Broad Agency Announcement

Synergistic Discovery and Design (SD2)

HR001117S0003

November 22, 2016

Defense Advanced Research Projects Agency
Information Innovation Office
675 North Randolph Street
Arlington, VA 22203-2114

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PART I: OVERVIEW INFORMATION

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

- **Funding Opportunity Title:** Synergistic Discovery and Design (SD2)

- **Announcement Type:** Initial Announcement

- **Funding Opportunity Number:** HR001117S0003

- **Catalog of Federal Domestic Assistance Numbers (CFDA):** Not Applicable

- **Dates**
  - Posting Date: November 22, 2016
  - Abstract Due Date: December 13, 2016, 12:00 noon (ET)
  - Proposal Due Date: February 14, 2017, 12:00 noon (ET)
  - Proposers Day: November 10, 2016

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

- **Types of Instruments that May be Awarded:** Procurement contracts or Other Transactions

- **Agency Contacts**

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  - **I2O Solicitation Website:** http://www.darpa.mil/work-with-us/opportunities

PART II: FULL TEXT OF ANNOUNCEMENT

I. Funding Opportunity Description

DARPA is soliciting innovative research proposals in the area of data-driven techniques and tools to enable scientific discovery and robust design. Proposed research should investigate innovative, revolutionary approaches to robust design in domains that lack complete models. Specifically excluded is research that primarily results in incremental 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) 6.102(d)(2) and 35.016. 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 (https://www.fbo.gov/).

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

Introduction/Background

The Synergistic Discovery and Design (SD2) program aims to develop data-driven methods to accelerate scientific discovery and robust design in domains that lack complete models. Engineers regularly use high-fidelity simulations to create robust designs in complex domains such as aeronautics, automobiles, and integrated circuits. In contrast, robust design remains elusive in domains such as synthetic biology, neuro-computation, and polymer chemistry due to the lack of high-fidelity models. SD2 will develop tools to enable robust design despite the lack of complete scientific models.

Examples of complex systems where inventors lack complete scientific models to support their design efforts include biological systems that have millions of protein-metabolite interactions, neuro-processes that require computations across billions of neurons, and advanced materials influenced by millions of monomer-protein combinations. These systems are part of domains that exhibit millions of unpredictable, interacting components for which robust models do not exist, and internal states are often only partially observable. In such domains, small perturbations in the environment can lead to unexpected design failures, and the number of engineering variables required to characterize stable operational envelopes remains unknown.

While domain experts remain geographically dispersed, they collectively analyze hundreds of terabytes of data to build models and refine designs. However, manually-intensive analysis of small datasets remains inefficient and often yields unreproducible results. In response, researchers have begun to outsource high-throughput experiments to automated labs and randomly search constrained parameter spaces for robust designs. However, these random search-based approaches work best with small parameter spaces and provide no insight into why some designs succeed and others fail. SD2 aims to develop data-driven methods to automatically discover models and refine designs in parallel at scale.

Program Description

SD2 will address the problem of design in domains that lack complete models by discovering models and refining designs via methods that extract information from data at petabyte scale. To ensure realism, challenge problems drawn from cutting edge domains will drive the development of SD2 methods.

Challenge Problems

Program wide evaluations of SD2 methods will involve a series of real world design challenges that today's scientific community does not yet know how to solve. The intent is to develop data-driven methods that can generate new scientific discoveries and design new capabilities that are not currently found in literature and are outside the limits of current science. SD2 methods will be evaluated based on their ability to discover new biological, chemical, and/or physical properties of complex systems at the cutting edge of research. SD2 will conduct experiments over the course of the program to test hypotheses and designs to determine whether new capabilities have been created. Program methods will succeed if they can solve the challenge problems at a rate faster than current publication cycles or decrease the expected time to convert an academic finding into a robust, industrial design or process.

Initially, SD2 will use challenge problems from synthetic biology for program wide evaluation. Synthetic biology provides a compelling driving application domain for the following reasons: (1) full characterization of the underlying biology requires complex mechanistic formalisms at a scale that defies manual discovery; (2) advances in the last 20 years have enabled scientists to more efficiently modify organisms in more complex and targeted ways; (3) terabytes of high quality synthetic biology data can be generated in a few days; and (4) design of synthetic biology systems remains a very laborious process that typically involves heuristic knowledge, brute force, and trial and error approaches.

Novel, high-impact challenge problems from alternative application domains are also in scope. SD2 will select challenge problems from alternative application domains based on the ability to collect high fidelity experimental data that can test the generality of the data-centric methods. Domains of interest include, but are not limited to, chemistry, material science, and neuro-computation. High impact problems that facilitate open data sharing and collaboration free of proprietary restrictions are encouraged.

Program Evaluation

Program wide evaluation will be organized around quarterly demonstration efforts based on challenge problems. The challenge problems will drive performers to algorithmically generate hypotheses and designs that can be experimentally tested within days, weeks, or months. Methods developed during the program should reduce the human effort required to achieve challenge goals.

At regular intervals, SD2 performers who are subject-matter experts will propose increasingly complex challenge problems based on lessons learned from experimental successes and failures. Notional design challenge problems may include the ability to design a 30 component circuit for nuclear waste absorption (in synthetic biology) or design a polymer that constricts in response to contact with a toxin (in polymer chemistry). Discovery challenges will reduce uncertainty associated with unpredictable experimental results. For example, discovery challenges might include the capability to identify environmental parameters that enables an unstable biological

circuit to operate as long as possible or diagnose root cause for experimental failure. Challenge problems will be screened to ensure that they:

- Test the ability to accelerate robust design in domains that lack models;
- Lead to discovery and design hypotheses that can be experimentally tested in days, weeks, or months;
- Do not pose Intellectual Property (IP) or data sharing restrictions; and
- Explore topics relevant to DoD interests, such as reproducibility and robustness.

Program Structure

Model discovery is a primary research focus for SD2, as accurate models can accelerate design in domains that lack high fidelity simulations. To facilitate model discovery, SD2 plans to advance computational analysis of raw experimental data at petabyte scale. The program will virtualize experimental workflows in order to increase access to high-throughput experimental resources. High-throughput experiments will provide large increments of high quality data from multiple labs. This data will flow into an SD2 analysis hub that serves as a data-sharing ecosystem for scalable, automated discovery and design. Novel discovery algorithms generated by the SD2 program will automatically process experimental data with the objective of detecting unexpected findings and refining system models. SD2-developed design algorithms will use the refined models to generate, test, and validate system designs. SD2 techniques and tools will be evaluated using challenge problems drawn from domains such as synthetic biology, polymer chemistry, and neuro-computation.

Technical Areas

The program structure includes five technical areas (TAs) that must work collaboratively to achieve program goals. SD2 encourages proposers to carefully review expectations for all five TAs and examine the "Demonstration Efforts" section (see page 8) in order to understand context for the TA to which they plan to propose. Short descriptions for each TA appear immediately below and detailed descriptions appear later in this document.

TA1 (Data-Centric Scientific Discovery): Develop computational workflows and algorithms to automatically detect significant variations between expected versus observed outcomes (hereafter termed "experimental surprise"); extract patterns, outliers, and design constraints from experimental data at scale; and use patterns to refine models.

TA2 (Design in the Context of Uncertainty): Extend engineering and planning formalisms to enable automated refinement of intermediate designs.

TA3 (Hypothesis and Design Evaluation): Experimentally evaluate the designs and hypothesized system knowledge generated by TA1 and TA2 in a manner that tests for reproducibility and robustness.

TA4 (Data and Analysis Hub): Extend open source tools to virtualize access to computational resources, data, and results in a manner that links multiple labs and research communities.

TA5 (Challenge Problem Integrator): Work with domain experts throughout the program to establish quarterly challenge problems to drive development of automated, data-driven methods that accelerate complex system design at scale.

Program Workflow

Figure 1 shows the workflow SD2 will use to develop new methods and to evaluate the resulting techniques and tools on real world challenge problems. Figure 2 specifies the input/output interactions between each program TA.

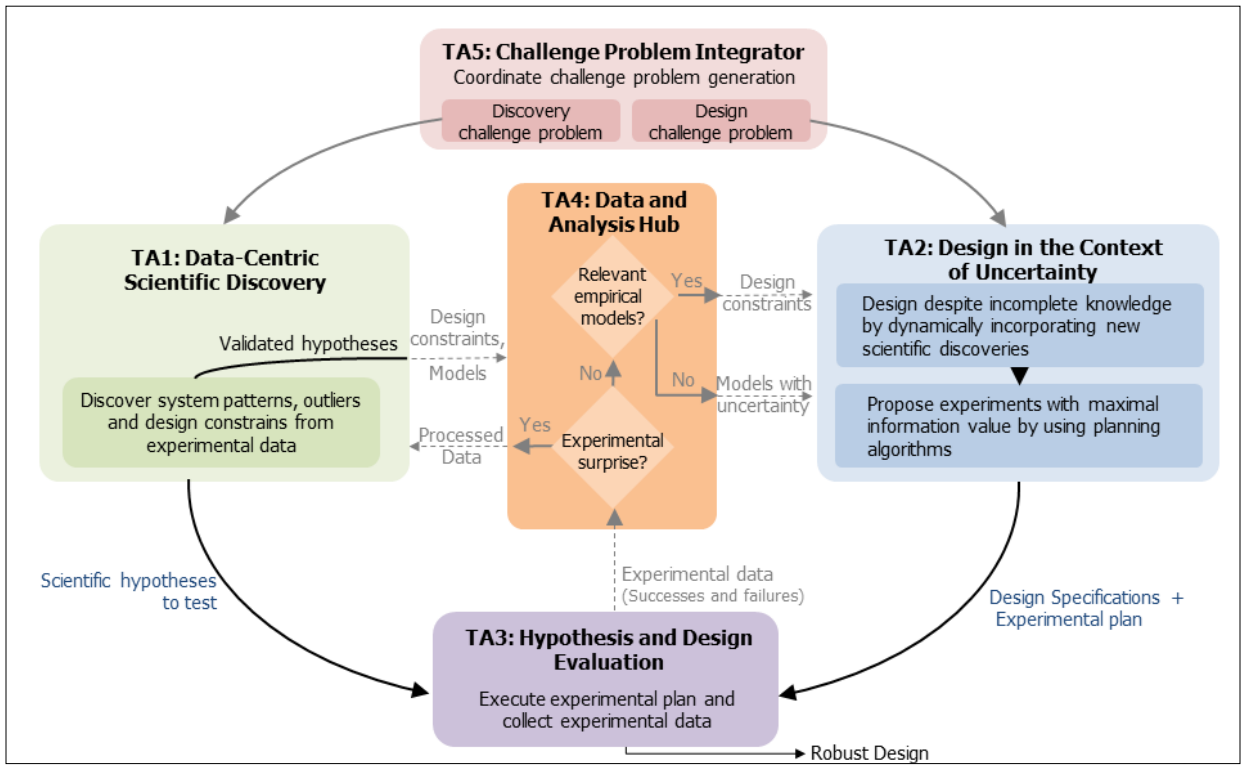

Figure 1: SD2 Program Structure and Workflow

Producer \ Receiver	TA1	TA2	TA3	TA4	TA5
TA1		Design constraints, models, and levels of uncertainty	Hypotheses and notional experiments during Phase 1	Discovery algorithms/workflows	Insights extracted from data to propose challenge problems
TA2	Information requirements for design		Proposed experimental plan to test designs and hypotheses	Design algorithms	Insights extracted from data to propose challenge problems
TA3	Data to test and demonstrate methods	Data to test and demonstrate methods, API for submitting experimental requests		Experimental data	Subject matter expertise to propose challenge problems
TA4	Infrastructure to demonstrate methods, APIs for running methods during data ingest	Infrastructure to demonstrate methods; APIs for running methods during data ingest	Hardware to facilitate data transfers, Data formatting requests		Insights extracted from trend analysis to propose challenge problems
TA5	Delivery of discovery challenge problems	Delivery of design challenge problems	Prioritization across experiments proposed by TA1 and TA2		

Figure 2: TA Interaction Matrix

Note: All application program interfaces (APIs) should be rapidly prototyped and performers should regularly collect feedback from the TAs using the API.

