability:** If none of the team member organizations (prime or subcontractor) are a Government entity or FFRDC, state “NONE.”

If any of the team member organizations are a Government entity or FFRDC, provide a statement (per Section III.A.1) that demonstrates the work to be performed by the Government entity or FFRDC team member is not otherwise available from the private sector.

(4). **Organizational Conflict of Interest Affirmations and Disclosure:** If none of the proposed team members is currently providing SETA or similar support as described in Section III.B, state “NONE.”

If any of the proposed team members (individual or organization) is currently performing SETA or similar support, furnish the following information:

<table>
<thead>
<tr>
<th>Prime Contract Number</th>
<th>DARPA Technical Office supported</th>
<th>A description of the action the proposer has taken or proposes to take to avoid, neutralize, or mitigate the conflict</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(5). **Intellectual Property (IP):** If no IP restrictions are intended, state “NONE.” The Government will assume unlimited rights to all IP not explicitly identified as restricted in the proposal.

For all technical data or computer software that will be furnished to the Government with other than unlimited rights, provide (per Section VI.B.1) a list describing all proprietary claims to results, prototypes, deliverables or systems supporting and/or necessary for the use of the research, results, prototypes and/or deliverables. Provide documentation proving ownership or possession of appropriate licensing rights to all patented inventions (or inventions for which a patent application has been filed) to be used for the proposed project. Use the following format for these lists:
(6). **Human Subjects Research (HSR):** If HSR is not a factor in the proposal, state “NONE.”

If the proposed work will involve human subjects, provide evidence of or a plan for review by an institutional review board (IRB). For further information on this subject, see Section VI.B.2.

(7). **Animal Use:** If animal use is not a factor in the proposal, state “NONE.”

If the proposed research will involve animal use, provide a brief description of the plan for Institutional Animal Care and Use Committee (IACUC) review and approval. For further information on this subject, see Section VI.B.3.

(8). **Representations Regarding Unpaid Delinquent Tax Liability or a Felony Conviction under Any Federal Law:** Per Section VI.B.10, complete the following statements.

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

(b) The proposer represents that it is [ ] is not [ ] a corporation that was convicted of a felony criminal violation under a Federal law within the preceding 24 months.

(9). **Cost Accounting Standards (CAS) Notices and Certification:** Per Section VI.B.11, any proposer who submits a proposal which, if accepted, will result in a CAS-compliant contract, must include a Disclosure Statement as required by 48 CFR
If this section is not applicable, state “NONE.”

(10). **Subcontractor Plan:** Pursuant to Section 8(d) of the Small Business Act (15 U.S.C. § 637(d)), it is Government policy to enable small business and small disadvantaged business concerns to be considered fairly as subcontractors to organizations performing work as prime contractors or subcontractors under Government contracts, and to ensure that prime contractors and subcontractors carry out this policy. If applicable, prepare a subcontractor plan in accordance with FAR 19.702(a) (1) and (2). The plan format is outlined in FAR 19.704.

If this section is not applicable, state “NONE.”

(11). **Personnel, Qualifications, and Commitments:** List key personnel (no more than one page per person), showing a concise summary of their qualifications, discussion of previous accomplishments, and work in this or closely related research areas. Indicate the level of effort in terms of hours to be expended by each person during each contract year and other (current and proposed) major sources of support for them and/or commitments of their efforts. DARPA expects all key personnel associated with a proposal to make substantial time commitment to the proposed activity and the proposal will be evaluated accordingly. It is DARPA’s intention to put key personnel conditions into the awards, so proposers should not propose personnel that are not anticipated to execute the award.

Include a table of key individual time commitments as follows:

<table>
<thead>
<tr>
<th>Key Individual</th>
<th>Project</th>
<th>Status (Current, Pending, Proposed)</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Name 1</td>
<td>DARPA Program Name</td>
<td>Proposed</td>
<td>xx hours</td>
<td>xx hours</td>
<td>xx hours</td>
</tr>
<tr>
<td>Project Name 1</td>
<td>Current</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>Project Name 2</td>
<td>Pending</td>
<td>xx hours</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>Individual Name 2</td>
<td>DARPA Program Name</td>
<td>Proposed</td>
<td>n/a</td>
<td>xx hours</td>
<td>xx hours</td>
</tr>
</tbody>
</table>

**xii. Appendix B:** If desired, include a brief bibliography with links to relevant papers,
b. **Volume 2 - Cost Proposal**

This volume is mandatory and must include all the listed components. No page limit is specified for this volume.

The cost proposal should include a spreadsheet file (.xls or equivalent format) that provides formula traceability among all components of the cost proposal. The spreadsheet file should be included as a separate component of the full proposal package. Costs must be traceable between the prime and subcontractors/consultants, as well as between the cost proposal and the SOW.

