



**Broad Agency Announcement**  
**Persistent Aquatic Living Sensors (PALS)**  
**BIOLOGICAL TECHNOLOGIES OFFICE**  
**HR001118S0027**  
**February 15, 2018**

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## PART I: OVERVIEW INFORMATION

- **Federal Agency Name** – Defense Advanced Research Projects Agency (DARPA), Biological Technologies Office
- **Funding Opportunity Title** – Persistent Aquatic Living Sensors (PALS)
- **Announcement Type** – Initial announcement
- **Funding Opportunity Number** – HR001118S0027
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  - Proposers Day – March 2, 2018

<https://www.fbo.gov/spg/ODA/DARPA/CMO/DARPA-SN-18-29/listing.html>
- **Concise description of the funding opportunity** – DARPA seeks innovative proposals for new systems that employ natural or engineered marine organisms as sensor elements to amplify signals related to the presence, movement, and classification of manned or unmanned underwater vehicles (M/UUV). The Persistent Aquatic Living Sensors (PALS) program will leverage or develop living organisms as sensor transducers, and pair them with a detector and analysis suite to produce deployable sensor systems able to provide timely information on vehicle activity across a wide variety of maritime environments.
- **Anticipated individual awards** - Multiple awards are anticipated.
- **Types of instruments that may be awarded** - Procurement contract, cooperative agreement or other transaction.
- **Agency contact**
  - Points of Contact  
The BAA Coordinator for this effort may be reached at:  
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## **PART II: FULL TEXT OF ANNOUNCEMENT**

### **1. Funding Opportunity Description**

This publication constitutes an announcement from the Defense Advanced Research Projects Agency (DARPA) for a Broad Agency Announcement (BAA) process, as defined in Federal Acquisition Regulation (FAR) 6.102(d)(2) and 35.016 and 2 CFR § 200.203. Any resultant award negotiations will follow all pertinent law and regulation, and any negotiations and/or awards for procurement contracts will use procedures under FAR 15.4, Contract Pricing, as specified in the BAA. Proposals received as a result of this BAA shall be evaluated in accordance with evaluation criteria specified herein through a scientific review process.

DARPA is soliciting innovative proposals for concepts that use naturally-occurring or engineered marine organisms as sensor elements in a system designed to provide persistent monitoring of manned and unmanned vehicle (M/UUV, e.g., submarines, semi-submersibles and/or unmanned underwater gliders or vessels) movement, particularly in shallow-coastal and littoral marine environments. Specifically, DARPA seeks to identify biological organism responses to M/UUVs and develop technology to characterize and synthesize the resulting behaviors and/or signals for use as input into a detector system. The integrated technology will comprise the biological organism's response coupled with detector hardware, software and algorithms to enable alert of the presence and movement of M/UUVs, as well as classification of size and class of the vehicle. Engineered organisms should only be used when naturally occurring organisms cannot improve upon capabilities over state of the art in terms of producing detectable signals with respect to standoff distance, feasible sensing time, and/or M/UUV classification. To the extent researchers do propose solutions that would tune organisms' reporting mechanisms, the proposers will be responsible for developing appropriate environmental safeguards to support future deployment. However, at no point in the PALS program will DARPA test modified organisms outside of contained, biosecure facilities.

#### **1.1. PROGRAM OVERVIEW**

Despite advances in sensor systems for submarine and underwater vehicle monitoring, spatial and temporal coverage of maritime environments still suffer from numerous gaps. In particular, due to a combination of high manpower requirements, lack of persistence, the need for short endurance or ship/shore-based power sources, and the often noisy or cluttered environments, current maritime procedures often employ sensor suites at the tactical level to protect high value assets, rather than at the strategic level, to maintain overall situational awareness. Furthermore, smaller targets, in particular, unmanned underwater vehicles, are exceedingly difficult to detect using current active or passive sonar technologies from any meaningful standoff distance.

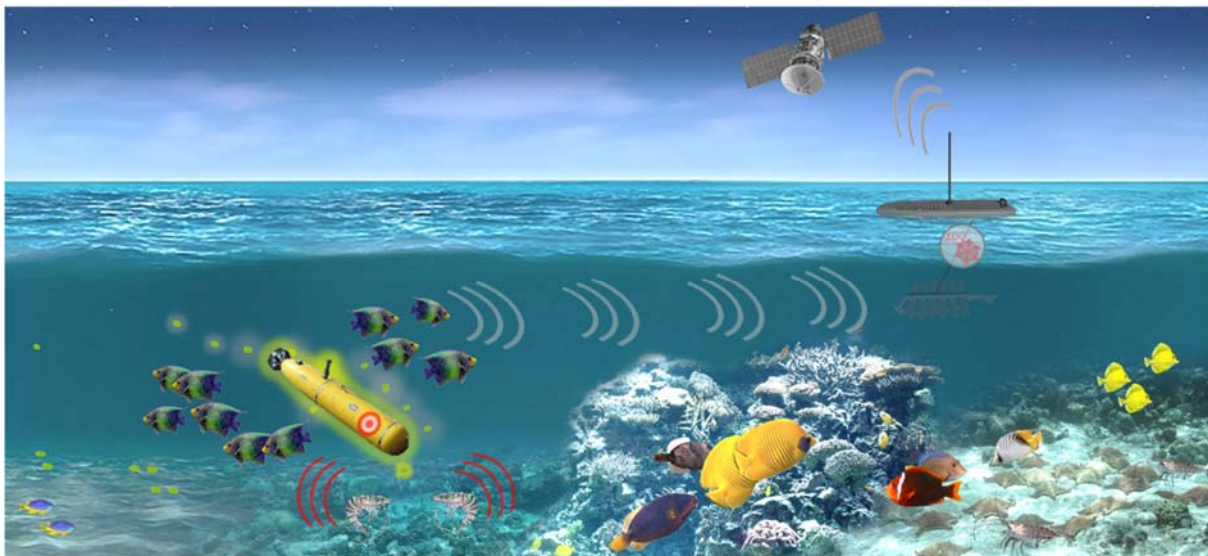
Marine organisms — or natural ‘sensors’ — shaped by millions of years of evolution, abound in the world's oceans. The sensory and behavioral characteristics of these biological organisms are routinely overlooked, often treated as noise by man-made sensor users. For example, sonar operators often complain about the strong signals of snapping shrimp in reef environments, disrupting their ability to listen for targets of interest. Biological sensors occupy every maritime environment and have evolved multi-modal sensing capabilities across many domains— electrical, acoustic, optical (including in extremely low light), magnetic, chemical, and even

tactile, in the form of mechanoreceptors capable of detecting and triangulating minute changes in fluid flow as well as sources of disturbances.