Collaborative Program Structure

DARPA intends for SD2 to be a highly collaborative program in which all performers (both within and across TAs) will constructively interact with one another. To facilitate the open exchange of information, performers will have an Associate Contractor Agreement (ACA) clause included in their award. This agreement is between performers that specify requirements to share information, data, technical knowledge, expertise or resources. The ACA agreement is intended to ensure appropriate coordination and integration of work by SD2 performers. For more information, see Section VIII.E.

Program-wide evaluation will require significant collaboration across all TAs. Regardless of initial teaming arrangements, SD2 performers will be expected to collaborate closely with other performers within their TA, as well as with performers of other TAs of the program. All SD2 performers must work cooperatively with one another to develop, integrate, test, and evaluate SD2 capabilities. TA4 infrastructure will facilitate collaboration among performers. As such, all proposals must include plans for delivering all necessary software, data, and domain knowledge to the TA4 performers. Similarly, experts from all TAs should plan to share experimental outcomes, lessons learned, and challenge problem ideas with one another and with the TA5 performer. Full interoperability of the prototype tools will not be required.

To promote collaboration among all performers, SD2 will hold quarterly working PI meetings, requiring the attendance of representatives from all TAs. The TA5 performer is responsible for organizing the technical agenda for these meetings in coordination with Government representatives. The intent of the working PI meetings is to facilitate collaboration among all SD2 performers, coordinate data management efforts, exchange insights gained from validation experiments, evaluate the effectiveness of discovery and design algorithms, refine challenge problems, and prioritize experiments for the next quarter.

During each quarterly working PI meeting, SD2 performers with experience in the selected application domain(s) will work together to choose compelling challenge problems for the following quarter. Each challenge problem should attempt to push the bounds on data-driven methods for model discovery and design refinement. The TA5 performer will act as a facilitator among the domain experts across the program to ensure the program takes advantage of all relevant expertise. Upon the TA5 performer finalizing the quarterly design challenge problem in coordination with the Government, TA2 performers must evaluate the scientific knowledge contained within the Data and Analysis Hub for relevance to the design challenge. Any gaps in knowledge will form the basis for data-centric, discovery, challenge problems for TA1. It is anticipated that by the end of each PI meeting, program performers (all TAs) should use lessons learned to agree on the next challenge problem(s) and agree on validation experiments for the next quarter. TA3 will execute the validation experiments prior to the next quarterly PI meeting. Then TA1 and TA2 will evaluate the experimental data in the following quarter. Figure 3 shows the anticipated timeline for the quarterly challenge problem cycle.

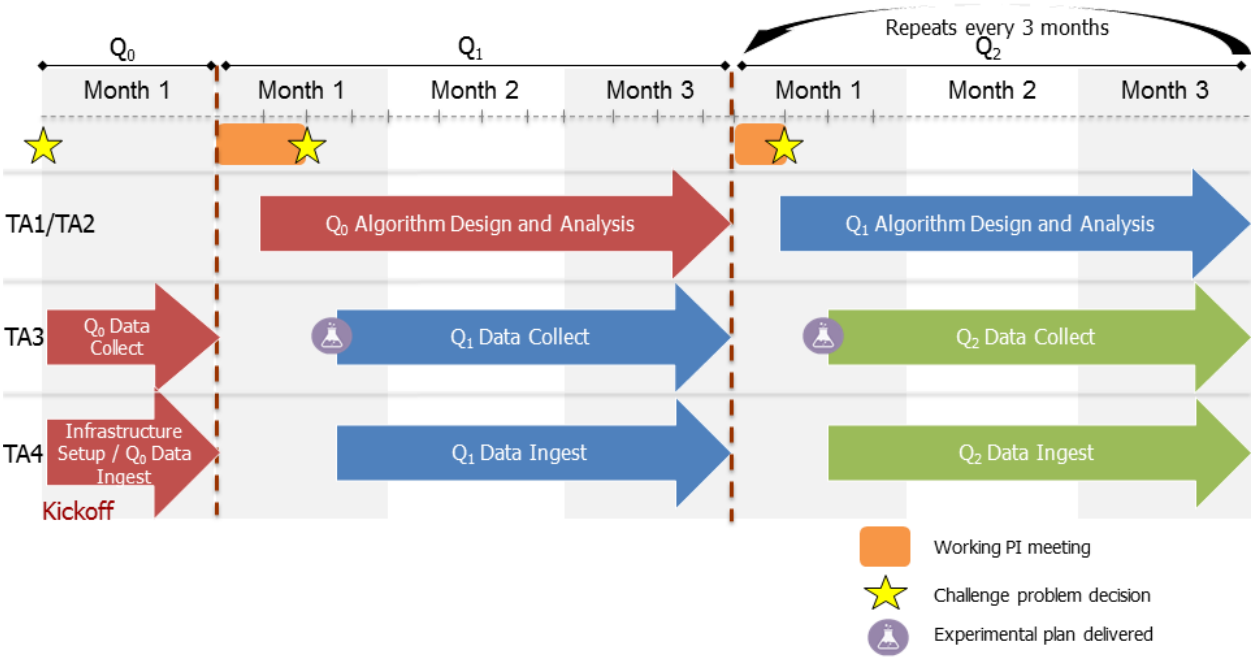

Figure 3: Notional Quarterly Challenge Problem Timeline

Demonstration Efforts

In response to challenge problems, SD2 performers will demonstrate methods on a steadily growing repository of experimental data. Each quarter, performers will present novel findings at the scheduled PI meeting. Proposers should plan to dynamically prioritize method development based on lessons learned during challenge problem demonstrations and feedback received through validation experiments. Proposals that predominantly focus on analysis of non-program datasets will be considered non-responsive.

Section VIII.F gives examples of design challenge problems in the field of synthetic biology that are appropriate for SD2. Novel, high-impact, challenge problems from alternative application domains that require relatively small data collects may also be proposed.

The following sections outline each technical area in more detail.

Technical Area 1: Data-Centric Scientific Discovery

TA1 performers must develop computational methods that convert experimental data into scientific knowledge that design algorithms can use for computation. TA1 algorithms must analyze experimental data, detect experimental surprise, diagnose failure, extract patterns, and use those patterns to refine system models. SD2 aims to reduce the amount of human intervention required for discovery tasks by creating methods that automate routine, mundane operations. Such automation will refocus human efforts on interesting scientific questions.

Proposers are encouraged to develop a reconfigurable set of tools that can discover scientific models from arbitrary experimental datasets. The reconfigurable tools should extract qualitative and quantitative insights from experimental data in a manner that incrementally builds models of increasing complexity. Ostensibly, the progression from data through qualitative observations to quantitative models involves four computational steps:

i) Discover categories of engineering variables (e.g., classes of proteins or genes with similar binding characteristics);

ii) Qualitatively characterize relationships between categories (e.g., protein category A inhibits gene category B);

iii) Identify stable regions of operation (e.g., the inhibitory effect occurs only at room temperature when the cell is not replicating); and

iv) Quantify relationships between engineering variables (e.g., the inhibitory effect is twice as strong when the amount of sugar in the environment doubles).

Proposers must describe a detailed technical approach that addresses how all four of these computational steps could be performed on arbitrary datasets using a reconfigurable set of tools. Approaches that combine multiple machine learning or data processing methods are in scope, as are approaches that expand the representational expressivity of a single modeling formalism. Model formalisms of interest include but are not limited to causal models, generative models, discriminative models, finite state machines, categorical grammars, dynamical system models, logical models, and graphical models.

Proposers should anticipate that models can periodically be validated via new experiments. Methods that incrementally increase model complexity at a rate commensurate with empirical evidence are of interest. Proposers are encouraged to address how they plan to identify suitable modeling formalisms, compare the relative validity of models both within and across formalisms, and provide a principled approach for moving from qualitative to quantitative formalisms based on experimental evidence.

Proposers should explain how their reconfigurable tools will reduce the human intervention required for a variety of discovery tasks traditionally performed by scientists. Discovery tasks of interest include, *but are not limited to*, the following objectives:

- Detect experimental surprise (i.e., significant variations between expected versus observed outcomes);
- Diagnose root causes for experimental failure;
- Hypothesize latent variables that account for experimental observations,
- Build and assess models;
- Construct operating envelopes to identify stable system behaviors that might support robust design; and
- Discover new scientific concepts or breakthroughs.

Proposers should highlight how their approach will address several such discovery tasks.

Ultimately, SD2 hopes to enable analysis of data from hundreds of thousands experiments with minimal human intervention. Computational methods that extract information primarily from the experimental data generated by TA3 are preferred. Methods that use literature or subject matter expertise to constrain model types or parameters are also considered in scope. However, approaches that rely heavily on human extraction from literature may be considered non-responsive.

All TA1 computational methods *must* scale to operate over relevant subsets of SD2's steadily growing repository of experimental data as described in TA3. TA1 proposals must describe the

scale at which baseline implementations will operate and assess the scale required to demonstrate methods on the full data repository. If needed, proposers must provide a technical plan to recast algorithms to a scale commensurate with the SD2 experimental data repository.