Pre-award costs will not be reimbursed unless a pre-award cost agreement is negotiated prior to award.

i. **Cover Sheet:** Include the same information as the cover sheet for Volume 1, but with the label “Proposal: Volume 2.”

ii. **Cost Summary:** Provide a single-page summary broken down by fiscal year listing cost totals for labor, materials, other direct charges (ODCs), indirect costs (e.g. overhead, fringe, general and administrative (G&A)), and any proposed fee for the project. Include costs for each task in each Government fiscal year of the project by prime and major subcontractors, total cost and proposed cost share, if applicable.

iii. **Cost Details:** For each task, provide the following cost details by month. Include supporting documentation describing the method used to estimate costs. Identify any cost sharing.

   (1) **Direct Labor:** Provide labor categories, rates and hours. Justify rates by providing examples of equivalent rates for equivalent talent, past commercial or Government rates or Defense Contract Audit Agency (DCAA) approved rates.

   (2) **Indirect Costs:** Identify all indirect cost rates (such as fringe benefits, labor overhead, material overhead, G&A, etc.) and the basis for each.

   (3) **Materials:** Provide an itemized list of all proposed materials, equipment, and supplies for each year including quantities, unit prices, proposed vendors (if known), and the basis of estimate (e.g., quotes, prior purchases, catalog price lists, etc.). For proposed equipment/information technology (as defined in FAR 2.101) purchases equal to or greater than $50,000, include a letter justifying the purchase. Include any requests for Government-furnished equipment or information with cost estimates (if applicable) and delivery dates.
(4) Travel: Provide a breakout of travel costs including the purpose and number of trips, origin and destination(s), duration, and travelers per trip.

(5) Subcontractor/Consultant Costs: Provide above info for each proposed subcontractor/consultant. Subcontractor cost proposals must include interdivisional work transfer agreements or similar arrangements.

The proposer is responsible for the compilation and submission of all subcontractor/consultant cost proposals. Proposal submissions will not be considered complete until the Government has received all subcontractor/consultant cost proposals.

Proprietary subcontractor/consultant cost proposals may be included as part of Volume 2 or emailed separately to BRASS@darpa.mil. Email messages must include “Subcontractor Cost Proposal” in the subject line and identify the principal investigator, prime proposer organization and proposal title in the body of the message.

(6) ODCs: Provide an itemized breakout and explanation of all other anticipated direct costs.

iv. Proposals Requesting a Procurement Contract: Provide the following information where applicable.

(1) Proposals for $700,000 or more: Provide “certified cost or pricing data” (as defined in FAR 2.101) or a request for exception in accordance with FAR 15.403.

(2) Proposals for $650,000 or more: Pursuant to Section 8(d) of the Small Business Act (15 U.S.C. § 637(d)), it is Government policy to enable small business and small disadvantaged business concerns to be considered fairly as subcontractors to organizations performing work as prime contractors or subcontractors under Government contracts, and to ensure that prime contractors and subcontractors carry out this policy. In accordance with FAR 19.702(a)(1) and 19.702(b), prepare a subcontractor plan, if applicable. The plan format is outlined in FAR 19.704.

(3) Proposers without a DCAA-approved cost accounting system: If requesting a cost-type contract, provide the DCAA Pre-award Accounting System Adequacy Checklist to facilitate DCAA’s completion of an SF 1408. The checklist may be found at http://www.gsa.gov/portal/forms/download/115778.
v. Proposals Requesting an Other Transaction for Prototypes (845 OT) agreement:
Proposers must indicate whether they qualify as a nontraditional Defense contractor, have teamed with a nontraditional Defense contractor, or are providing a one-third cost share for this effort. Provide information to support the claims.

Provide a detailed list of milestones including: description, completion criteria, due date, and payment/funding schedule (to include, if cost share is proposed, contractor and Government share amounts). Milestones must relate directly to accomplishment of technical metrics as defined in the solicitation and/or the proposal. While agreement type (fixed price or expenditure based) will be subject to negotiation, the use of fixed price milestones with a payment/funding schedule is preferred. Proprietary information must not be included as part of the milestones.

2. Proprietary and Classified Information

DARPA policy is to treat all submissions as source selection information (see FAR 2.101 and 3.104) and to disclose the 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.

   a. 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.

   b. Classified Information

   Because BRASS emphasizes the idea of creating and leveraging open source architecture technology, classified submissions (classified technical proposal or classified appendices to unclassified proposals) WILL NOT be accepted under this solicitation.

C. Submission Dates and Times

Proposers are warned that submission deadlines as outlined herein are strictly enforced. Note: some proposal requirements may take from 1 business day to 1 month to complete. See the proposal checklist in Section VIII.D for further information.

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

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to verify receipt.

Failure to comply with the submission procedures outlined herein may result in the submission not being evaluated.

**Proposals**

The proposal package—full proposal (Volume 1 and 2) and, as applicable, encryption password, proprietary subcontractor cost proposals—must be submitted per the instructions outlined herein and received by DARPA no later than May 22, 2015 at 1200 noon (EDT). Submissions received after this time will not be reviewed.

**D. Funding Restrictions**

Not applicable.