The Persistent Aquatic Living Sensors (PALS) program aims to leverage the biological maritime ecosystem across a wide array of marine environments, particularly in the shallow-coastal and littoral regions, to find M/UUV targets (*Table 1*). It aims to transform existing biology, historically characterized as background noise, into highly content-rich biological signals that can be interpreted to track, classify, and report on the presence of M/UUVs. Performers on the PALS program may consider organisms from bacteria through macro-organisms, as well as multi-organism interactions, and will:

- (1) Characterize the biological signal: engineer and/or reproducibly observe, understand, and model behavioral response of biological organisms to M/UUVs and confounder objects, including discriminations of like-sized objects at multiple scales.
- (2) Interpret the biological signal: detect observed unique biological signals and translate these into actionable alert information.

The PALS effort requires two stages of sensing. In the first stage, the biological organisms sense the intrusion of an M/UUV or confounder into their environment and respond with an output signal or observable behavior. In the second stage, a man-made detector system captures and interprets the unique biological signal or behavior generated by the organism(s), making an analyzed result available in the form of distilled alerts. These components will be integrated into demonstrator systems, which are able to be deployed in a maritime environment and capable of end-to-end system performance through delivery of alerts via commercial satellite link. A notional depiction of this overall vision is shown in *Figure 1*. Ultimately, PALS systems will offer long-endurance, widespread sensory coverage in multiple maritime environments, augmenting and enhancing current detection capabilities.



**Figure 1:** PALS program vision for manned/unmanned underwater vehicle detection using an amplifying biological signal transducer and associated detector, signal processor, and exfiltration platform.

**1.1.1. Organisms, Targets, and Environments**

Proposers are expected to enumerate the anticipated details of their system capability; specifically, the organisms they intend to use, their target set, and the geographical region(s) associated with the overall system deployment, including both the Technical Area 1 presence as well as Technical Area 2 hardware functionality. Detailed information on each technical area is provided below.

Proposers may choose from any marine organism to serve as their living sensor. Viable categories of organisms are as follows: single or clustered organisms (e.g., a fish or a school of fish), populations of organisms (e.g., a reefscape), micro-organisms, or engineered organisms (e.g., genetically modified bacteria). The organism selected must demonstrate a pronounced and characterizable response to M/UUV presence and must be called out in sufficient detail at the time of proposal to assess the likelihood of success.

PALS systems must be capable of identifying and discriminating some (or all) of the following target types or classes: 1) small Unmanned Underwater Vehicles (UUVs) with minimum dimensions (DxL) of 0.3 meters x 2.7 meters, 2) semi-submersible manned underwater vehicles with minimum dimensions (DxL) of 2.0 meters x 12 meters, *or* signatures (e.g., chemical, biological, optical, acoustic) associated with the construction or operation of same, 3) fully-submersible manned vehicles (aka submarines) with minimum dimensions (DxL) 2.0 meters x 30 meters up to and including nuclear-powered ballistic missile, and nuclear- or diesel-electric-powered attack submarines. Preference will be given to approaches that accurately identify and discriminate the smallest size class targets listed above.

Proposers must also identify the environment or environments where their system will be deployed, taking into consideration the prevalence of their target biological sensory organism(s), as well as the operational characteristics of these environments. Allowable operating environments are shown in *Table 1* and must be at least five (5) meters in depth.

**Table 1:** Environment characteristics

<b>Environment</b>	<b>Characteristics</b>
Reef	Low turbidity, shallow depths, and strong light penetration in salt water
Strait	Variable turbidity and light penetration in salt water
River outflow/estuary	High turbidity in brackish water
Continental shelf/other	Greater depths, lower light penetration, and large coverage areas in salt water

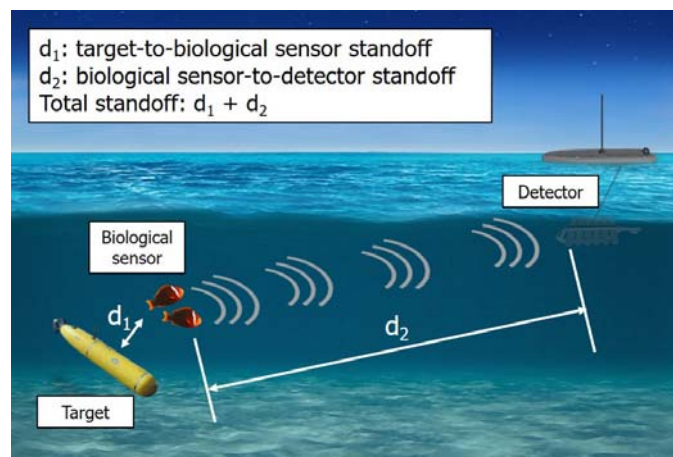
**1.1.2. Technical Approach**

The program is comprised of two technical areas (TAs). Performer teams must propose to both TAs jointly in order to produce fully integrated systems. The functionality of the integrated system will be assessed on demonstrations in maritime environments of increasing complexity. Proposals that do not respond to both TAs will be deemed non-responsive.

***Technical Area 1: Characterize Biological Signal***

The aim of TA1 is to study natural organisms (or possibly employ synthetic biology solutions using engineered organisms) in order to distinguish and produce detectable signals that can be observed and synthesized to produce accurate alerts of M/UUV presence. The signals are expected to generate a response that amplifies the weak signature of many M/UUV targets,

whether through direct gain amplification (acoustic signature of the organism is more pronounced than the target, for example), or through modulation to another domain with a signal that propagates further or is in some way easier to detect than the original M/UUV target signal. Synthetic biology may be pursued in order to enhance signal amplification, when necessary to achieve the proper system standoff. Experimental work on characterizing the natural biological organisms' responses and signal outputs can start in constrained lab and tank environments and move to progressively larger, more uncontrolled maritime environments to confirm the functionality at more realistic standoff distances. The critical distance is the total standoff distance (see Figure 2), and may be apportioned between the target, biological sensor (TA1 component), and man-made detector (TA2 component) in the manner chosen by the performer – organisms can be proximal to the target with detector hardware further away, or the organisms may be far from the target with detector hardware in close proximity.