TA1 proposals must clearly delineate the types of scientific hypotheses each proposed computational method can extract. All TA1 computational methods must either formulate a testable hypothesis or provide information in a form that enables a subject matter expert to form a testable hypothesis. Scientific hypotheses and models generated by TA1 algorithms will be experimentally validated by TA3 performers. TA1 proposals must explain what information will be provided to TA2 and TA3 to formulate validation experiments.

All TA1 outputs and workflows must be shared with other SD2 performers via the Data and Analysis Hub. Proposers should plan to fine-tune their technical approach based on lessons learned during challenge problem demonstrations on program provided datasets. For example, TA1 performers should dynamically adjust a model's level of abstraction based on challenge problems and data. An ideal level of abstraction would provide enough detail to accelerate program wide progress toward design challenges and would limit details that did not substantially improve design quality.

The experimental data used to develop TA1 algorithms will be generated by TA3 or provided by the Government via TA4 infrastructure. Proposals that predominantly focus on analysis of non-program datasets will be considered non-responsive. TA1 performers must use TA4 infrastructure for algorithm development whenever appropriate.

Technical Area 2: Design in the Context of Uncertainty

TA2 performers must develop design algorithms that provide novel design capabilities in domains with incomplete models. Design algorithms will be used to address domain-specific design challenges such as: design a 30 component circuit for nuclear waste absorption (in synthetic biology) or design a polymer that constricts in response to toxin (in polymer chemistry). The TA2 design algorithms will consist of two classes: (1) algorithms for targeted design of system components, and (2) algorithms for experimental planning. All TA2 and joint TA1/TA2 proposals must address experimental planning. TA2-only proposals must also address targeted design of system components. TA1/TA2 proposals may optionally address targeted design of system components. The experimental data used to develop TA2 algorithms will be generated by TA3 or provided by the Government via TA4 infrastructure.

TA2-only proposals must specify the intended application domain for targeted design and outline a notional design challenge. SD2 is open to any design challenge within synthetic biology that can be tested via data generated by traditional synthetic biology data collects (e.g., omics, HPLC, flow cytometry, etc.). SD2 is also open to challenges in other applications as long as the TA2 proposal references a notional TA3 team that can provide experimental data to evaluate designs. Proposers interested in teaming are encouraged to visit the SD2 teaming website at: https://www.schafertmd.com/darpa/i2o/sd2/pd.

TA2-only proposals must outline a detailed technical approach to achieve targeted design of system components. Targeted design algorithms should enable users to specify a functionality requirement appropriate for the application domain and receive designs that have the potential to attain desired functionality. For example, a component design algorithm might propose DNA

constructs that enable a single-celled organism to fluoresce in response to a toxin. Design approaches that require significant manual extraction of information from literature, hand-coded heuristic knowledge, and manually coded design rules are out of scope.

Proposers must describe the required inputs and resulting outputs of the algorithm. For example, DNA design capabilities for synthetic biology might require algorithm inputs such as a molecule to be detected, type and duration of detection signal, and required operating conditions (e.g., temperature, suspended vs. plated, media composition, etc). Resulting outputs might include biological circuit design specifications (e.g., DNA construct, circuit logic, circuit inputs and outputs, host organism, and the range of environmental conditions across which the circuit should function).

TA2-only proposals must also include a sound technical plan to automatically and dynamically incorporate design constraints from experimental data and TA1 models into the targeted-design algorithms. Approaches should incorporate increasingly complex information from TA1 throughout the program. TA2-only proposals must specify assumptions about TA1 outputs that would provide added value to the TA2 approach. Knowledge representations of interest might include design rules or constraints, design grammars, and/or empirical distributions.
All TA2 proposals must include a detailed technical approach that specifies how to generate prioritized experimental plans and algorithms that derive plans for testing component designs and TA1 hypotheses. TA2 proposals should also address how to:

- Prioritize experiments based on the anticipated information theoretic value;
- Assess utility of running an experiment or sequence of experiments;
- Minimize the number of experiments required to develop and validate robust, reproducible designs that function across labs and across pre-specified ranges of environmental contexts;
- Prioritize the measurements and number of samples required for a particular experiment;
- Specify which experiments to run in one laboratory location instead of multiple laboratory locations; and
- Maximize information that can be gained from experiments while minimizing cost.

Experimental planning algorithms must be domain agnostic. TA2 proposals should describe approaches that require minimal reconfigurations to perform experimental planning functions in multiple domains. Inputs to the experimental planning algorithms might include available actions (e.g. experimental measurements) from TA3, component designs or hypotheses from TA1 and TA2 algorithms, costs associated with actions, available instrumentation, and consumables. The experimental planning algorithm should output a list of prioritized experiments that minimize the experimental overhead required to converge on a successful design. The prioritized list should specify details required to execute the experiments, such as the types of consumables, instrumentation, and experimental workflows.

TA2 proposals must describe how component design and experimental planning algorithms will decrease the percentage of mundane tasks that require human intervention. TA2 proposals should also describe the level of domain expertise required to use the proposed design tools. Approaches that substantially reduce the level of domain expertise required to generate successful designs are of particular interest.

TA2 performers must use TA4 infrastructure for algorithm development whenever appropriate.

Technical Area 3: Hypothesis and Design Evaluation

TA3 performers must generate experimental data throughout all phases of the program to validate TA1 hypotheses and evaluate TA2 designs. TA3 performers must provide computer readable application program interfaces (APIs) that enable both subject matter experts and computer algorithms to submit experiment requests. Ideally, automated workflows will remotely log experiment and contextual data in a manner that facilitates data comparison between geospatially distributed laboratories.

TA3 proposals must specify an intended application domain, describe data collection capabilities, and outline at least three relevant challenge areas. For each challenge area, proposers should identify a series of notional design and discovery challenges that could drive TA1 and TA2 development. Proposals should connect challenge problems with notional experiments that would provide relevant data. For each challenge, TA3 proposers should also explain the impact that a novel solution would have within the research community or the Department of Defense (DoD). More information about the types of challenge problems of interest to SD2 can be found in the "Challenge Problems" section (see page 5) and "Demonstration Efforts" section (see page 8).

SD2 will use synthetic biology as an initial application domain. However, TA3 proposals are not required to specify synthetic biology as the intended application domain. Novel, high-impact challenge problems from alternative application domains are also in scope. Alternative domains of interest to SD2 include polymer chemistry, synthetic chemistry, and neuro-computation. All TA3 proposals must provide experimental capabilities that support rapid experimental cycles (days, weeks, or months), open data sharing, computer readable experimental workflows, and cross lab data calibration. TA3 proposals using microbial, preclinical (animal), cell-culture, and cell-free experiments are in scope. <u>However, TA3 proposals that involve human subjects research (HSR) are not in scope.</u>

TA3 proposals must outline a sound technical plan for providing access to experimental resources via an API. Competitive teams will provide detailed, computer-readable, workflow languages that precisely describe experimental protocols, track environmental sensor readings, support supply chain management, and facilitate cross-lab comparisons. Proposals should address how the data collection techniques will facilitate data calibration and comparisons across geo-spatially distributed labs.

By the end of the program, integrated TA2/TA3 capabilities will enable experimental planning algorithms to submit experiment requests. Open source APIs are desired to provide the interface between TA3 experimental capabilities and TA2 algorithms. As such, TA3 proposals must include a description of APIs with notional lists of experimental commands, parameters, and associated costs. TA3 proposals should address how to incorporate novel instruments and experimental protocols in a manner that should not require recompilation of TA2 code.

All data generated by TA3 will be open source, and all data must be transferred to TA4 performers for ingestion into the Data and Analysis Hub. Proposers must describe how they plan to support data transfers to the Data and Analysis Hub (TA4).

TA3 proposals must include sound, detailed technical descriptions of domain-specific data collection capabilities. TA3 proposals must describe the level of automation for each experimental capability. High levels of automation are preferred. SD2 has strong interest in

unique, high-throughput, experimentation capabilities combined with reproducible, fine-grained, experimental capabilities. Fine-grained capabilities may rely on low- or mid-volume manual protocols, but they must provide high-value perspectives that can be calibrated against larger data collects. Strong proposals in TA3 will provide complementary capabilities that include both high-throughput measurements, as well as a broad range of fine-grained, experimental protocols. Proposers may highlight existing datasets that will be augmented with experiments conducted throughout the program.

TA3 performers must have access to equipment that enables data collection at appropriate volume and variety for the specified application domain. Proposals specifying synthetic biology data collects must satisfy the following criteria:

- Labs physically located in at least 3 geographically distinct areas;
- Equipment and staff to perform experiments with different types of single-celled organisms and cell lines;
- High-throughput robotics equipment and staff to collect high fidelity omics and biophysical data collectively at a rate of 100 GB to 1 TB per day;
- Breadth of experimental capabilities to address a large variety of design and discovery challenges;
- Sensor instrumentation to collect parallelized environmental and cellular contextual data; and
- Computer readable workflow language to enable cross lab comparison.

TA3 proposals specifying alternative application domains must satisfy the following criteria:

- Instrumentation that produce a breadth of data on the order of megabytes (MB) to 100s GBs per day;
- Sensor instrumentation to collect parallelized environmental and contextual data;
- Computer readable protocol language to enable cross lab comparison; and
- Novel, high-impact data collects.

All TA3 proposals must include a table describing all types of data collect, associated instrumentation, rate of sample preparation, rate of data generation, data format, amount of data generated per sample, and resources compatible with the data collect. The table should be constructed using the following template:

Type of Data Collect	***Instrumentation***	***Rate of sample preparation***	***Maximum rate of data generation***	***Format of data, typical file size per sample***	***Organisms***
Proteomics (Protein peak heights)	*(model #, Vendor)*	*100/day*	*1 TB/day*	*.txt file, 1GB*	*Bacteria Yeast*
QPCR (Cycle Threshold values)	*(model #, Vendor)*	*1000/day*	*50GB/day*	*.xml file, 2GB*	*Bacteria Yeast Mammalian*

Note: The above table was written assuming synthetic biology as the application domain. TA3 proposals specifying alternative application domains must include a table with similar level of detail.

Within synthetic biology, high-throughput instrumentation of interest includes, *but is not limited to*: proteomics, mass spectrometry-based techniques, live cell multiplex assay, flow cytometry, and next generation sequencing. TA3 proposals to alternative application domains must have access to equipment that enables a similar breadth and depth of reproducible experimental capabilities.

In addition to instrumentation, TA3 proposals must list other types of experimental resources. For instance, synthetic biology proposals should include organisms and/or cell lines supported by the experimental facility as well as special consumables and novel capabilities. For example, proposals should specify if the proposer can synthesize DNA constructs for the entire program. All TA3 proposals should specify the approved safety levels of their laboratories. Organisms of interest include*, but are not limited to*: Prokaryotes such as *Escherichia coli, Bacillus subtilis, Salmonella typhimurium* and Eukaryotes such as *Saccharomyces cerevisiae and Pichia pastoris.* Novel and less well characterized organisms such as extremophiles are also of interest.