**E. Other Submission Requirements**

1. **Unclassified Submission Instructions**

   Proposers must submit all parts of their submission package using the same method; submissions cannot be sent in part by one method and in part by another method nor should duplicate submissions be sent by multiple methods. **Email submissions of full proposals will not be accepted.** Please note that the only allowed email submissions are the proprietary subcontractor/consultant cost proposals, as mentioned above.

   a. **Proposals Requesting a Procurement Contract or Other Transaction**

   DARPA/I2O will employ an electronic upload submission system (https://baa.darpa.mil/) for UNCLASSIFIED proposals requesting award of a procurement contract or other transaction under this solicitation.

   First time users of the DARPA BAA Submission Website must complete a two-step account creation process at https://baa.darpa.mil/. The first step consists of registering for an Extranet account by going to the above URL and selecting the “Account Request” link. Upon completion of the online form, proposers will receive two separate emails; one will contain a user name and the second will provide a temporary password. Once both emails have been received, proposers must go back to the submission website and log in using that user name and password. After accessing the Extranet, proposers must create a user account for the DARPA BAA Submission Website by selecting the “Register Your Organization” link at the top of the page. The DARPA BAA Submission Website will display a list of solicitations open for submissions. Once a proposer’s user account is created, they may view instructions on uploading their proposal.

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

All submissions submitted electronically through DARPA's BAA website must be uploaded as zip files (.zip or .zipx extension). The final zip file should contain only the files requested herein and must not exceed 50 MB in size. Only one zip file will be accepted per submission. Note: Submissions not uploaded as zip files will be rejected by DARPA.

Please note that all submissions MUST be finalized, meaning that no further editing will be possible, when submitting through the DARPA BAA Submission Website in order for DARPA to be able to review your submission. If a submission is not finalized, the submission will not be accepted and will not be reviewed.

Website technical support may be reached at Action@darpa.mil and is typically available during regular business hours (9:00 AM – 5:00 PM ET, Monday-Friday). Questions regarding submission contents, format, deadlines, etc. should be emailed to BRASS@darpa.mil.

Since proposers may encounter heavy traffic on the web server, they should not wait until the day proposals are due to request an account and/or upload the submission.

b. Proposals Requesting a Cooperative Agreement

Proposers requesting a cooperative agreement may submit proposals through one of the following methods: (1) mailed directly to DARPA; or (2) electronic upload per the instructions at http://www.grants.gov/applicants/apply-for-grants.html. Cooperative agreement proposals may not be submitted through any other means.

Proposers choosing to mail hard copy proposals to DARPA must include one paper copy and one electronic copy (e.g., CD/DVD) of the full proposal package.

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 if all steps are not completed in a timely manner. See the Grants.gov user guides and checklists at http://www.grants.gov/web/grants/applicants/applicant-resources.html for further information.

Once Grants.gov has received an uploaded proposal submission, Grants.gov will send two email messages to notify proposers that: (1) their submission has been received by Grants.gov; and (2) the submission has been either validated or rejected by the system. It may take up to two business days to receive these emails. If the proposal is rejected by Grants.gov, it must be corrected and re-submitted before DARPA can retrieve it (assuming the solicitation has not expired). If the proposal is validated, then the proposer has successfully submitted their proposal and Grants.gov will notify DARPA. Once the proposal is retrieved by DARPA, Grants.gov will send a third email to notify the proposer. The proposer will then receive an email from DARPA acknowledging receipt and providing a
control number.

To avoid missing deadlines, proposers should submit their proposals to Grants.gov in advance of the proposal due date, with sufficient time to complete the registration and submission processes, receive email notifications and correct errors, as applicable.

Technical support for the Grants.gov website may be reached at 1-800-518-4726 and support@grants.gov. Questions regarding submission contents, format, deadlines, etc. should be emailed to BRASS@darpa.mil.

2. Classified Submission Instructions

As mentioned previously, because BRASS emphasizes the idea of creating and leveraging open source architecture technology, classified submissions (classified technical proposal or classified appendices to unclassified proposals) WILL NOT be accepted under this solicitation.
V. APPLICATION REVIEW INFORMATION

A. Evaluation Criteria

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

− Overall Scientific and Technical Merit: The proposed technical approach is feasible, achievable, complete and supported by a proposed technical team that has the expertise and experience to accomplish the proposed tasks. The task descriptions and associated technical elements are complete and in a logical sequence, with all proposed deliverables clearly defined such that a viable attempt to achieve project goals is likely as a result of award. The proposal identifies major technical risks and clearly defines feasible mitigation efforts. The Scientific and Technical Merit will be dictated by how detailed and comprehensive the proposer addresses the challenges and questions identified in the background section of the BAA (see page 6).

− Potential Contribution and Relevance to the DARPA Mission: The potential contributions of the proposed project are relevant to the national technology base. Specifically, DARPA’s mission is to maintain the technological superiority of the U.S. military and prevent technological surprise from harming national security by sponsoring revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their application. This includes considering the extent to which any proposed intellectual property restrictions will potentially impact the Government’s ability to transition the technology.