**Figure 2:** Standoff definitions

Engineering of new organisms will be allowed only in cases where the engineered organism offers unique sensing modalities or where the biological signal gain needs to be amplified beyond the naturally occurring variant, such that it offers sufficient content to be readily detected and analyzed, and contingent upon having built-in safeguards to prevent release into the environment. A minimum of two safeguards (e.g., encapsulation, limited nutrient supply, sensitivity to salt water, etc.) must be included as part of the envisioned concept of operations, implying that the response to target occurs with the safeguards in place. All engineered organisms must remain entirely in secure biocontainment for the duration of the program. Engineered organisms will be tested in containment but must be designed to be deployable in the ocean without causing any deleterious effects to the environment.

In order to achieve success, performer teams will have to systematically examine their selected organisms at multiple scales (1, 10, 100, and 500 meters) and against multiple test objects (some or all of the targets defined in Section 1.1.1, with similarly sized confounders), and map very precise response functions onto target and confounder presence, reflecting a well-defined interpretation of the biological organism as a sensor transducer. This will require developing an understanding of signal roll-off as a function of organism distance to target objects, and as a function of detector distance to the organisms.



Proposers must select and justify the organism(s) they plan to use when drafting a response, along with the biological signal(s) they intend to leverage. These organisms must demonstrate the modeled behaviors in their native ecosystem. As such, proposals requiring the transportation of the selected organisms to an environment where they are not naturally found will be deemed nonresponsive, with the exception of engineered organisms. Justification should include a discussion on the worldwide prevalence of their selected organism(s), along with the transferability/heritability of the biological signals to be leveraged in different globally encountered species, genotypes, etc., essential for the functionality of the system in different maritime environments.

### ***Technical Area 2: Interpret the Biological Signal***

The aim of TA2 is to detect the observed unique biological signals from TA1, and translate these into actionable information. This will require the development of the hardware, software and algorithms necessary to detect the biological organism signals; capture their unique response signals to M/UUV targets; classify the patterns associated with these responses; and use these classifications to produce distilled alerts consisting of a target's size, type, location and bearing. Commercial off-the-shelf host platforms must be used (see additional detail on available space, weight, and power in Appendix 2), but the detector hardware may involve novel designs in order to best capture the specific features of biological signals provided by the TA1 teams. TA2 development will occur at the same scale as TA1 research – if the organism is able to be tested in a constrained tank, the TA2 work can leverage these tanks, but larger or more distributed organisms will dictate that TA2 development be performed in more unconstrained environments. The list of tasks to be performed by phase is presented in *Table 2*.

Responses to TA2 must include development of an analytical detector system able to capture and interpret the biological signal, and ensure adequate detection platform endurance. The organism defined in TA1 should provide a signal that can be captured by sensory equipment from TA2, with detail provided in Appendix 2. Performer teams must work across program phases to progressively mine more content from the biological signal, starting with object detection and ultimately working towards target classification and bearing. Software performer teams will have to increase their processing efficiency to conserve power, either through innovative code development or by leveraging industry advances over the course of the program, to support the final endurance targets.

Based on the desire to leverage the inherently ubiquitous, self-replicating nature of biological organisms as part of the overall PALS component design, TA2 hardware should not rely on manually intensive integration between the detector and the biological organism(s). Therefore, proposals involving the use of manually attached tags will be viewed less favorably than those employing proximal or remote sensing of the biological organism(s) and their behaviors. Priority will be given to systems that harness biological organisms' ability to persistently monitor large areas of ocean more effectively than current systems, with hardware solutions that are low-profile and of suitable at-sea duration. Increasing the endurance of the detection system throughout the program is an important metric for program success.

#### **1.1.3. Program Phases**

The program will be divided into three phases, which are designed to successively build upon results of previous phases. Phases will mature the end-to-end system concept by first identifying



the core biological and non-biological components, understanding system performance through quantitative testing, and progressively migrating to more challenging maritime environments in order to produce long-endurance, operationally relevant systems. At the conclusion of each program phase, testing will be conducted to confirm that each subsystem (Phase 1) or full system (Phases 2 and 3) performs as required per the specifications outlined in Section 1.2. Specifically, independent validation and verification (IV&V) testing will be conducted by a third-party organization, to be identified and retained by DARPA. This third-party IV&V organization will be responsible for establishing and executing the testing protocols and procedures in accordance with the metrics outlined in Section 1.2, with supervision from DARPA.

The three program phases will have a total duration of forty-eight (48) months. Phase 1 will be eighteen (18) months, Phase 2 will be eighteen (18) months, and Phase 3 will be twelve (12) months. At the conclusion of Phase 1, performer down-selections will occur, with continued funding being contingent upon a system’s ability to meet the required metrics and present a solid development plan for the remainder of the program, as outlined in Section 1.2. The major tasks and objectives for the program, organized by phase and TA, are provided below, in *Table 2*, and are discussed in more detail in the following subsections. A calendar of overall program events is outlined in *Figure 3*.