A single TA3 performer should satisfy as many of the above criteria for laboratory capabilities as possible within the specified application domain. Teaming between TA3 performers is encouraged. SD2 has provided a teaming website to facilitate coordination of teams (https://www.schafertmd.com/darpa/i2o/sd2/pd/). To facilitate the open exchange of information between multiple laboratories, TA3 selected proposals will contain an ACA clause in any FAR based award (and similar data collaboration language in other awards) and ACAs will need to be in place before the first program kick-off meeting. For more information, please see section VIII.E.

Technical Area 4: Data and Analysis Hub

TA4 performers must establish and maintain a data sharing ecosystem that facilitates rapid data ingest, collaborative data analysis, and computational research. The ecosystem will require purchase or rental of cyber-infrastructure (i.e., computational hardware, storage services, and networking), installation and configuration of software, as well as the development of tools for data management, computation, and collaboration. TA4 is responsible for ingesting and pre-processing scripts, baseline visualization scripts, baseline compute for all TA1-4 data processing, and hardware for TA3/TA4 data transfers (see Figure 4).

Notional data processing pipeline	Raw data files →	Raw Data Tables →	Pre-processed data →	Intermediate Outputs →	Result tables	Statistics
Definition	Data generated by TA3 performers or government furnished data	Post-ingest version of raw data files	Algorithm inputs generated via TA4 scripts at ingest time	Temporary tables produced by TA1 or TA2	TA1/2 algorithm final results	Generated by TA4 scripts on any raw, preprocessed, intermediate output, and result table
TA responsible for production	Data from TA3	Outputs of TA4 ETL scripts	Outputs of TA4 pre-processing scripts	Scratch space used by TA1 or TA2 performers	Final outputs of TA1 or TA2 algorithms	Outputs of TA4 trend analysis scripts
TA responsible for infrastructure	TA4 loads and transports data	TA4 provides compute + storage	TA4 provides compute + storage	TA4 provides compute + storage	TA4 provides compute + storage	TA4 provides compute + storage

Figure 4: TA4 responsibilities associated with the notional data processing pipeline

TA4 performers must provide infrastructure that enables an alternative approach to scientific research. The TA4 team must flexibly incorporate high-impact capabilities into the data and analysis hub based on lessons learned throughout the program. Strong proposals will describe a compelling vision beyond the basic requirements outlined in this section.

TA4 proposals must include a sound, detailed, technical plan that describes hardware, user-management, data management, analytic environments, integration, collaboration tools, and maintenance. Proposals should clearly identify existing commercial or open source tools that will be leveraged over the course of the program. Proposals should also clearly delineate which technical requirements necessitate novel extensions to existing tools. Sections describing novel extensions should include a clear technical plan that first outlines current capabilities and then explains how tools will be extended, adapted, or developed to achieve TA4 technical objectives.

TA4 proposals must describe a plan for provisioning hardware that supports data ingest at an average rate of 1 terabyte (TB) per day over four years, supports central processing units (CPU) and graphic processing units (GPU) computations, enables performers in all TAs to perform collaborative data analysis, dynamically adjusts to program-wide storage and compute needs, and facilitates long-term archival storage. TA4 will be responsible for provisioning storage and compute for the entire program as well as for development, but not execution, of a plan for data preservation and curation of the results beyond the end of the period of performance. During the program period of performance, cyber-infrastructure provided should accommodate active archival storage for all raw data and fast access to data required for computational research. Proposers should define reasonable assumptions about aggregate storage and compute requirements across TA1-TA3 and use those assumptions as the basis for cost estimates.

To reduce cost, the hardware plan may include options to incrementally augment the core system with additional storage and compute at regular intervals throughout the program. Approaches of interest include, but are not limited to, incremental hardware purchase, hardware as a service, or infrastructure as a service. Proposers should clearly explain whether they plan to use public, private, or hybrid infrastructure. The cyber-infrastructure must facilitate high speed connections for users distributed across the country, enable low latency data processing from distributed research locations, and support data transfers from multiple locations. Cyber-infrastructure may support either streaming ingest from multiple TA3 labs or batch ingests at regular intervals. TA4

proposals must include a clear plan that describes the hardware used to facilitate information transfer.

TA4 proposals must also include a user-management plan that addresses access to, and provisioning of, storage and compute. TA4 is responsible for baseline compute and storage for all TAs. If the proposed hardware plan involves private infrastructure, the user-management plan should address access. If the proposed hardware plan involves a public cloud provider, the user-management plan should describe a technical approach that ensures novice users do not accidentally run jobs with unnecessarily expensive compute. Ideally, the user-management approach will have automated mechanisms to track jobs and ensure that scripts are first tested for scalability on small data samples before running on large data tables. Solutions that adjust baseline compute thresholds based on script history or user expertise are encouraged. Solutions that automatically pause or kill jobs that exceed projected compute profiles are also encouraged. For public cloud solutions, the user-management plan should also address how to provide non-program participants with access to data but not program-funded compute.

TA4 proposals must also contain a data-management plan, which should explain in detail how proposers will address the following technical objectives:

- Support data ingest, indexing, search, and filtering operations over raw experimental data, environmental sensor data, and experimental workflow data (see TA3 for additional information);
- Support data ingest and pre-processing at an average rate of 1 TB per day;
- Support robust ingest processes for common data formats;
- Provide a rapid ingest process for data with novel formats;
- Store data in manner that facilitates exploration and algorithmic processing by TA1-TA4 performers;
- Track data provenance for raw and pre-processed data;
- Provide APIs and/or conventions for tracking the provenance of outputs generated by TA1, TA2, and TA3 algorithms;
- Adaptively archive or re-index data based on usage patterns so that common operations occur quickly and infrequently used data is archived or flagged for deletion; and
- Retain all raw data in a manner that would support infrequent re-processing as needed.

Of particular interest are approaches that track usage statistics and algorithmically propose adaptive data retention policies based on usage patterns, data provenance, and data type. Ideally, raw data would be archived, while processed data would be retained, archived, or flagged for deletion based on usage and provenance. Data should be stored in a manner that makes common operations fast and uncommon operations possible. Proposers should plan to take advantage of usage statistics to distinguish between common and uncommon operations. Methods that promote syntactic and semantic interoperability are encouraged. Approaches that provide flexible support for new data types are encouraged, while approaches that rely on brittle schema are discouraged.

Proposers are encouraged to develop a data management plan with security controls for multi-tenant environments. Ideally, the technical approach will provide mechanisms to add security controls during years three and four of the SD2 program. Ideally, the security controls would

enable sensitive datasets to be shared, processed by TA1/TA2 algorithms, and explored only by approved users.

TA4 proposals must also include a technical plan to establish a flexible analysis environment that (1) regularly incorporates open source tools as they become available, and (2) provides core data pre-processing, statistical analysis, and data visualization capabilities. Proposed analysis environments should address the following technical objectives:

- Provide and demonstrate tools that support rapid exploration, sampling, and statistical analyses of novel datasets;
- Automatically generate data summaries, trend analyses, and exploratory visualizations on newly loaded datasets;
- Provide a library of just-in-time pre-processing methods that extract features from tables with raw experimental data (e.g. extract protein peaks from mass spectrometry data or perform BLAST alignment of genomic data);
- Minimize the development time required to integrate pre-processing methods in novel domains;
- Provision the analysis environment with novel open source research tools. Open source tools of interest include, but are not limited to, Spark, Spark Machine Learning library, DeepLearning4j, Caffe, R-Hadoop, and python;
- Provide TA1 and TA2 with a library of open source data visualization tools that facilitate display and exploration of analytic results with common formats (e.g., time series, histograms, event sequences, and network data types); and
- Provide logging tools and resource management visualizations to facilitate algorithm debugging within the data and analysis hub.

TA4 proposals must include an integration plan that outlines how the team will facilitate integration of raw data from TA3 performers and integration of TA1/TA2 algorithms into the data processing workflow. The integration plan should address the following technical objectives:

- Establish a process for regular data ingest from TA3 labs at an average rate of 1TB per day;
- Work with TA3 and TA1 to develop formatting conventions that facilitate rapid ingest of raw data from multiple labs;
- Support periodic data transfers from Government provided data sources;
- Ensure that the analysis environment contains open source research tools and visualization components commonly required by TA1, TA2, or TA3 performers;
- Provide an integration framework for TA1 and TA2 algorithms;
- Ensure that integration APIs track algorithm usage and data provenance;
- Work with TA1 and TA2 to identify common pre-processing steps and workflows, as well as incorporate common operations into an automated data ingest pipeline;
- Establish communication processes that highlight the status of TA4 products, such as data ingest tables, data pre-processing tables, integration of common operations, and updates to data visualizations;
- Evaluate which scaling techniques work best across the program;
- Establish best practices with regards to parallelization, scalability, data ingest, and data provenance;
- Provide tutorials to TA1, TA2, and TA3 performers regarding best practices; and

- Provide liaisons to other technical areas to facilitate data ingest, data processing, establishment of the analysis environment, and debugging of algorithms at scale.

Full integration of TA1 and TA2 algorithms is not required. However, TA4 must integrate methods that TA1 and TA2 performers consistently want to run at data ingest.

In addition, TA4 proposals must include a technical plan to demonstrate collaboration tools that enable researchers to share workflows and results. Proposed collaboration environments should address the following technical objectives:

- Develop, extend, or identify tools that enable researchers to share workflows and results with collaborators who use different operating systems or different analysis environments;
- Enable researchers to explore each other's analytic workflows and results in a manner that does not require substantial data downloads or time-consuming installation of new software on desktop or laptop computers;
- Track usage statistics for software methods and data tables; and
- Develop collaboration tools that highlight popular data tables, visualizations, analytic workflows, and results.

Whenever possible, proposers are encouraged to incorporate open source technologies, including but not limited to Vagrant, Docker, Jupyter Notebooks, HubZero, and iRODS.

TA4 proposals must also include a hardware and software maintenance plan. Maintenance plans should address how to efficiently perform software upgrades, respond to bugs, maintain software repositories, manage cloud configurations, and upgrade hardware as needed. Proposers should explain how the technical approach will minimize the manpower required for maintenance. Proposers are encouraged to highlight best practices and refer to relevant tools, such as Puppet, Chef, or Salt.