− Cost Realism: The proposed costs are based on realistic assumptions, reflect a sufficient understanding of the technical goals and objectives of the solicitation, and are consistent with the proposer’s technical/management approach (to include the proposed SOW). The costs for the prime and subcontractors/consultants 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).

B. Review and Selection Process

DARPA policy is to ensure impartial, equitable, and comprehensive proposal evaluations and to select proposals that meet DARPA technical, policy, and programmatic goals.

Qualified Government personnel will conduct a scientific and technical review of each conforming proposal and (if necessary) convene panels of experts in the appropriate areas. 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 appropriate nondisclosure agreements/requirements.
The review process identifies proposals that meet the established criteria and are, therefore, selectable for negotiation of funding awards by the Government. Selections under this solicitation will be made to proposers on the basis of the evaluation criteria listed above. Proposals that are determined to be selectable will not necessarily receive awards. Selections may be made at any time during the period of solicitation.

Proposals are evaluated individually, not rated competitively against other proposals because they are not submitted in accordance with a common work statement. For purposes of evaluation, a proposal is defined to be the document and supporting materials as described in Section IV.

Failure to comply with the submission procedures may result in the submission not being evaluated. No submissions will be returned. After proposals have been evaluated and selections made, the original of each proposal will be retained at DARPA.
VI. AWARD ADMINISTRATION INFORMATION

A. Selection Notices

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

B. Administrative and National Policy Requirements

1. Intellectual Property

Proposers should note that the Government does not own the intellectual property of technical data/computer software developed under Government contracts; it acquires the right to use the technical data/computer software. Regardless of the scope of the Government’s rights, performers may freely use their same data/software for their own commercial purposes (unless restricted by U.S. export control laws or security classification). Therefore, technical data and computer software developed under this solicitation will remain the property of the performers, though DARPA desires a minimum of Government Purpose Rights (GPR) to software or technical data developed through DARPA sponsorship.

If proposers desire to use proprietary software or technical data or both as the basis of their proposed approach, in whole or in part, they should: 1) clearly identify such software/data and its proposed particular use(s); 2) explain how the Government will be able to reach its program goals (including transition) within the proprietary model offered; and 3) provide possible nonproprietary alternatives in any area that might present transition difficulties or increased risk or cost to the Government under the proposed proprietary solution.

Proposers expecting to use, but not to deliver, commercial open source tools or other materials in implementing their approach may be required to indemnify the Government against legal liability arising from such use.

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

a. Intellectual Property Representations

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

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

c. Procurement Contracts

− **Noncommercial Items (Technical Data and Computer Software):** Proposers requesting a procurement contract must list all noncommercial technical data and computer software that it plans to generate, develop, and/or deliver, in which the Government will acquire less than unlimited rights and to assert specific restrictions on those deliverables. In the event a proposer does not submit the list, the Government will assume that it has unlimited rights to all noncommercial technical data and computer software generated, developed, and/or delivered, unless it is substantiated that development of the noncommercial technical data and computer software occurred with mixed funding. If mixed funding is anticipated in the development of noncommercial technical data and computer software generated, developed, and/or delivered, proposers should identify the data and software in question as subject to GPR. In accordance with DFARS 252.227-7013, “Rights in Technical Data - Noncommercial Items,” and DFARS 252.227-7014, “Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation,” the Government will automatically assume that any such GPR restriction is limited to a period of 5 years, at which time the Government will acquire unlimited rights unless the parties agree otherwise. The Government may use the list during the evaluation process to evaluate the impact of any identified restrictions and may request additional information from the proposer, as may be necessary, to evaluate the proposer’s assertions. Failure to provide full information may result in a determination that the proposal is not compliant with the solicitation. A template for complying with this request is provided in Section IV.B.2.a.xi.(5).

− **Commercial Items (Technical Data and Computer Software):** Proposers requesting a procurement contract must list all commercial technical data and commercial computer software that may be included in any noncommercial deliverables contemplated under the research project, and assert any applicable restrictions on the Government’s use of such commercial technical data and/or computer software. In the event a proposer does not submit the list, the Government will assume there are no restrictions on the Government’s use of such commercial items. The Government may use the list during the evaluation process to evaluate the impact of any identified restrictions and may request additional information from the proposer.
to evaluate the proposer’s assertions. Failure to provide full information may result in a determination that the proposal is not compliant with the solicitation. A template for complying with this request is provided in Section IV.B.2.a.xi.(5).

d. Other Types of Awards

Proposers responding to this solicitation requesting an award instrument other than a procurement contract shall follow the applicable rules and regulations governing those award instruments, but in all cases should appropriately identify any potential restrictions on the Government’s use of any intellectual property contemplated under those award instruments in question. This includes both noncommercial items and commercial items. The Government may use the list as part of the evaluation process to assess the impact of any identified restrictions, and may request additional information from the proposer, to evaluate the proposer’s assertions. Failure to provide full information may result in a determination that the proposal is not compliant with the solicitation. A template for complying with this request is provided in Section IV.B.2.a.xi.(5).