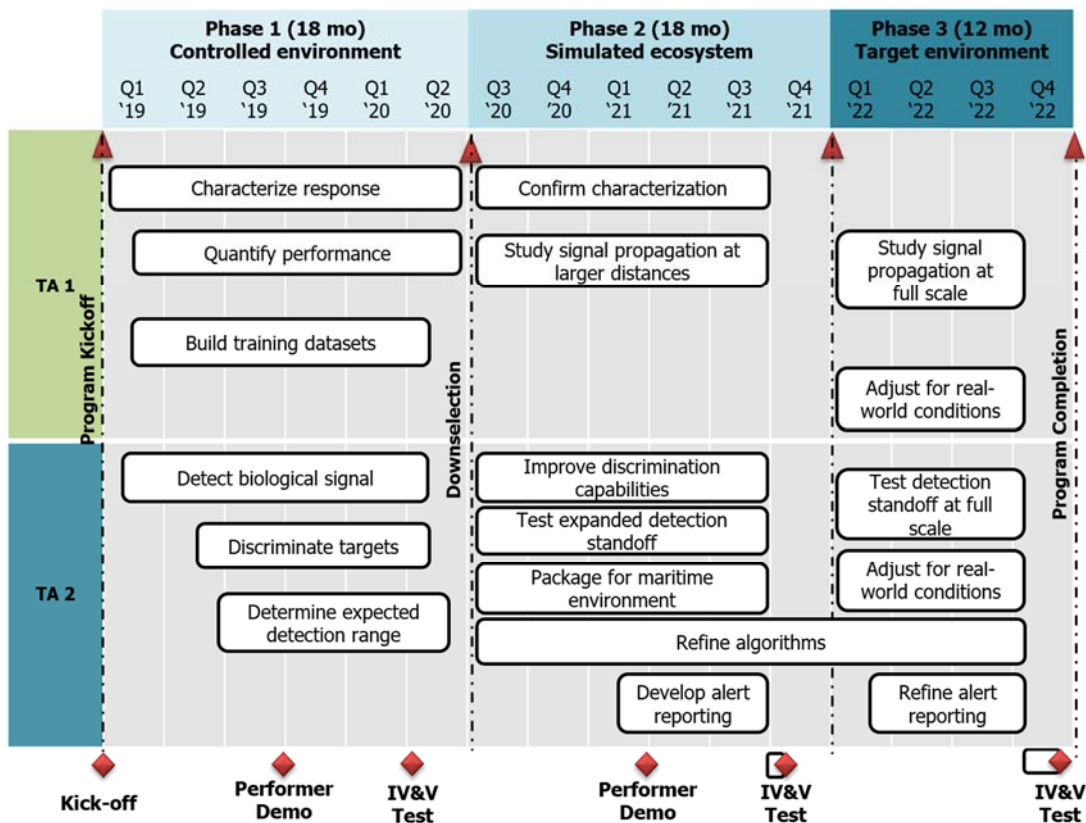


Figure 3: Gantt chart of major test activities by phase, with notional quarters (calendar year designation) and tasking by technical area

**Table 2:** Tasks by phase and technical area

<b>Phase</b>	<b>Technical Area 1</b>	<b>Technical Area 2</b>
<b>Phase 1 (18 months)</b>	<ul style="list-style-type: none"> <li>• Characterize organism response to M/UUVs and confounder objects</li> <li>• Confirm target signal propagation for 1 and 10 m total standoff distances (Metrics, <i>Table 3</i>)</li> <li>• Build training datasets of organism responses</li> </ul>	<ul style="list-style-type: none"> <li>• Detect biological signals in response to targets</li> <li>• Discriminate M/UUV targets from confounders</li> <li>• Determine expected operational system standoff</li> </ul>
<b>Phase 2 (18 months)</b>	<ul style="list-style-type: none"> <li>• Confirm target signal propagation to biological sensor for 10, 100 and 500 m total standoff (Metrics, <i>Table 3</i>)</li> <li>• Confirm characterization of biological signal at required standoff</li> <li>• Test biological sensors in more realistic environment</li> </ul>	<ul style="list-style-type: none"> <li>• Confirm biological signal propagation to detector for 10, 100 and 500 m total standoff (Metrics, <i>Table 3</i>)</li> <li>• Package hardware for maritime environment</li> <li>• Refine algorithms at required standoff</li> <li>• Develop alert reporting scheme</li> </ul>
<b>Phase 3 (12 months)</b>	<ul style="list-style-type: none"> <li>• Optimize target characterization and discrimination by biological sensor at 100 and 500 m total standoff (Metrics, <i>Table 3</i>)</li> </ul>	<ul style="list-style-type: none"> <li>• Adjust algorithms for real-world conditions</li> <li>• Refine alert reporting tolerances</li> </ul>

### ***Phase 1***

During Phase 1, performer teams will (1) evaluate the candidate organism and biological signal; (2) characterize the organism response to the target(s); (3) develop and test the detection algorithm in a laboratory or near-shore environment; and (4) demonstrate successful observation and/or creation of the biological signal, with appropriate target discrimination (see Milestones and Deliverables by Phase, *Table 4*). Testing may be done in a laboratory or, for non-synthetic biology approaches, in the near-shore environment. In early Phase 1 tests, targets will be presented at a greatly reduced standoff in order to maximize the gain on the target signal. Phase 1 will contain a technical interchange meeting (TIM) across technical area groups, preliminary design reviews (PDRs) for both technical areas, and a critical design review (CDR) for the TA2 prototype.

Nine months from the formal program kickoff, performers will have a mid-phase demonstration to test their detection scheme concepts in a tank or shallow coastal environment, using benchtop laboratory instrumentation. Performers will demonstrate that their system identifies and collects the intended target signal, produces a unique biological signal in response to the targets enumerated in Section 1.1.3, and processes this signal to indicate the presence of an M/UUV. This demonstration must prove that the prototype components offer the ability to differentiate M/UUV from confounder, including different man-made objects, environmental / organism clutter, and acoustic interference. Teams must demonstrate this ability at a total standoff of 1 meter. At month 15, performers will support an end-of-phase test and evaluation exercise managed by the IV&V team. This test must demonstrate the ability to detect 95% of all M/UUV targets with metrics outlined in *Table 3*. Performers will receive test results from the IV&V team by the end of month 15, and must deliver a report in month 16 containing the results and discussion of IV&V testing, as well as the proposed path to reaching metrics for Phases 2 and 3.

Performer teams who are engineering their own organisms must be able to demonstrate successful enhancement of a target signal for their organism compared to naturally-occurring variants of the organism in a controlled setting, in addition to interpreting these signals as outlined in Phase 1 and meeting the metrics as shown in *Table 3*. They are expected to host the mid-phase demonstration and support the IV&V end-of-phase test as described above.

## ***Phase 2***

In Phase 2, performers will continue to refine their models of organism behavior under more realistic conditions (complexity and scale), and develop and refine the hardware and software components that are required to detect and interpret the targeted biological signal(s) (see *Table 4*). TA1 teams will study the interactions of their organisms with both targets and confounders to develop models of behavioral differences, performed in larger and more complex environments to produce more complete datasets. Meanwhile, TA2 performers will develop their detection and analysis system to fit onto a commercial off-the-shelf (COTS) platform, such as a buoy. The space, weight, and power available for system components are presented in Appendix 2, which includes considerations for system components designed for operation from the seafloor. Phase 2 will include a technical interchange meeting (TIM) across technical areas, as well as preliminary and critical design reviews (PDR / CDR) for the TA2 system. Performers will undertake large seawater tank or aquarium-style simulated ecosystem or marine tests using their integrated system to improve detection and confidence levels and to demonstrate performance in a larger, more realistic environment. The simulated ecosystem must resemble the target environment as closely as possible to enable performers to adequately discriminate the target from naturally occurring confounders. Performers must use experimentally derived data to produce a receiver operating characteristic (ROC) curve on overall system performance, illustrating the performance trade-off between false alarm and target detection. Performers will provide their ROC curves as a living document to be refined during Phase 3, including open-ocean testing, and must present a risk table that identifies the confounder organisms and/or phenomena that are most likely to interfere with identification of the M/UUV target in open ocean tests, along with a mitigation strategy for each. They will also host a mid-phase demonstration to confirm their progress.

The overall system will need to report on target size and bearing, and must deliver alerts within ten minutes of detection by the TA2 hardware. A packaged hardware system must be provided to the IV&V team for a 30-day maritime deployment test during which the hardware must operate without intervention (detail in Section 1.2). In addition, performers are expected to support an end-of-phase IV&V test event, which will ensure that all metrics (*Table 3*) are met.