TA4 proposals will be evaluated on the completeness, achievability, and feasibility of the technical plans for hardware, user-management, data management, analytic environment, integration, collaboration tools, and maintenance. Proposals will also be evaluated based on the novelty of any proposed extensions. Of particular interest are novel open source solutions that work across a variety of public and private infrastructures in a cost-effective way. Proposals with strong biological and experimental data processing techniques are encouraged. In addition, strong proposals will include a comprehensive approach for adaptive data management and code integration based on data provenance and usage statistics. When appropriate, open source TA4 components are preferred. All proposals should clearly delineate which parts of the solution rely on existing tools versus novel extensions. Full interoperability of the prototype tools will not be required.

SD2 seeks to establish a collaborative ecosystem that goes beyond mere integration of existing tools. Hence, proposers are encouraged to offer a compelling vision beyond the basic requirements.

Technical Area 5: Challenge Problem Integrator

The TA5 performer will coordinate program wide evaluation. The TA5 performer must elicit knowledge from domain experts across the SD2 program to establish quarterly challenge

problems that drive the development of tools for data-driven design in domains that lack models. The TA5 performer will work with Government representatives each quarter to finalize the list of challenge problems and validation experiments. In addition, the TA5 performer will act as an evaluator to assess whether SD2 methods support discovery and design beyond what is otherwise possible today.

TA5 proposals must describe a plan that draws on domain expertise throughout the program to generate and refine challenge problems at each quarterly working PI meeting. The TA5 performer should screen challenge problems based on potential impact. Challenge problems should be framed so that successful designs and discoveries would capture the attention of domain experts outside of the program. For example, challenge problem solutions might lead to noteworthy publications, convert an academic result into a robust capability suitable for industrial application, or provide the foundation for a noteworthy DoD capability.

TA5 proposals must describe a notional process for challenge problem selection. Proposals should address how to ensure that challenge problems are ambitious enough to aggressively drive TA1 and TA2 algorithm development, while not so ambitious that they place unreasonable demands on performers. TA5 proposals should also address how to engage both domain and data analysis experts throughout the program to share lessons learned and propose challenge problem directions. Finally, proposals should address how to ensure that challenges are framed as a conversation that builds on insights gained from experimental outcomes.

The TA5 performer is responsible for the technical agenda at each working PI meeting. TA5 proposals must include a notional structure for quarterly working PI meetings that facilitates collaboration and knowledge elicitation across all TAs. The plan should include a progression of tasks to be accomplished at each quarterly working PI meeting throughout the SD2 program. The plan should identify at least 5 coordination challenges that could arise during a working PI meeting, and explain how the TA5 proposer would structure interactions that would encourage SD2 performers to collaboratively generate solutions. For example, TA1 and TA2 performers may submit experimental requests to TA3 that collectively exceed TA3 resources. TA5 proposals might discuss creative ways to negotiate joint solutions that take advantage of TA3's limited experimental resources and accomplish goals shared by TA1 and TA2 performers.

The TA5 performer will support collaboration via knowledge elicitation. TA5 proposals must describe, in detail, the knowledge elicitation techniques the proposer will use during and between working PI meetings to engage with domain experts, solicit challenge problem ideas and lessons learned, converge on high impact challenge problems, manage resources in a manner that creates a balanced risk portfolio across all challenges, and ensure effective collaboration across all technical areas. TA5 proposals should include scientific evidence to support the advocated knowledge solicitation approaches.

The TA5 proposer must establish metrics to evaluate whether SD2 algorithms accelerate discovery and design. The metrics should compare TA1 and TA2 algorithms to human-data analysis capabilities in order to determine which subtasks humans perform best, what subtasks algorithms perform best, and how the overall effect might be amplified via novel human-algorithm partnerships, for instance through an After-action review. For the human parts of the evaluation, the TA5 performer should quantify the level of expertise required. Of particular interest are subtasks that human domain experts perform with ~100% accuracy, but algorithms do not perform better than chance (e.g., perform with only ~50% accuracy). Such subtasks

should be used as challenges for algorithm development throughout the SD2 program. The TA5 performer should provide a technical plan to compare SD2 success rates to baseline discovery and design success rates.

Abstracts and Proposal Structure

Abstracts should address only one TA per submission. Proposals for TA1 and TA2 may address these two technical areas together or separately. Multiple primes are envisioned for TA1 and TA2. Proposals for TA3, TA4, and TA5 must address a single technical area. One prime or multiple primes with a teaming agreement is envisioned for TA3 and for TA4. A single prime is envisioned for TA5. Proposers selected for TA5 cannot be selected for any portion of the other four technical areas, whether as a prime, subcontractor, or consultant. Proposals addressing multiple technical areas, other than TA1 and TA2, will not be permitted.

Abstracts

It is highly recommended that an abstract be submitted to DARPA prior to submission of a full proposal. As teaming arrangements may not be finalized at the time of abstract submission, it is not necessary for abstracts to reflect final teaming arrangements. However, mention of potential teaming arrangements and collaborations is encouraged.

Proposals

Proposed work to any TA must fulfill the objectives of that area, as outlined herein. Statements of Work (SOWs) and Cost Proposals should be detailed and broken down by technical area. The SOW must provide a detailed task breakdown, citing specific tasks and their connection to the interim milestones and metrics, as applicable. Each phase of the program should be separately defined. To the extent practical, the SOW should be organized by the work required to achieve a particular technical objective.

Schedule and Budgeting Information

Proposers should submit a 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/revised as necessary throughout the SD2 program's period of performance.

Subject to the availability of funding, the program is intended to last for 48 months (4 years), and is structured as two 18-month phases, followed by a single 12-month phase. It is envisioned that there will be no formal down select. However, DARPA will regularly assess individual performer efforts in terms of the viability of their technical approaches, the trend in the performance of their systems over time, and their overall progress toward SD2 program objectives. For budgeting purposes, use July 1, 2017, as an estimated start date.

The Government will specify the locations for Principal Investigator (PI) meetings and other events. It is currently anticipated that the program kickoff meeting will occur in mid-July 2017, after contract signing. All required ACAs must be in place prior to the initial kick-off meeting. *It is strongly encouraged that any subcontracts are fully negotiated prior to proposal submission.*

Working PI meetings will be held approximately every three months. Performers should budget for two contiguous weeks of PI meetings during the first quarter and one week PI meetings for

every subsequent quarter. The majority of each team's personnel should be present at the first PI meeting exercises to become familiar with the application domains. The remaining PI meetings will require a minimum of three technical team members to be onsite during the meeting. For planning purposes, assume the locations split between the east and west coasts of the United States. Whenever possible, PI meetings will be scheduled around academic calendars to encourage broad attendance.

Working PI meetings will include activities such as: tool tutorials from performers, trend analysis of experimental data, information sharing, challenge problem generation, experimental resource negotiation, and a discussion of the data sharing requirements. The goals of the working PI meetings will be to: (a) enhance coordination across performer teams and technical areas; (b) demonstrate accomplishments of each quarter; (c) consolidate lessons learned from the previous quarter's data analysis efforts; and (d) review plans for the upcoming quarter. Later in the program, working PI meetings may include potential outreach efforts to encourage the broader scientific community to use SD2 tools once established.

In addition to occasional site visits, monthly or bi-monthly teleconference meetings will be held with each PI to enhance communications with the Government team. Should important issues arise between working PI meetings, the Government team will be available to support informal interim technical interchange meetings.

Milestones

The Government will use quarterly challenge problems and working PI meetings to assess performer progress toward the SD2 objectives. Challenge problems will prompt performers to: algorithmically process data to reproduce results from literature (Phase 1); discover novel findings and designs (Phase 2); and evaluate TA1 and TA2 methods on novel applications (Phase 3). At its conclusion, the SD2 program aims to develop methods that analyze petabytes of data from multiple sources examine millions of engineering variables per design, and discover multiple publication-worthy model refinements per year.

In broad terms, the milestones of the three phases are expected as follows:

- **Phase 1 (Reproduce):** Challenge problems will require TA1 and TA2 performers to algorithmically process data to reproduce results from literature. Within this phase, TA3 performers must demonstrate that the computer readable workflows are sufficient to minimize the variability across labs due to environmental conditions. TA3 performers must also deliver all experimental data to TA4 performers for ingestion into the Data and Analysis Hub. TA4 performers must establish the cyber-infrastructure to facilitate high speed connections for users distributed across the country, enable low latency data processing from distributed research locations, and support data transfers from multiple locations. Cyber-infrastructure may support either streaming ingest from multiple TA3 labs or batch ingests at regular intervals. TA4 performers must ingest raw experimental data at a rate of 1TB per day scaling to 1PB of aggregate data, develop a flexible integration framework, and extend collaboration tools to support exploration of experimental trends. The criteria for success in this phase is reducing variability across labs due to experimental conditions.

- **Phase 2 (Adapt):** Challenge problems will require TA1 and TA2 performers to discover novel findings and designs. Within this phase, TA1 performers must identify the causes for design failures using scientific discovery algorithms and TA2 performers

must use discovery algorithm outputs to improve designs. TA3 performers must deliver all experimental data to TA4 performers for ingestion into the Data and Analysis Hub. TA4 performers must scale to 3PB of aggregate data, demonstrate adaptive data management, extend collaboration tools to share discovery/design results, and support open source code and data releases. The criteria for success in this phase is discovering root causes for experimental surprises due to flawed scientific models.

• **Phase 3 (Discover):** Challenge problems will prompt evaluation of TA1 and TA2 methods on novel applications. Within the primary application domain of synthetic biology, TA1 performers should refine and scale the scientific discovery algorithms to identify intricate relationships across complex organisms. TA2 performers must utilize these scientific discoveries to transfer functionality into organisms useful for DoD applications. TA3 performers must deliver all experimental data to TA4 performers for ingestion into the Data and Analysis Hub. TA4 performers must scale to 5PB of aggregate data, extend collaboration tools to share discovery/design results with outside researchers, and support open source code and data releases. The criteria for success in this phase is to discover non-canonical mechanisms and use them for design.

Deliverables

The Government will use quarterly challenge problems and working PI meetings to assess performer progress toward SD2 objectives. The TA5 performer will work with Government representatives to finalize challenge problems and validation experiments. The TA5 performer must deliver coherent and compelling challenge problems and a prioritized list of validation experiments to Government representatives by the conclusion of each quarterly PI meeting. TA2 performers must generate the design and experimental plan to address the quarterly challenge problem no later than 1 week following the working PI meeting. TA3 performers must complete experimental requests from TA1 and TA2 and transfer all data to TA4 performers two weeks prior to each quarterly working PI meeting. TA4 performers must ingest all data submitted by TA3 performers into the data and analysis hub upon receipt and prior to the start of each quarterly PI meeting.

All data generated during the program must be delivered to TA4 during the program and to a location specified by the Government at the end of the program. The Government reserves the right to reduce the data retention policy based on lessons learned during the program. If the size of the end-of-program data is reduced, the Government will provide written guidance to the TA4 performer.