2. Human Subjects Research (HSR)

All research selected for funding involving human subjects, to include the use of human biological specimens and human data, must comply with Federal regulations for human subject protection. Further, research involving human subjects that is conducted or supported by the DoD must comply with 32 CFR 219, “Protection of Human Subjects” and DoD Instruction 3216.02, “Protection of Human Subjects and Adherence to Ethical Standards in DoD-Supported Research.”

Institutions awarded funding for research involving human subjects must provide documentation of a current Assurance of Compliance with Federal regulations for human subject protection, such as a Department of Health and Human Services, Office of Human Research Protection Federal Wide Assurance. All institutions engaged in human subject research, to include subcontractors, must have a valid Assurance. In addition, all personnel involved in human subject research must provide documentation of completion of HSR training.

For all research that will involve human subjects in the first year or phase of the project, the institution must submit evidence of or a plan for review by an institutional review board (IRB) as part of the proposal. The IRB conducting the review must be the IRB identified on the institution’s Assurance of Compliance. The protocol, separate from the proposal, must include a detailed description of the research plan, study population, risks and benefits of study participation, recruitment and consent process, data collection, and data analysis. The designated IRB should be consulted for guidance on writing the protocol. The informed consent document must comply with 32 CFR 219.116. A valid Assurance of Compliance with human subjects protection regulations and evidence of appropriate training by all investigators and personnel should accompany the protocol for review by the IRB.

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7 http://www.hhs.gov/ohrp
In addition to a local IRB approval, a headquarters-level human subjects administrative review and approval is required for all research conducted or supported by the DoD. The Army, Navy, or Air Force office responsible for managing the award can provide guidance and information about their component’s headquarters-level review process. Confirmation of a current Assurance of Compliance and appropriate human subjects protection training is required before headquarters-level approval can be issued.

The time required to complete the IRB review/approval process will vary depending on the complexity of the research and the level of risk to study participants. The IRB approval process can last 1 to 3 months, followed by a DoD review that could last 3 to 6 months. Ample time should be allotted to complete the approval process. DoD/DARPA funding cannot be used toward HSR until all approvals are granted.

3. Animal Use

Award recipients performing research, experimentation, or testing involving the use of animals shall comply with the rules on animal acquisition, transport, care, handling, and use as outlined in:

- 9 CFR Parts 1-4, Department of Agriculture regulation that implements the Animal Welfare Act of 1966, as amended (7 U.S.C. §§ 2131-2159);
- National Institutes of Health Publication No. 86-23, "Guide for the Care and Use of Laboratory Animals" (8th Edition); and
- DoD Instruction 3216.01, “Use of Animals in DoD Programs.”

For projects anticipating animal use, proposals should briefly describe plans for Institutional Animal Care and Use Committee (IACUC) review and approval. Animal studies in the program will be expected to comply with the “Public Health Service Policy on Humane Care and Use of Laboratory Animals.”

All award recipients must receive approval by a DoD-certified veterinarian, in addition to IACUC approval. No animal studies may be conducted using DoD/DARPA funding until the U.S. Army Medical Research and Materiel Command (USAMRMC) Animal Care and Use Review Office (ACURO) or other appropriate DoD veterinary office(s) grant approval. As a part of this secondary review process, the recipient will be required to complete and submit an ACURO Animal Use Appendix.

4. Export Control

Per DFARS 225.7901-4, all procurement contracts resultant from this solicitation will include the DFARS Export Control clause (252.225-7048). Language similar to DFARS Clause 252.225-7048 may be incorporated into OTs and other awards as deemed appropriate.

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5. **Electronic and Information Technology**

All electronic and information technology acquired through this solicitation must satisfy the accessibility requirements of Section 508 of the Rehabilitation Act (29 U.S.C. § 794d) and FAR 39.2. Each project involving the creation or inclusion of electronic and information technology must ensure that: (1) Federal employees with disabilities will have access to and use of information that is comparable to the access and use by Federal employees who are not individuals with disabilities; and (2) members of the public with disabilities seeking information or services from DARPA will have access to and use of information and data that is comparable to the access and use of information and data by members of the public who are not individuals with disabilities.

6. **Employment Eligibility Verification**

Per FAR 22.1802, recipients of FAR-based procurement contracts must enroll as Federal contractors in E-verify\(^{10}\) and use the system to verify employment eligibility of all employees assigned to the award. All resultant contracts from this solicitation will include the clause at FAR 52.222-54, “Employment Eligibility Verification.” This clause will not be included in cooperative agreements or OTs.