Performer teams who are engineering their own organisms must be able to demonstrate systems (e.g., discriminate target from confounders, larger standoff distances) consistent with Phase 2 metrics, milestones, and deliverables in a biocontainment facility. Teams working with engineered organisms must also demonstrate their two safeguard systems by the end of Phase 2, in advance of large-scale testing in Phase 3.

## ***Phase 3***

In the final phase, teams must migrate their system to an uncontrolled marine environment, and increase their total standoff and system endurance significantly. The Phase 3 development

environment must naturally contain the organisms or ecosystems that the teams intend to use as their biological sensing elements, with the exception of synthetic biology approaches. Teams must demonstrate that their systems satisfy the metrics shown in *Table 3*, including testing out to 500 meters total standoff, while handling more confounding targets as would be found in real-world deployment (see Milestones and Deliverables by Phase, *Table 4*). TA1 teams will focus on enhancing their behavioral models and testing the organism responses at the increased standoff, while TA2 teams will focus on receipt of biological signal, increased computational efficiency, and more accurate reporting detail. Performer teams who are engineering their own organisms will continue to work in constrained environments using their two environmental safeguards, but will also need to demonstrate increased sensitivity and specificity at 100 m in the presence of confounders. The final integrated hardware and software must maintain a 60-day endurance in a marine environment at a duty cycle of one measurement every thirty minutes. At the conclusion of Phase 3, performers will support end-of-phase testing managed by the IV&V team in a marine environment, will confirm that all metrics (*Table 3*) are met.

## 1.2. PROGRAM METRICS

In order for the Government to evaluate the effectiveness of a proposed solution in achieving the stated program objectives, proposers should note that the Government hereby promulgates the following program metrics that may serve as the basis for determining whether satisfactory progress is being made to warrant continued funding of the program. Continued funding for each subsequent phase is contingent upon meeting or exceeding the metrics prescribed for the current phase. Although the following program metrics are specified, proposers should note that the Government has identified these goals with the intention of bounding the scope of effort, while affording the maximum flexibility, creativity, and innovation in proposing solutions to the stated problem, to include variations in performance across the target class size.

The metrics identified for this program were designed with the intent to encourage and drive creative and innovative solutions that lead to incremental increases in the understanding of the biological responses being exploited, and the utility of these signals in the detection and discrimination of potential targets over the course of the program. Further, these metrics serve to increase the suitability and effectiveness of the overall detection system. The metrics identified, for each TA, apply to the system in its entirety, and will require that both TA-specific objectives are met in order for the metrics to also be successfully met. Only successful completion of both TAs will be considered successful completion of a given phase. Overarching program metrics are outlined in *Table 3*.

**Table 3:** Program metrics

<u>Metric</u>		<u>Phase 1</u>	<u>Phase 2</u>	<u>Phase 3</u>
Object Detection at System Standoff <sup>1</sup>		95% at 1 meter	95% at 10 meters	95% at 100 meters
Sensitivity (TP/P)	1 meter	0.60	N/A – Not Tested	N/A-Not Tested
	10 meters	0.25	0.90	N/A – Not Tested
	100 meters	N/A – Not Tested	0.70	0.90
	500 meters <sup>2</sup>	N/A – Not Tested	0.25	0.70
Specificity (TN/N)	1 meter	0.60	N/A – Not Tested	N/A-Not Tested
	10 meters	0.25	0.90	N/A – Not Tested
	100 meters	N/A – Not Tested	0.70	0.90
	500 meters <sup>2</sup>	N/A – Not Tested	0.25	0.70
Hardware endurance		N/A	30 Days	60 Days
Report timeliness <sup>3</sup>		N/A	10 Minutes	5 Minutes
Report content		Target size	Target bearing +/- 22.5	Target bearing +/- 15

1. System standoff is the sum of target-to-organism distance and organism-to-detector distance, defined in *Figure 2*. 2. Teams using genetically modified organisms must follow all metrics in a constrained environment and will only test out to 100 m. 3. “Timeliness” is defined as the amount of time elapsed between detection of a potential target (i.e. by the man-made detector) and the system’s discrimination between a target and a confounder and the issuance of an alert, when appropriate.

The object detection metric will require that 95% of all presented objects, both M/UUV and similarly size confounders, trigger a response from the biological sensor and a subsequent detection from the TA2 system, across all three size classes presented in [Section 1.1.1](#), at the distances presented in *Table 3*. When the presentation of actual targets is not feasible (for example, use of a full-sized manned submarine), the IV&V team will utilize a surrogate target able to produce a similar signal intensity at the specified distance, with this surrogate target mutually agreed upon between DARPA, the IV&V team, and the performer as based on organism and detector phenomenology employed.

Sensitivity and specificity metrics refer to the overall system’s ability to accurately capture the correct signals and reject erroneous signals (false alarms, including both improperly classified confounder objects as well as alerts when no objects are present). Both parameters will be calculated by the IV&V team as part of their end-of-phase test analysis. The detailed calculation of these metrics is presented in Appendix 3. The metrics presented are for the smallest targets to be identified by the proposed system, with the expectation that standoff will vary with target size. DARPA expects performers to propose detail on the distance where their sensitivity and specificity may fall below (or exceed) the metrics provided for different sized targets, and will consider that in the evaluation process.

For hardware endurance metrics, one full copy of the TA2 detector and alerting system will be surrendered to the Government IV&V team, to be deployed into a controlled seawater environment for the durations specified in *Table 3*. The system will not be presented with actual M/UUV targets during this testing window, but rather will be pre-configured by the TA2 team to be presented with a simulated biological sensor alert consisting of pre-recorded data that is known to engage the entire processing pipeline of the TA2 detector and alerting systems, once every 2 hours. The system will be continuously sensing as if it were operationally deployed, and should send alerts of simulated target detection throughout the test in order to demonstrate

continued functionality. Upon conclusion of the test window, the system must be fully functional, as demonstrated by the IV&V team.

The reporting timeliness metric is intended to ensure near real-time processing of the biological signals by the detector system, as opposed to extensive post-processing. Furthermore, some organisms may demonstrate a response with cumulative effects, which reach a threshold level for emitting a detectable signal that has a slow time constant. Therefore, the calculation of the timeliness metric is defined as the time from receipt of the biological signal at the detector system to the time that an alert is sent via satellite link to the system user. The IV&V team will coordinate with performers to determine the best manner in which to timestamp the detector system receipt time.