In addition, all performers are required to provide the following deliverables to the Government, as appropriate:

- 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 kickoff meeting and after PI meetings;
- Monthly Progress Reports - A monthly progress report describing resources expended, major risks, planned activities, trip summaries, changes to key personnel, and any potential issues and problem areas requiring the attention of the government team shall be provided within 10 days after the end of each month;
- A Technical and Management Work Plan with a project schedule including milestones, updated as required; and

- Final Report after each program phase. The final report shall concisely summarize the effort conducted.

Government-furnished Property/Equipment/Information

The Government will provide funds to purchase infrastructure associated with TA4 objectives. The Government will not provide funds to invest in TA3 instrumentation and equipment over $5,000. The Government will not provide funds to invest in infrastructure for TA1, TA2, or TA5. TA1, TA2, TA3, and TA5 are expected to use TA4 provided infrastructure.

Intellectual Property

SD2 will emphasize creating and leveraging *open source/open architecture* technology. Intellectual property rights asserted by proposers are strongly encouraged to be aligned with open source regimes. Exceptions for proprietary technology will be considered only in compelling cases. See Section VI.B.2 for more details on intellectual property.

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 and/or 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 or Other Transaction (OT) depending upon the nature of the work proposed, the required degree of interaction between parties, and other factors.

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

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

B. Fundamental Research

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

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

As of the date of publication of this BAA, the Government expects that program goals as described herein may be met by proposers intending to perform fundamental research and does not anticipate applying publication restrictions of any kind to individual awards for fundamental research that may result from this 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 research included in their proposal is fundamental or not. While proposers should clearly explain the intended results of their research, the Government shall have sole discretion to select award instrument type and to negotiate all instrument terms and conditions with selectees. Appropriate clauses will be included in resultant awards for non-fundamental research to prescribe publication requirements and other restrictions, as appropriate. This clause can be found at www.darpa.mil/work-with-us/additional-baa.

For certain research projects, it may be possible that although the research being performed by the awardee is restricted research, a subawardee may be conducting fundamental research. In those cases, it is the awardee's responsibility to explain in their proposal why its subawardee's effort is fundamental research

III. Eligibility Information

A. Eligible Applicants

DARPA welcomes engagement from all responsible sources capable of satisfying the Government's needs, including academia (colleges and universities); businesses (large, small, small disadvantaged, etc.); other organizations (including non-profit); entities (foreign, domestic, and Government); FFRDCs; minority institutions; and others.

DARPA welcomes engagement from non-traditional sources in addition to current DARPA performers.

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

FFRDCs

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

Government Entities

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

Authority and Eligibility

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

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. Organizational Conflicts of Interest

FAR 9.5 Requirements

In accordance with FAR 9.5, proposers are required to identify and disclose all facts relevant to potential OCIs involving the proposer's organization and *any* proposed team member (subawardee, consultant). Under this Section, the proposer is responsible for providing this disclosure with each proposal submitted to the BAA. The disclosure must include the proposer's, and as applicable, proposed team member's OCI mitigation plan. The OCI mitigation plan must include a description of the actions the proposer has taken, or intends to take, to prevent the existence of conflicting roles that might bias the proposer's judgment and to prevent the proposer from having unfair competitive advantage. The OCI mitigation plan will specifically discuss the disclosed OCI in the context of each of the OCI limitations outlined in FAR 9.505-1 through FAR 9.505-4.

Agency Supplemental OCI Policy

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

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

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

Government Procedures

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

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

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

C. Cost Sharing/Matching

Cost sharing is not required; however, it will be carefully considered where there is an applicable statutory condition relating to the selected funding instrument (e.g., OTs under the authority of 10 U.S.C. § 2371). Cost sharing is encouraged where there is a reasonable probability of a potential commercial application related to the proposed research and development effort.

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

D. Other Eligibility Requirements

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

While proposers may submit proposals for all five technical areas, proposers selected for TA5 cannot be selected for any portion of any of the other four technical areas, whether as a prime, subcontractor, or in any other capacity from an organizational to individual level. This is to avoid OCI situations between the TAs and to ensure objective test and evaluation results. The decision as to which proposal to consider for award is at the discretion of the Government.

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 (https://www.fbo.gov), or referenced herein.

B. Content and Form of Application Submission

1. Abstracts

Proposers are highly encouraged to submit an abstract in advance of a proposal to minimize effort and reduce the potential expense of preparing an out of scope proposal. The abstract provides a synopsis of the proposed project, including brief answers to the following questions:

- What is the proposed work attempting to accomplish or do?
- How is it done today, and what are the limitations?
- Who will care and what will the impact be if the work is successful?
- How much will it cost, and how long will it take?

DARPA will respond to abstracts with a statement as to whether DARPA is interested in the idea. If DARPA does not recommend the proposer submit a full proposal, DARPA will provide feedback to the proposer regarding the rationale for this decision. Regardless of DARPA's response to an abstract, proposers may submit a full proposal. DARPA will review all full proposals submitted using the published evaluation criteria and without regard to any comments resulting from the review of an abstract.

Abstract Format: Abstracts to TA1, TA2, TA3, and TA5 shall not exceed a maximum of 3 pages including the cover sheet and all figures, tables, and charts. Abstracts to TA4 shall not exceed a maximum of 5 pages including the cover sheet and all figures, tables, and charts. The page limit does not include a submission letter (optional). *Please address only one TA per abstract submission.*

All pages shall be formatted for printing on 8-1/2 by 11 inch paper with 1-inch margins and 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.

Abstracts must include the following components:

- **Cover Sheet**: Provide the administrative and technical points of contact (name, address, phone, email, lead organization). Include the BAA number, title of the proposed project, primary subcontractors, estimated cost, duration of the project, and the label "Abstract."

- **Goals and Impact:** Describe what is being proposed and what 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 relationship of this work to any other projects from the past and present.

- **Technical Plan:** Outline and address all technical challenges inherent in the approach and possible solutions for overcoming potential problems. Provide appropriate specific milestones (quantitative, if possible) at intermediate stages of the project to demonstrate progress.

- **Capabilities/Management Plan:** Provide a brief summary of expertise of the team, including subcontractors and key personnel. Identify a principal investigator for the project and include a description of the team's organization including roles and responsibilities. Describe the organizational experience in this area, existing intellectual property required to complete the project, and any specialized facilities to be used as part of the project. List Government-furnished property, facilities, or data assumed to be available. If desired, include a brief bibliography with links to relevant papers, reports, or resumes of key performers. Do not include more than two resumes as part of the abstract. Resumes count against the abstract page limit.

- **Statement of Work, Cost and Schedule:** Provide a cost estimate for resources over the proposed timeline of the project, broken down by year. Include labor, materials, a list of deliverables and delivery schedule. Provide cost estimates for each subcontractor (may be a rough order of magnitude). Level of effort for all personnel and subcontractors must be broken down by skill set.

2. 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.

Reminder - Proposals for TA1 and TA2 may address these two technical areas together or separately. Proposals for TA3, TA4, and TA5 must address a single technical area. Proposers selected for TA5 cannot be selected for any portion of the other four technical areas, whether as a prime, subcontractor, or consultant. Proposals addressing multiple technical areas, other than TA1 and TA2, will not be permitted.

a. Volume 1: Technical and Management Proposal

The maximum page count for Volume 1 is 40 pages, including all figures, tables, and charts; but not including the cover sheet, table of contents, or appendices. If the proposal addresses both TA1 and TA2 objectives, the maximum page count for Volume 1 is 50 pages, including all figures, tables, and charts; but not including the cover sheet, table of contents, or appendices. 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 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 (HR001117S0003)
- 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) or OT.[1]
- Total amount of the proposed effort
- 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[2]
- Taxpayer identification number[3]
- Commercial and Government Entity (CAGE) code[4]
- Proposer's reference number (if any)

ii. Table of Contents

iii. Executive Summary: Provide a synopsis of the proposed project, including answers to the following questions:

- What is the proposed work attempting to accomplish or do?

[1] Information on award instruments can be found at http://www.darpa.mil/work-with-us/contract-management.
[2] The DUNS number is used as the Government's contractor identification code for all procurement-related activities. Go to http://fedgov.dnb.com/webform/index.jsp to request a DUNS number (may take at least one business day). For further information regarding this subject, please see www.darpa.mil/work-with-us/additional-baa for further information.
[3] See 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. For further information regarding this subject, please see www.darpa.mil/work-with-us/additional-baa.

- How is it done today, and what are the limitations?
- What will be the impact if the work is successful, and who will it affect?
- 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. Innovative Claims and Deliverables: 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 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. 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 a 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:

Key Individual	Project	Status (Current, Pending, Proposed)	Hours on Project		
			Phase 1	Phase 2	Phase 3
Name 1	**Program name**	Proposed	x	x	x
	Project Name 1	Current	x	x	n/a
	Project Name 2	Pending	n/a	x	x
Name 2	**Program Name**	Proposed	x	x	x
	Project Name 3	Proposed	x	x	x

viii. 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.

ix. 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.
- Identify any tasks/subtasks (by the prime or subcontractor) that will be accomplished at a university and believed to be fundamental research.

x. 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.

xi. Level of Effort Summary by Task: Provide a one-page table summarizing estimated level of effort per task (in hours) broken out by senior, mid-level and junior personnel and skill set (e.g. software engineer, data scientist, computational modeler, biologist, chemist, biological engineer, etc.), in the format shown below in Figure 3. Also include dollar-denominated estimates of travel, materials and equipment. For this table, consider materials to include the cost of any data sets or software licenses proposed. For convenience, an Excel template is available for download with the BAA.