7. **System for Award Management (SAM) Registration and Universal Identifier Requirements**

Unless the proposer is exempt from this requirement, as per FAR 4.1102 or 2 CFR 25.110, as applicable, all proposers must be registered in the SAM and have a valid DUNS number prior to submitting a proposal. All proposers must provide their DUNS number in each proposal they submit. All proposers must maintain an active SAM registration with current information at all times during which they have an active Federal award or proposal under consideration by DARPA. Information on SAM registration is available at [http://www.sam.gov](http://www.sam.gov).

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

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

8. **Reporting Executive Compensation and First-Tier Subcontract Awards**

Per FAR 4.1403, FAR-based procurement contracts valued at $25,000 or more will include the clause at FAR 52.204-10, “Reporting Executive Compensation and First-Tier Subcontract Awards.” A similar award term will be used in cooperative agreements.

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\(^{10}\)[http://www.uscis.gov/e-verify]
9. Updates of Information Regarding Responsibility Matters

Per FAR 9.104-7(c), all contracts valued at $500,000 or more, where the contractor has current active Federal contracts and grants with total value greater than $10,000,000, will include FAR clause 52.209-9, “Updates of Publicly Available Information Regarding Responsibility Matters.”

10. Representation by Corporations Regarding Unpaid Delinquent Tax Liability or a Felony Conviction under Any Federal Law – Fiscal Year 2014 Appropriations (Deviation 2014-O0004)

In accordance with section 101(a) of Division A of the Continuing Appropriations Act, 2014 (Pub. L. 113-46), none of the funds made available by that Act for DoD (including Military Construction funds) may be used to enter into a contract with any corporation that: (1) has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability, where the awarding agency is aware of the unpaid tax liability, unless the agency has considered suspension or debarment of the corporation and made a determination that this further action is not necessary to protect the interests of the Government; or (2) was convicted of a felony criminal violation under any Federal law within the preceding 24 months, where the awarding agency is aware of the conviction, unless the agency has considered suspension or debarment of the corporation and made a determination that this action is not necessary to protect the interests of the Government. Each proposer must complete and return the representations outlined in Section IV.B.2.a.xi.(8) with their proposal submission.

11. Cost Accounting Standards (CAS) Notices and Certification

Per FAR 52.230-2, any procurement contract in excess of $700,000 resulting from this solicitation will be subject to the requirements of the Cost Accounting Standards Board (48 CFR 99), except those contracts that are exempt as specified in 48 CFR 9903.201-1. Any proposer who submits a proposal that, if accepted, will result in a CAS-compliant contract, must include a Disclosure Statement as required by 48 CFR 9903.202. The disclosure forms may be found at http://www.whitehouse.gov/omb/procurement_casb.

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

CUI refers to unclassified information that does not meet the standard for National Security Classification but is pertinent to the national interests of the United States or to the important interests of entities outside the Federal Government and under law or policy requires: (1) protection from unauthorized disclosure, (2) special handling safeguards, or (3) prescribed limits on exchange or dissemination. All non-DoD entities doing business with DARPA are expected to adhere to the following procedural safeguards, in addition to any other relevant Federal or DoD specific procedures, for submission of any proposals to DARPA and any potential business with DARPA:

- Do not process DARPA CUI on publicly available computers or post DARPA CUI to publicly available Webpages or Websites that have access limited only by domain or
Internet protocol restriction.

− Ensure that all DARPA CUI is protected by a physical or electronic barrier when not under direct individual control of an authorized user and limit the transfer of DARPA CUI to subcontractors or teaming partners with a need to know and commitment to this level of protection.
− Ensure that DARPA CUI on mobile computing devices is identified and encrypted and all communications on mobile devices or through wireless connections are protected and encrypted.
− Overwrite media that has been used to process DARPA CUI before external release or disposal.

13. Safeguarding of Unclassified Controlled Technical Information

Per DFARS 204.7300, the DFARS clause at 252.204-7012 (Safeguarding of Unclassified Controlled Technical Information), applies to this solicitation and all resultant contracts.

C. Reporting

1. Technical and Financial Reports

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

2. Representations and Certifications

In accordance with FAR 4.1201, prospective proposers shall complete electronic annual representations and certifications at http://www.sam.gov.

3. Wide Area Work Flow (WAWF)

Unless using another means of invoicing, performers will be required to submit invoices for payment directly at https://wawf.eb.mil. If applicable, WAWF registration is required prior to any award under this solicitation.

4. i-Edison

Award documents will contain a requirement for patent reports and notifications to be submitted electronically through the i-Edison Federal patent reporting system at http://s-edison.info.nih.gov/iEdison.
VII. AGENCY CONTACTS

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

- **Technical POC:** Dr. Suresh Jagannathan, Program Manager, DARPA/I2O
- **Email:** BRASS@darpa.mil
- **Mailing address:**
  DARPA/I2O  
  ATTN: DARPA-BAA-15-36  
  675 North Randolph Street  
  Arlington, VA 22203-2114
- **I2O Solicitation Website:**
VIII. OTHER INFORMATION

A. Frequently Asked Questions (FAQs)

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

DARPA will attempt to answer questions in a timely manner; however, questions submitted within 7 days of closing may not be answered. If applicable, DARPA will post FAQs to http://www.darpa.mil/Opportunities/Solicitations/I2O_Solicitations.aspx.