Alert reporting content must contain basic information in all phases of the program – timestamp, detector GPS location, and target object size (from the 3 bins of sizes outlined in Section 1.1.1). In addition, in Phases 2 and 3, the system must include a detected object’s bearing from the detector system, with precision requirements called out in *Table 3*.

Proposals should cite the quantitative and qualitative success criteria that the effort will achieve by the time of each phase’s program metric measurement.

### **1.3. PROGRAM MILESTONES AND DELIVERABLES**

In addition to the specific metrics outlined in sub-section 1.2 above, the following milestones must be provided. These milestones are specific to each TA and phase, and reaching these milestones will facilitate overall, successful completion of the requirements for this program. These milestones, along with the corresponding deliverables, are identified in *Table 4*.

**Table 4: Milestones and deliverables by phase**

<b>Phase</b>	<b>Technical Area</b>	<b>Milestones</b>	<b>Deliverables</b>
<b>Phase 1 (18 Months)</b>	<b>Tech Area 1</b>	<ul style="list-style-type: none"> <li>• Technical interchange meeting 1</li> <li>• Preliminary design review of organism selection / engineering</li> <li>• Characterize response of organism(s) to target or target proxy</li> <li>• Produce training data sets for TA2 algorithm development</li> <li>• Host mid-phase demonstration</li> <li>• Facilitate IV&amp;V test to quantify detection performance and target discrimination at 1 and 10 m standoff</li> <li>• For engineered organisms only: demonstrate superior performance over naturally occurring organisms</li> </ul>	<ul style="list-style-type: none"> <li>• For engineered organisms only: Month 2: Phase 1 organism design</li> <li>• Month 7: Mid-Phase Demonstration test plan</li> <li>• Month 10: Mid-Phase Demonstration report (30 days after demo)</li> <li>• Month 12: Report containing risk table and mitigation plan</li> <li>• Month 16: Report on Phase 1 IV&amp;V test results and Phase 2 task plan (30 days after test)</li> </ul>
	<b>Tech Area 2</b>	<ul style="list-style-type: none"> <li>• Preliminary design review of hardware/software prototypes</li> <li>• Critical design review of hardware/software prototypes</li> <li>• Demonstrate benchtop hardware and software developed to perform detection</li> <li>• Construct initial algorithm to discriminate target signal from noise</li> <li>• Generate design for packaged system to be constructed in Phase 2</li> </ul>	<ul style="list-style-type: none"> <li>• Month 6: Final prototype design</li> <li>• Month 15: One (1) prototype system of biological organisms and necessary hardware / software to detect biological signals provided to IV&amp;V team</li> <li>• Month 16: Code report on algorithms used to characterize biological signal</li> </ul>
<b>Phase 2 (18 Months)</b>	<b>Tech Area 1</b>	<ul style="list-style-type: none"> <li>• Technical interchange meeting 2</li> <li>• Characterize organismal response to target in presence of confounders</li> <li>• Produce training data sets in simulated ecosystem environment</li> <li>• Host mid-phase demonstration</li> <li>• Facilitate IV&amp;V test for sensitivity and specificity at 10, 100 and 500 m</li> <li>• For engineered organisms only: demonstrate 2 safeguard systems</li> </ul>	<ul style="list-style-type: none"> <li>• Month 20: Environmental assessment and permit documents</li> <li>• Month 24: Mid-phase demonstration plan</li> <li>• Month 28: Mid-phase demonstration report</li> <li>• Month 32: Report containing the ROC curve and risk table with mitigation plan</li> <li>• Month 35: Report on Phase 2 IV&amp;V test results and Phase 3 task plan (30 days after demo)</li> </ul>
	<b>Tech Area 2</b>	<ul style="list-style-type: none"> <li>• Preliminary design review of hardware/software system</li> <li>• Critical design review of hardware/software system</li> <li>• Construct refined algorithms based on simulated ecosystem data</li> <li>• Package hardware system for 30-day marine endurance test</li> <li>• Develop target bearing algorithm</li> <li>• Produce alert reporting scheme</li> </ul>	<ul style="list-style-type: none"> <li>• Month 24: Phase 2 system design</li> <li>• Month 34: Provide two (2) fully integrated systems to IV&amp;V team for endurance and performance testing</li> <li>• Month 35: Updated code report on algorithms used to characterize biological signal</li> </ul>



<u>Phase</u>	<u>Technical Area</u>	<u>Milestones</u>	<u>Deliverables</u>
<b>Phase 3 (12 Months)</b>	<b>Tech Area 1</b>	<ul style="list-style-type: none"> <li>• Technical interchange meeting 3</li> <li>• Characterize organismal response to target in real world environment</li> <li>• Facilitate IV&amp;V tests for sensitivity and specificity at 100 and 500 m</li> </ul>	<ul style="list-style-type: none"> <li>• Month 38: Updated environmental assessment and permit documents</li> <li>• Month 47: Final report on IV&amp;V test results (30 days after test)</li> </ul>
	<b>Tech Area 2</b>	<ul style="list-style-type: none"> <li>• Produce or adapt hardware for 60-day endurance test</li> <li>• Develop refined algorithms based on real world environment data</li> <li>• Develop improved bearing scheme</li> <li>• Produce improved alert reporting scheme</li> </ul>	<ul style="list-style-type: none"> <li>• Month 45: Provide two (2) fully integrated systems to IV&amp;V team for endurance and performance testing</li> </ul>

#### 1.4. PROGRAM DEMONSTRATIONS

In order to ensure that appropriate progress is being made towards meeting the prescribed metrics, teams will be required to demonstrate their systems—or, when applicable, specific sub-systems—to the Government, at pre-defined times during and/or just prior to the conclusion of a given program phase. Each demonstration or test will have a specific purpose related to the particular goals of the given phase, as described below.

##### *Phase 1*

###### Midterm Demonstration

At the midpoint of Phase 1 (i.e. no later than month 9), a benchtop/laboratory-scale demonstration will be hosted by the performer. Teams will be required to present the initial results of the efforts to characterize the biological signal of interest and must demonstrate the ability to identify M/UUV targets and discriminate target from confounder at the artificially-close standoff of one meter. By the time of the midterm demonstration, teams will be required to prove that a qualitatively unique biological signal is generated in response to a potential target, and that the signal generated in response to a man-made target is distinct from those generated by confounders (e.g., floating debris, marine life, etc.). These differences can occur in the signal content, timing, or any other domain suitable to recognize a distinction between an M/UUV and a confounder.