SOW Task		Duration (months)	Intensity (hrs/mo)	Labor Hours for Prime							Labor Hours for Subcontractor/Consultants							
				Sr	Skill set(s)	Mid	Skill set(s)	Jr	Skill set(s)	Total	SubC-Sr	Skill set(s)	SubC-Mid	Skill set(s)	SubC-Jr	Skill set(s)	Conslt	Total
1.1.0	<Phase 1 Task 1 name>	7	135	240		680		24		944	-						200	1,144
1.1.1	<Subtask 1.1.1 name>	4	90	80		280		-		360	-						200	560
1.1.2	<Subtask 1.1.2 name>	3	195	160		400		24		584	-						-	584
1.2.0	<Phase 1 Task 2 name>	6	385	108		400		1,800		2,308	1,400						-	3,708
1.2.1	<Subtask 1.2.1 name>	3	656	48		320		1,600		1,968	600						-	2,568
1.2.2	<Subtask 1.2.2 name>	3	113	60		80		200		340	800						-	1,140
:	:	:	:	:		:		:		:	:						:	:
		Phase 1 Total Hours		348		1,080		1,824		3,252	1,400						200	4,652
Phase 1 Costs *First column is prime, second is*								Travel		$ 44,000	$ 12,000						$ 2,000	$ 58,000
total subcontractor, third is total consultant, fourth is total								Materials & Equipment		$ 8,000	$ -						$ -	$ 8,000
2.1.0	<Phase 2 Task 1 name>	8	100	176		560		64		800	100						100	1,000
2.1.1	<Subtask 2.1.1 name>	7	51	96		240		24		360	100						100	560
2.1.2	<Subtask 2.1.2 name>	4	110	80		320		40		440	-						-	440
2.2.0	<Phase 2 Task 2 name>	6	417	180		520		1,800		2,500	1,240						-	3,740
2.2.1	<Subtask 2.2.1 name>	4	435	140		400		1,200		1,740	400						-	2,140
2.2.2	<Subtask 2.2.2 name>	4	190	40		120		600		760	840						-	1,600
:	:	:	:	:		:		:		:	:						:	:
		Phase 2 Total Hours		356		1,080		1,864		3,300	1,340						100	4,640
Phase 2 Costs *First column is prime, second is*								Travel		$ 47,000	$ 12,000						$ 2,000	$ 61,000
total subcontractor, third is total consultant, fourth is total								Materials & Equipment		$ 4,000	$ -						$ -	$ 4,000
3.1.0	<Phase 3 Task 1 name>	9	71	120		400		120		640	100						100	840
3.1.1	<Subtask 3.1.1 name>	3	93	40		200		40		280	100						100	480
3.1.2	<Subtask 3.1.2 name>	6	60	80		200		80		360	-						-	360
3.2.0	<Phase 3 Task 2 name>	6	460	160		800		1,800		2,760	1,200						-	3,960
3.2.1	<Subtask 3.2.1 name>	4	370	80		400		1,000		1,480	600						-	2,080
3.2.2	<Subtask 3.2.2 name>	3	427	80		400		800		1,280	600						-	1,880
:	:	:	:	:		:		:		:	:						:	:
		Phase 3 Total Hours		280		1,200		1,920		3,400	1,300						100	4,800
Phase 3 Costs *First column is prime, second is*								Travel		$ 48,000	$ 12,000						$ 2,000	$ 62,000
total subcontractor, third is total consultant, fourth is total								Materials & Equipment		$ -	$ -						$ -	$ -
		Project Total Hours		984		3,360		5,608		9,952	4,040						400	14,092
Total Project Costs *First column is prime, second is*								Travel		$ 139,000	$ 36,000						$ 6,000	$ 181,000
total subcontractor, third is total consultant, fourth is total								Materials & Equipment		$ 12,000	$ -						$ -	$ 12,000

Figure 3: Example level-of-effort summary table. Numbers illustrate roll-ups and subtotals. The SubC column captures all subcontractor hours and the Conslt column captures all consultant hours.

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:

Individual Name	Role (Prime, Subcontractor or Consultant)	Organization	Non-US?		FFRDC or Govt?
			Org	Ind.	

(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:

Prime Contract Number	DARPA Technical Office supported	A description of the action the proposer has taken or proposes to take to avoid, neutralize, or mitigate the conflict

(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 having less than unlimited rights 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:

NONCOMMERCIAL				
Technical Data and/or Computer Software To be Furnished With Restrictions	**Summary of Intended Use in the Conduct of the Research**	**Basis for Assertion**	**Asserted Rights Category**	**Name of Person Asserting Restrictions**
(List)	(Narrative)	(List)	(List)	(List)
(List)	(Narrative)	(List)	(List)	(List)

COMMERCIAL				
Technical Data and/or Computer Software To	**Summary of Intended Use in**	**Basis for Assertion**	**Asserted Rights**	**Name of Person Asserting Restrictions**

be Furnished With Restrictions	the Conduct of the Research		Category	
(List)	(Narrative)	(List)	(List)	(List)
(List)	(Narrative)	(List)	(List)	(List)

(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.2.

(8). Representations Regarding Unpaid Delinquent Tax Liability or a Felony Conviction under Any Federal Law: For further information regarding this subject, please see www.darpa.mil/work-with-us/additional-baa.

Please also complete the following statements.

(1) The proposer 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,

(2) The proposer 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: For 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 9903.202. The disclosure forms may be found at http://www.whitehouse.gov/omb/procurement_casb.

If this section is not applicable, state "NONE". For further information regarding this subject, please see www.darpa.mil/work-with-us/additional-baa.

xiii. Appendix B: If desired, include a brief bibliography to relevant papers, reports, or resumes. Do not include technical papers. This section is optional, and the materials will not be evaluated as part of the proposal review. Resumes may also be included in this section.

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 working 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 Tables: Provide a single-page summary table broken down by fiscal year listing cost totals for labor, materials, other direct charges (ODCs), indirect costs (overhead, fringe, general and administrative (G&A)), and any proposed fee for the project. Include costs for each task in each fiscal year of the project by prime and major subcontractors, total cost and proposed cost share, if applicable. Provide a second table containing the same information broken down by project phase.

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 from a Government audit agency such as the Defense Contract Audit Agency (DCAA), the Office of Naval Research (ONR), the Department of Health and Human Services (DHHS), etc.

(2) Indirect Costs: Identify all indirect cost rates (such as fringe benefits, labor overhead, material overhead, G&A, or F&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. If the proposer has conducted a cost or price analysis to determine reasonableness,

submit a copy of this along with the subcontractor proposal.

The proposer is responsible for the compilation and submission of all subcontractor/consultant cost proposals. At a minimum, the submitted cost volume must contain a copy of each subcontractor or consultant non-proprietary cost proposal (i.e. cost proposals that do not contain proprietary pricing information such as rates, factors, etc.) Proprietary subcontractor/consultant cost proposals may be included as part of Volume 2. Proposal submissions will not be considered complete unless the Government has received all subcontractor/consultant cost proposals.

If proprietary subcontractor/consultant cost proposals are not included as part of Volume 2, they may be emailed separately to SD2@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. Any proprietary subcontractor or consultant proposal documentation which is not uploaded to BAAT as part of the proposer's submission or provided by separate email shall be made immediately available to the Government, upon request, under separate cover (i.e., mail, electronic/email, etc.), either by the proposer or by the subcontractor/consultant organization.

Please note that a ROM or similar budgetary estimate is not considered a fully qualified subcontract cost proposal submission. Inclusion of a ROM or similar budgetary estimate, or failure to provide a subcontract proposal, will result in the full proposal being deemed non-compliant.

(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 $750,000 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 $700,000 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.

(2) Proposers without an adequate 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. Proposers without an

accounting system considered adequate for determining accurate costs must complete an SF 1408 if a cost type contract is to be negotiated. To facilitate this process, proposers should complete the SF 1408 found at http://www.gsa.gov/portal/forms/download/115778 and submit the completed form with the proposal. To complete the form, check the boxes on the second page, then provide a narrative explanation of your accounting system to supplement the checklist on page one.

v. Proposals Requesting an Other Transaction for Prototypes (845 OT) Agreement: Proposers must indicate whether they qualify as a nontraditional Defense contractor[5], 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.

3. 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

Classified submissions (classified technical proposals or classified appendices to unclassified proposals) WILL NOT be accepted under this solicitation.

If a determination is made that the award instrument may result in access to classified information, a DD Form 254, "DoD Contract Security Classification Specification," will be issued by DARPA and attached as part of the award. A DD Form 254 will not be provided to proposers at the time of submission. For reference, the DD Form 254 template is available at http://www.dtic.mil/dtic/pdf/formsNguides/dd0254.pdf.

[5] For definitions and information on 845 OT agreements see http://www.darpa.mil/Opportunities/Contract_Management/Other_Transactions_and_Technology_Investment_Agreements.aspx.

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.

When utilizing the DARPA BAA Submission Website, as described below in Section IV.E below, a control number will be provided at the conclusion of the submission process. This control number should be used in all further correspondence regarding your abstract/proposal submission.

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

1. Abstracts

Abstracts must be submitted per the instructions outlined herein and received by DARPA no later than December 13, 2016 at 12:00 noon (ET). Abstracts received after this date and time will not be reviewed. Emailed submissions of abstracts will not be accepted.

2. Proposals

The proposal package -- full proposal (Volume 1 and 2) and, as applicable, proprietary subcontractor cost proposals, classified appendices to unclassified proposals -- must be submitted per the instructions outlined herein and received by DARPA no later than February 14, 2017 at 12:00 noon (ET). Submissions received after this date and time will not be reviewed. Emailed submissions of full proposals will not be accepted.

D. Funding Restrictions

Not applicable.

E. Other Submission Requirements

Submission Instructions

Proposers must submit all parts of their submission package using the same method; submissions cannot be sent in part by one method and in part by another method nor should duplicate submissions be sent by multiple methods. Email submissions will not be accepted.

a. Abstracts

DARPA/I2O will employ an electronic upload submission system (https://baa.darpa.mil/) for all UNCLASSIFIED abstract responses under this solicitation. *Abstracts should not be submitted via Email or Grants.gov.*

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 abstract.

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 abstract 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 deemed acceptable 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 SD2@darpa.mil.

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

b. 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 deemed acceptable 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 SD2@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.

V. Application Review Information

A. Evaluation Criteria

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

- *Overall Scientific and Technical Merit*:
  The proposed technical approach is innovative, feasible, achievable, and complete.

  The 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 proposal outlines a plan that uses TA3 and Government provided datasets to drive and evaluate technical progress.

- *Potential Contribution and Relevance to the DARPA Mission:*
  The potential contributions of the proposed effort are relevant to the national technology base. Specifically, DARPA's mission is to make pivotal early technology investments that create or prevent strategic surprise for U.S. National Security.

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

B. Review and Selection Process

The review process identifies proposals that meet the evaluation criteria described above and are, therefore, selectable for negotiation of awards by the Government. DARPA policy is to ensure impartial, equitable, comprehensive proposal evaluations and to select proposals that meet DARPA technical, policy, and programmatic goals. If necessary, panels of experts in the appropriate areas will be convened. As described in Section IV, proposals must be deemed conforming to the solicitation to receive a full technical review against the evaluation criteria; proposals deemed non-conforming will be removed from consideration.

DARPA will conduct a scientific/technical review of each conforming proposal. Conforming proposals comply with all requirements detailed in this BAA; proposals that fail to do so may be deemed non-conforming and may be removed from consideration. Proposals will not be

evaluated against each other since they are not submitted in accordance with a common work statement. DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons

Selections may be made at any time during the period of solicitation. Pursuant to FAR 35.016, the primary basis for selecting proposals for award negotiation shall be technical, importance to agency programs, and fund availability. Conforming proposals based on a previously submitted abstract will be reviewed without regard to feedback resulting from review of that abstract. Furthermore, a favorable response to an abstract is not a guarantee that a proposal based on the abstract will ultimately be selected for award negotiation. Proposals that are determined selectable will not necessarily receive awards.