B. Collaborative Efforts/Teaming

It is DARPA’s desire to receive comprehensive, quality responses to this solicitation. To facilitate strong, collaborative teaming efforts and business relationships, a website https://www.schafertmd.com/darpa/i2o/brass/teaming has been established. Specific content, communications, networking, and team formation are the sole responsibility of the participants. Neither DARPA nor the DoD endorses the destination web site or the information and organizations contained therein, nor does DARPA or the DoD exercise any responsibility at the destination. This website is provided consistent with the stated purpose of this solicitation.

C. Proposers Day

The Proposers Day will be held on April 8, 2015, at the Capital Conference Center, located in Arlington, Virginia. Check-in begins at 12:30 PM (EDT). The meeting will begin at 1:00 PM (EDT).

Please see the special notice, DARPA-SN-15-35, for more information regarding the BRASS Proposers Day. This special notice can be found at: https://www.fbo.gov/index?s=opportunity&mode=form&id=6a504973154d1550772ce542d4b4b8&tab=core&_cview=0.

Attendance at the Proposers Day is voluntary and is not required to propose to this solicitation. DARPA will not provide reimbursement for costs incurred in participating in this Proposers Day.
D. Submission Checklist

The following items apply prior to proposal submission. Note: some items may take up to 1 month to complete.

<table>
<thead>
<tr>
<th>Item</th>
<th>BAA Section</th>
<th>Applicability</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obtain DUNS number</td>
<td>IV.B.2.a.i</td>
<td>Required of all proposers</td>
<td>The DUNS Number is the Federal Government’s contractor identification code for all procurement-related activities. See <a href="http://fedgov.dnb.com/webform/index.jsp">http://fedgov.dnb.com/webform/index.jsp</a> to request a DUNS number. Note: requests may take at least one business day.</td>
</tr>
<tr>
<td>Obtain Taxpayer Identification Number (TIN)</td>
<td>IV.B.2.a.i</td>
<td>Required of all proposers</td>
<td>A TIN is used by the Internal Revenue Service in the administration of tax laws. See <a href="http://www.irs.gov/businesses/small/international/article/0,,id=96696,00.html">http://www.irs.gov/businesses/small/international/article/0,,id=96696,00.html</a> for information on requesting a TIN. Note: requests may take from 1 business day to 1 month depending on the method (online, fax, mail).</td>
</tr>
<tr>
<td>Register in the System for Award Management (SAM)</td>
<td>VI.B.7</td>
<td>Required of all proposers</td>
<td>The SAM combines Federal procurement systems and the Catalog of Federal Domestic Assistance into one system. See <a href="http://www.sam.gov">www.sam.gov</a> for information and registration. Note: new registrations can take an average of 7-10 business days. SAM registration requires the following information: - DUNS number - TIN - CAGE Code. A CAGE Code identifies companies doing or wishing to do business with the Federal Government. If a proposer does not already have a CAGE code, one will be assigned during SAM registration. - Electronic Funds Transfer information (e.g., proposer’s bank account number, routing number, and bank phone or fax number).</td>
</tr>
<tr>
<td>Register in E-Verify</td>
<td>VI.B.6</td>
<td>Required for proposers requesting procurement contracts</td>
<td>E-Verify is a web-based system that allows businesses to determine the eligibility of their employees to work in the United States. See <a href="http://www.uscis.gov/e-verify">http://www.uscis.gov/e-verify</a> for information and registration.</td>
</tr>
<tr>
<td>Ensure representations and certifications are up to date</td>
<td>VI.C.2</td>
<td>Required of all proposers</td>
<td>Federal provisions require entities to represent/certify to a variety of statements ranging from environmental rules compliance to entity size representation. See <a href="http://www.sam.gov">http://www.sam.gov</a> for information.</td>
</tr>
<tr>
<td>Ensure eligibility of all team members</td>
<td>III</td>
<td>Required of all proposers</td>
<td>Verify eligibility, as applicable, for in accordance with requirements outlined in Section 3.</td>
</tr>
<tr>
<td>Register at Grants.gov</td>
<td>IV.E.1.b</td>
<td>Required for proposers requesting cooperative agreements</td>
<td>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 if all steps are not completed in a timely manner. See the Grants.gov user guides and checklists at <a href="http://www.grants.gov/web/grants/applicants/applicant-resources.html">http://www.grants.gov/web/grants/applicants/applicant-resources.html</a> for further information.</td>
</tr>
</tbody>
</table>
The following items apply as part of the submission package:

<table>
<thead>
<tr>
<th>Item</th>
<th>BAA Section</th>
<th>Applicability</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume 1 (Technical and Management Proposal)</td>
<td>IV.B.2.a</td>
<td>Required of all proposers</td>
<td>Conform to stated page limits and formatting requirements. Include all requested information.</td>
</tr>
</tbody>
</table>
| Appendix A | IV.B.2.a.xi | Required of all proposers | - Team member identification  
- Government/FFRDC team member proof of eligibility  
- Organizational conflict of interest affirmations  
- Intellectual property assertions  
- Human subjects research  
- Animal use  
- Unpaid delinquent tax liability/felony conviction representations  
- CASB disclosure, if applicable |
| Volume 2 (Cost Proposal) | IV.B.2.b | Required of all proposers | - Cover Sheet  
- Cost summary  
- Detailed cost information including justifications for direct labor, indirect costs/rates, materials/equipment, subcontractors/consultants, travel, ODCs  
- Cost spreadsheet file (.xls or equivalent format)  
- If applicable, list of milestones for 845 OTs  
- Subcontractor plan, if applicable  
- Subcontractor cost proposals  
- Itemized list of material and equipment items to be purchased with vendor quotes or engineering estimates for material and equipment more than $50,000  
- Travel purpose, departure/arrival destinations, and sample airfare |
Dr. Suresh Jagannathan
I2O
DARPA
703 526 2859
suresh.jagannathan@darpa.mil

Biosketch:
Dr. Suresh Jagannathan joined DARPA in September 2013. Dr. Jagannathan has published more than 125 peer-reviewed conference and journal publications and has co-authored one textbook. He holds three patents. He serves on numerous program and steering committees, and is on the editorial boards of several journals.

Sep 2013 – Present  Program Manager, DARPA
As a PM in I20 (Information Innovation Office), responsible for the creation, review, and deployment of new programs related to security, languages and systems, cyber-physical systems, etc. relevant to the mission of the agency.

Sep 2002 – Present  Professor Purdue University
Programming Languages and Implementations, Multicore and Distributed Systems, Functional Programming, Program Analysis

2009 – 2010  Visiting scholar, University of Cambridge
Worked on CompcertTSO, a verifying compiler for C, built on top of the Compcert system, extended to reason about the TSO relaxed memory model underlying x86 multiprocessors.

1990 – 2002  Senior Research Scientist, NEC Research Institute
Engaged in a long-range research program related to core foundational ideas in programming languages design and implementation.

January 1989 – June 1991  Research Faculty, Yale University
Computer Science department involved in concurrency and parallelism research.

Education
PhD and MS in Electrical Engineering and Computer Science from MIT
BS in Computer Science from the State University of New York, Stony Brook.

Program:
His research interests include programming languages, compilers, program verification, and concurrent and distributed systems.

Mining and Understanding Software Enclaves (MUSE) BAA-14-22
The Defense Advanced Research Projects Agency (DARPA) is soliciting innovative research proposals in the areas of program analysis, verification, and big data analytics for specifying, discovering, and understanding properties of complex software systems. Proposed research should investigate innovative approaches that enable revolutionary advances in science, methods, or systems. Specifically excluded is research that primarily results in evolutionary improvements to the existing state of practice.

DARPA is soliciting innovative research proposals in the areas of formal methods, program analysis, compiler design, and runtime and virtual machine implementation to realize tools for the construction of long-lived, survivable, and scalable adaptive software systems. Proposed research should investigate innovative approaches that enable revolutionary advances in science, devices, or systems.

Illustrative Publications Reflecting Personal Research Interests:
Proof-Directed Parallelization Synthesis by Separation Logic
Botincan, Matko; Dodds, Mike; Jagannathan, Suresh
ACM TRANS ON PROGRAMMING LANGUAGES AND SYSTEMS 35 2 Article No: 8 JUL 2013

Lightweight checkpointing for concurrent ML
Ziarek, Lukasz; Jagannathan, Suresh
JOURNAL OF FUNCTIONAL PROGRAMMING 20 137-173 MAR 2010

Static specification inference using predicate mining
Ramanathan, Murali Krishna; Grama, Ananth; Jagannathan, Suresh
ACM SIGPLAN NOTICES 42 6 123-134 JUN 2007

A transactional object calculus
Jagannathan, S; Vitek, J; Welc, A; et al.
SCIENCE OF COMPUTER PROGRAMMING 57 2 164-186 AUG 2005

A semantic framework for designer transactions
Vitek, J; Jagannathan, S; Welc, A; et al.
LECTURE NOTES IN COMPUTER SCIENCE 2986 249-263 2004

Continuation-based transformations for coordination languages
Jagannathan, S
THEORETICAL COMPUTER SCIENCE 240 1 117-146 JUN 6 2000

METALEVEL BUILDING-BLOCKS FOR MODULAR SYSTEMS
JAGANNATHAN, S
ACM TRANS ON PROGRAMMING LANGUAGES AND SYSTEMS 16 3 456-492 MAY 1994

PARALLELISM, PERSISTENCE AND META-CLEANLINESS IN THE SYMMETRICAL LISP INTERPRETER
GELERNTER, D; JAGANNATHAN, S; LONDON, T
SIGPLAN NOTICES 22 7 274-282 JUL 1987