###### End-of-Phase IV&V Test

During month 15, each PALS approach will be tested, and systems must fully satisfy the Phase 1 metrics identified in *Table 3*. Testing will be performed by a third-party, independent verification and validation (IV&V) team, to be retained by the Government, and will be supported by the performer teams as-needed. The IV&V team will confirm that systems are capable of detecting and discriminating targets at multiple standoff distances, as identified in *Table 3*. Teams must surrender their hardware, software, and (if necessary) may hand over organisms to the IV&V team, to have them perform the testing.

**Phase 2****Midterm Prototype Demonstration**

At the midpoint of Phase 2 (i.e. no later than nine (9) months from Phase 2 start date), individual system prototypes will be demonstrated by the performer in a surrogate environment (large aquarium, salt water tank or coastal area), and must demonstrate improved sensitivity, specificity, and range from Phase 1 performance. The demonstration must present a clear path towards achieving the final Phase 2 targets. This demonstration will be hosted by the performer.

**End-of-Phase IV&V Testing and Demonstration**

Near the end of Phase 2, a test will be managed by the IV&V team and supported by the performer as-needed. For this event, two systems must be surrendered to the IV&V team to test performance against the Phase 2 metrics of *Table 3* – one system for endurance testing, and one for performance testing. Performance testing will be performed in a surrogate environment (aquarium, large salt water tank or coastal area). The system must also demonstrate that it can perform its intended functions during a 30-day endurance test in a marine environment. The DARPA team will coordinate with the IV&V team to determine an appropriate demonstration window during this testing, and may invite Government stakeholders to observe the event at their discretion. Teams with engineered organisms will be tested in constrained environments that simulate real-world conditions and must demonstrate both safeguards to the IV&V team in this constrained test environment.

**Phase 3**

At the conclusion of Phase 3, fully integrated systems will be tested by the IV&V team in a real-world, marine environment, and must be capable of detecting and discriminating targets and delivering operationally relevant alerts. For this event, two systems must be surrendered to the IV&V team to test performance against the Phase 3 metrics of *Table 3* – one system for endurance testing, and one for performance testing. Performer teams are expected to support the IV&V-led testing, as-needed. Engineered organisms will be tested in a controlled environment for total standoff distances as large as 100 meters, with environment to be identified by the IV&V team in close coordination with DARPA and the performer team. The system must also demonstrate that it can withstand a 60-day endurance test in a marine environment. DARPA will coordinate with the IV&V team to determine an appropriate demonstration window during system testing, and may invite Government stakeholders to observe the event at their discretion. There is no mid-phase demonstration in Phase 3.

**1.5. GENERAL REQUIREMENTS*****Proposing Teams***

It is expected that proposals will involve multidisciplinary teams that include expertise from multiple complementary disciplines (e.g., biology, chemistry, engineering, weak signals detection, machine learning, data science, analytics, oceanography, and physics).

Specific content, communications, networking, and team formation are the sole responsibility of the proposer teams. Proposer teams must submit a single, integrated proposal led by a single Program Integrator/Manager or prime contractor that addresses all program phases, as applicable.

DARPA will hold a Proposers Day (see Section 8, Other Information) to facilitate the formation of proposer teams with the expertise necessary to meet the goals of the program and enable sharing of information among interested proposers through the DARPA Opportunities Page and the Proposers Day registration website.

### ***Data Sharing***

DARPA anticipates that a large amount of data will be generated under this program by each performer and that the analyses and validation will be strengthened by compiling and integrating information across all performers. The PALS program will require that performer data, analysis, and software executables (or source code) be shared with DARPA, the IV&V team, and US Government stakeholders. Performers are strongly encouraged to establish the appropriate agreements to enable collaboration and data sharing beyond these organizations. DARPA encourages sharing of pre-existing data, including those generated through funding from other sources, although this is not a requirement of the program.

### ***Biocontainment/Bio Safety (Engineered Organisms)***

This program will support engineered biological research conducted in containment and will not support proposals that include uncontained environmental release of engineered organisms.

### ***Controlled Unclassified Information (CUI)***

To prevent the release of sensitive technical information, certain aspects of proposals may be considered CUI and may require safeguarding or dissemination controls, pursuant to and consistent with applicable laws, regulations, and Government-wide policies to include Department of Defense Manual 5200.01 Volume 4. CUI as defined is not classified under Executive Order 13526 or the Atomic Energy Act, as amended.

Common categories of CUI at DARPA include the following:

- Controlled Technical Information (CTI) - Distribution B through X;
- Export Controlled and International Traffic in Arms Regulations (ITAR);
- International Agreements;
- Privacy - Personally Identifiable Information (PII);
- Procurement & Acquisition - Proprietary Information;
- Procurement & Acquisition - Source Selection Sensitive;
- Law Enforcement Sensitive (LES); and
- DoD Category - For Official Use Only (FOUO).

Certain military technical information relating to the sensors and testing environment in real-world scenarios and relationships between both biological sensors and non-biological sensors and their targets could also be considered CUI by DARPA. Final determinations will be made on a case-by-case basis.

***Ship Time Request (if applicable)***

University-National Oceanographic Laboratory System (UNOLS)-based ship time will be paid for by DARPA, and should not be factored into performer budget estimates. However, to ensure adequate resourcing for this and to aid in evaluation, proposers must present ship time needs in their responses. These needs will not include ship time associated with the end-of-phase IV&V testing, as this ship time will be managed by the IV&V team instead of the performers. Based on the target environments listed in *Table 1*, Coastal/Local Class vessels should be sufficient for most project activities. Larger, as well as non-UNOLS, vessels may be considered at the discretion of the Government team. Ship time information is requested in the abstract submission as described in the instructions in section 4.2.1 (below – Proposal Abstract Format), and in the full proposals in the form of submitting a preliminary UNOLS ship time request (STR) to reserve the vessel(s) contingent on selection. To provide the UNOLS STR, select DARPA as the agency in the pulldown menu, add all other appropriate information, and manage the requests per the UNOLS process found at: [https://strs.unols.org/Public/diu\\_login.aspx](https://strs.unols.org/Public/diu_login.aspx). Non-UNOLS ship time should be factored into performer budgets.