For evaluation purposes, a proposal is defined to be the document and supporting materials as described in Section IV.B.2. Subject to the restrictions set forth in FAR 37.203(d), input on technical aspects of the proposals may be solicited by DARPA from non-Government consultants/experts who are strictly bound by the appropriate non-disclosure requirements. No submissions will be returned.

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 to have a minimum of Government Purpose Rights (GPR) to technical data/computer software developed through DARPA sponsorship.

The program will emphasize creating and leveraging open source technology and architecture. Intellectual property rights asserted by proposers are strongly encouraged to be aligned with open source regimes. Exceptions to proprietary technology will be considered only in compelling cases.

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) Part 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. 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.

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.xii.(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 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.xii.(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.xii.(5).

2. Human Research Subjects/Animal Use

Proposers that anticipate involving Human Research Subjects or Animal Use must comply with the approval procedures detailed at www.darpa.mil/work-with-us/additional-baa.

3. 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.

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

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

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).

C. Reporting

1. Technical and Financial Reports

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

2. Representations and Certifications

If a procurement contract is contemplated, prospective awardees will need to be registered in the SAM database prior to award and complete electronic annual representations and certifications consistent with FAR guidance at 4.1102 and 4.1201; the representations and certifications can be found at www.sam.gov. Supplementary representations and certifications can be found at www.darpa.mil/work-with-us/additional-baa.

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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. FAR and DFARS Clauses

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

5. 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 https://public.era.nih.gov/iedison.

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

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

VII. Agency Contacts

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

- **Technical POC:** Dr. Jennifer Roberts, Program Manager, DARPA/I2O

- **Email:** SD2@darpa.mil

- **Mailing address**:
  DARPA/I2O
  ATTN: HR001117S0003
  675 North Randolph Street
  Arlington, VA 22203-2114

- **I2O Solicitation Website:**
  http://www.darpa.mil/Opportunities/Solicitations/I2O_Solicitations.aspx

VIII. Other Information

A. Frequently Asked Questions (FAQs)

Administrative, technical, and contractual questions should be sent via email to SD2@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 (//www.schafertmd.com/darpa/i2o/sd2/pd/) 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 was held on November 10, 2016 in Arlington, VA. The special notice regarding the SD2 Proposers Day can be found at https://www.fbo.gov/index?s=opportunity&mode=form&id=b1e38a17bbbb714f6f718ebae3840dd2&tab=core&_cview=0.

For further information regarding the SD2 Proposers Day, including slides from the event, please see http://www.darpa.mil/work-with-us/opportunities under HR001117S0003.

D. Submission Checklist

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

✓	Item	BAA Section	Applicability	Comment
	Abstract	IV.B.1	Optional, but recommended	Conform to stated page limit. Address only one TA per abstract submission.
	Obtain DUNS number	IV.B.2.a.i	Required of all proposers	The DUNS Number is the Federal Government's contractor identification code for all procurement-related activities. See http://fedgov.dnb.com/webform/index.jsp to request a DUNS number. Note: requests may take at least one business day.
	Obtain Taxpayer Identification Number (TIN)	IV.B.2.a.i	Required of all proposers	A TIN is used by the Internal Revenue Service in the administration of tax laws. See 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).

	Register in the System for Award Management (SAM)	VI.B.4	Required of all proposers	The SAM combines Federal procurement systems and the Catalog of Federal Domestic Assistance into one system. See www.sam.gov 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).
	Ensure representations and certifications are up to date	VI.C.2	Required of all proposers	Federal provisions require entities to represent/certify to a variety of statements ranging from environmental rules compliance to entity size representation. See http://www.sam.gov for information.
	Ensure eligibility of all team members	III	Required of all proposers	Verify eligibility, as applicable, for in accordance with requirements outlined in Section 3.

The following items apply as part of the submission package:

✓	Item	BAA Section	Applicability	Comment
	Volume 1 (Technical and Management Proposal)	IV.B.2.a	Required of all proposers	Conform to stated page limits and formatting requirements. Include all requested information.
	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

E. Associate Contractor Agreement Clause (ACA)

This same or similar clause will be included in contract awards against HR001117S0003. Awards other than FAR based contracts will contain similar agreement language:

(a) It is recognized that success of the Synergistic Discovery and Design research effort depends in part upon the open exchange of information between the various Associate Contractors involved in the effort. This clause is intended to ensure that there will be appropriate coordination and integration of work by the Associate Contractors to achieve complete compatibility and to prevent unnecessary duplication of effort. By executing this contract, the Contractor assumes the responsibilities of an Associate Contractor. For the purpose of this clause, the term Contractor includes subsidiaries, affiliates, and organizations under the control of the contractor (e.g., subcontractors).

(b) Work under this contract may involve access to proprietary or confidential data from an Associate Contractor. To the extent that such data is received by the Contractor from any Associate Contractor for the performance of this contract, the Contractor hereby agrees that any proprietary information received shall remain the property of the Associate Contractor and shall be used solely for the purpose of the Synergistic Discovery and Design research effort. Only that information which is received from another contractor in writing and which is clearly identified as proprietary or confidential shall be protected in accordance with this provision. The obligation to retain such information in confidence will be satisfied if the Contractor receiving such information utilizes the same controls as it employs to avoid disclosure, publication, or dissemination of its own proprietary information. The receiving Contractor agrees to hold such information in confidence as provided herein so long as such information is of a proprietary/confidential or limited rights nature.

(c) The Contractor hereby agrees to closely cooperate as an Associate Contractor with the other Associate Contractors on this research effort. This involves as a minimum:

(1) maintenance of a close liaison and working relationship;

(2) maintenance of a free and open information network with all Government-identified associate Contractors;

(3) delineation of detailed interface responsibilities;

(4) entering into a written agreement with the other Associate Contractors setting forth the substance and procedures relating to the foregoing, and promptly providing the Agreements Officer/Procuring Contracting Officer with a copy of same; and

(5) receipt of proprietary information from the Associate Contractor and transmittal of Contractor proprietary information to the Associate Contractors subject to any applicable proprietary information exchange agreements between associate contractors when, in either case, those actions are necessary for the performance of either.

(d) In the event that the Contractor and the Associate Contractor are unable to agree upon any such interface matter of substance, or if the technical data identified is not provided as scheduled, the Contractor shall promptly notify the DARPA Synergistic Discovery and Design Program

Manager. The Government will determine the appropriate corrective action and will issue guidance to the affected Contractor.

(e) The Contractor agrees to insert in all subcontracts hereunder which require access to proprietary information belonging to the Associate Contractor, a provision which shall conform substantially to the language of this clause, including this paragraph (e).

(f) Associate Contractors for the Synergistic Discovery and Design research effort include:

Contractor	Technical Area

(end of clause)

F. Challenge Problem Examples

Example Design Challenge Problem 1

The following series of design challenges, if successfully addressed, will provide the foundation to build complex biological circuits across many organisms and contexts. Rapid design of circuits in novel organisms could enable future DoD relevant capabilities such as detection and absorption of nuclear waste in various environments.

Phase 1: Reproduce a 4 input AND gate across 3 different lab environments in one organism. Ensure that the AND gate continues to function predictably for at least 10 days in at least 80% of experiments.

Phase 2: Create at least 3 different logic gates (one of which must be a NAND or NOR gate) with more than 2 inputs that function predictably in at least 2 organisms across 3 different lab environments.

Phase 3: Create a comprehensive set of logic gates (e.g., AND, OR, NOT, NAND, NOR, XOR, and XNOR) as separate constructs and make them function predictably in at least 5 different organisms across 3 different lab environments.

Example Design Challenge Problem 2

The following series of design challenges, if successfully addressed, will provide the foundation for fully synthetic pathways in multiple organisms across a variety of environmental contexts. Rapid pathway design could enable future DoD relevant capabilities such as a synthetic immune response pathway for epidemic prevention.

Phase 1: Use existing parts libraries (e.g., IGEM) and the genome of *Escherichia coli* to design a biological circuit that will have no off target effects and replicate across 3 different lab environments.

Phase 2: Design a biological circuit based on a pathway with at least 5 genes to function predictively in 3 different organisms, one of which must be prokaryotic and eukaryotic and replicate across 3 different lab environments.

Phase 3: Design a biological circuit based on a pathway with at least 30 genes to function predictively in 10 different organisms, 5 of which must be eukaryotic and replicate across 3 different lab environments.

Example Discovery Challenge Problem

Identify critical design variables that impact design success rates. Identify operational envelopes that ensure robust design performance, and note any environmental contexts that induce a state change in the organism.

Dr. Jennifer M. Roberts
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Information Innovation Office (I2O)
DARPA
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Jennifer.roberts@darpa.mil ?

Biosketch:
Dr. Jennifer Roberts joined DARPA as a program manager in 2015.
Prior to joining DARPA, Dr. Roberts worked at Aptima and led an intercompany team of data scientists, software developers and cloud experts to create scalable analytics for network defense. Her team's analytics sought to distinguish routine behaviors from suspicious activities and attacks in datasets with billions of events.

	Research Scientist, Aptima
Nov 2010 – May 2011	Associate Research Scientist, Aptima, Inc.

Education
PhD in computer science and engineering from MIT in 2010
MS in electrical engineering and computer science from MIT
BS in electrical engineering and computer science from the Univ of Md, College Park.

Program:
Her principal research interests include scalable analytics and machine learning algorithms that yield insights to human users. Applications of interest include cyber, genetics and human cognition.

Current Projects

Synergistic Discovery and Design HR001117S0003
The SD2 program aims to develop data-driven methods to accelerate scientific discovery and robust design in domains that lack complete models. Engineers regularly use high-fidelity simulations to create robust designs in complex domains such as aeronautics, automobiles, and integrated circuits. In contrast, robust design remains elusive in domains such as synthetic biology, neuro-computation, cyber, and polymer chemistry due to the lack of high-fidelity models. SD2 will develop tools to enable robust design despite the lack of complete scientific models.

Illustrative Publications Reflecting Personal Research Interests:
Bayesian networks for cardiovascular monitoring
Roberts, Jennifer M.; Parlikar, Tushar A.; Heldt, Thomas; et al.
2006 28th Annual International Conf of the IEEE Engineering in Medicine and Biology Society Vol 1-15, 5471-5475 2006

Use-Driven Concept Formation
Roberts, Jennifer M
PhD Dissertation, Massachusetts Institute of Technology, 2010