***Permits and compliance***

It is the proposing team's responsibility to obtain all necessary federal, state, and local government permits and approvals, and abide by all applicable laws where necessary for the proposed work to be conducted. If work is to be conducted in international waters, all international laws must be followed. Proposing teams are expected to design their proposals so that they minimize the potential adverse impact on the environment. Proposals will be reviewed to ensure that they have sufficient environmental documentation to allow the Government team to determine whether the proposal is categorically excluded from further National Environmental Policy Act (NEPA) analysis, or whether an Environmental Assessment or Environmental Impact Statement is necessary in conformance with requirements of the NEPA. For those applications needing an Environmental Assessment, affected proposers will be informed after the proposal review stage and will be requested to assist in the preparation of a draft of the assessment (prior to award). Failure to apply for and/or obtain federal, state, and local permits, approvals, letters of agreement, or failure to provide environmental analysis where necessary (e.g., NEPA environmental assessment) will also delay the award of funds if a project is otherwise selected for funding.

***Other Requirements***

Performers are expected to attend program level meetings to provide scientific and technical updates to the selected performers on the PALS program on progress towards their milestones and scientific goals, and to summarize outstanding challenges and limitations that must still be overcome to achieve the overarching goals of the program. Program level meetings will be held at the kick-off of each phase (Phases 1, 2 and 3), as well as mid-phase (Phases 1 and 2) for the program duration.

## 2. Award Information

### 2.1. GENERAL AWARD INFORMATION

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

The Government reserves the right to select for negotiation all, some, one, or none of the proposals received in response to this solicitation and to make awards without discussions with proposers. The Government also reserves the right to conduct discussions if it is later determined to be necessary. If warranted, portions of resulting awards may be segregated into pre-priced options. Additionally, DARPA reserves the right to accept proposals in their entirety or to select only portions of proposals for award. In the event that DARPA desires to award only portions of a proposal, negotiations may be opened with that proposer. The Government reserves the right to fund proposals in phases with options for continued work, as applicable. The Government reserves the right to request any additional, necessary documentation once it makes the award instrument determination. Such additional information may include but is not limited to Representations and Certifications (see Section VI.B.2., “Representations and Certifications”). The Government reserves the right to remove proposers from award consideration should the parties fail to reach agreement on award terms, conditions, and/or cost/price within a reasonable time, and the proposer fails to timely provide requested additional information. Proposals identified for negotiation may result in a procurement contract, cooperative agreement, or other transaction, depending upon the nature of the work proposed, the required degree of interaction between parties, whether or not the research is classified as Fundamental Research, and other factors.

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

In 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.

### 2.2. 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 proposers not intending to perform fundamental research or the proposed research may present a high likelihood of disclosing performance characteristics of military systems or manufacturing technologies that are unique and critical to defense. Based on the nature of the performer and the nature of the work, the Government anticipates that some awards will include restrictions on the resultant research that will require the awardee to seek DARPA permission before publishing any information or results relative to the program.

Proposers should indicate in their proposal whether they believe the scope of the research included in their proposal is fundamental or not. While proposers should clearly explain the intended results of their research, the Government shall have sole discretion to 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 <http://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

### **3. Eligibility Information**

#### **3.1. ELIGIBLE APPLICANTS**

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

##### **3.1.1. Federally Funded Research and Development Centers (FFRDCs) and Government Entities**

###### **3.1.1.1. 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.

### 3.1.1.2. 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.

### 3.1.1.3. 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.

### 3.1.2. Non-U.S. Organizations

Non-U.S. organizations and/or individuals may participate to the extent that such participants comply with any and all necessary nondisclosure agreements, security regulations, Government export controls and regulations, including the International Traffic in Arms Regulations (ITAR), export control laws, and other governing statutes applicable under the circumstances. For research categorized as Controlled Unclassified Information (CUI), U.S. persons (green card holders) are authorized to participate, but foreign nationals are not.

## 3.2. 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.

### **3.3. COST SHARING/MATCHING**

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

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

## **4. Application and Submission Information**

### **4.1. ADDRESS TO REQUEST APPLICATION PACKAGE**

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

### **4.2. CONTENT AND FORM OF APPLICATION SUBMISSION**

All submissions, including abstracts and proposals must be written in English with type not smaller than 12 point font. Smaller font may be used for figures, tables, and charts. Copies of all documents submitted must be clearly labeled with the DARPA BAA number, proposer organization, and proposal title/proposal short title.

#### 4.2.1. Proposal Abstract Format

Proposers are strongly 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. DARPA will respond to abstracts providing feedback and indicating whether, after preliminary review, there is interest within BTO for the proposed work. DARPA will attempt to reply within 30 calendar days of receipt. Proposals may be submitted irrespective of comments or feedback received in response to the abstract. Proposals are reviewed without regard to feedback given as a result of abstract review. For abstract submission dates, see Part I., Overview Information. Submissions received after these dates and times may not be reviewed.

The abstract is a concise version of the proposal comprising a maximum of **8** pages including all figures, tables, and charts. The (optional) submission letter is not included in the page count. All pages shall be formatted for printing on 8-1/2 by 11-inch paper with font size not smaller than 12 point. Smaller font sizes may be used for figures, tables, and charts.

Submissions must be written in English.

The page limit does NOT include:

1. Official transmittal letter (optional);
2. Cover sheet;
3. Executive summary slides;
4. Resumes; and
5. Bibliography (optional)
6. Statement of Work (SOW)

Abstracts must include the following components:

**A. Cover Sheet** (does not count towards page limit): Include the administrative and technical points of contact (name, address, phone, fax, email, lead organization). Also include the BAA number, title of the proposed project, primary subcontractors, estimated cost, duration of the project, and the label “ABSTRACT.”

**B. Goals and Impact:** Clearly describe what is being proposed and what difference it will make (qualitatively and quantitatively), including brief answers to the following questions:

1. What is the proposed work attempting to accomplish or do?
2. How is it done today? And what are the limitations?
3. What is innovative in your approach and how does it compare to SOA?
4. What are the key technical challenges in your approach and how do you plan to overcome these?
5. Who will care and what will the impact be if you are successful?
6. How much will it cost and how long will it take?

**C. Executive Summary Slides** (does not count towards page limit): Provide a summary in PowerPoint that effectively and succinctly conveys the information

requested in the slide template provided as **Attachment 1** to the BAA posted at <https://www.fbo.gov>. Use of this template is required.

**D. Technical Plan:** Outline and address all technical challenges inherent in the approach and possible solutions for overcoming potential problems. This section should provide appropriate specific milestones (quantitative, if possible) at intermediate stages of the project to demonstrate progress and a brief plan for accomplishment of the milestones. Abstracts should:

1. Identify and describe the organisms to be used as the sensing elements and describe their distribution globally as well as within their native environment (include any known temporal or seasonal changes in distribution). For synthetic biological approaches, describe the organism, the intended modification(s), the safeguard plans, and envisioned improvement in signal detectability achieved by the approach.
2. Discuss which target size(s) your full system will be able to detect.
3. Describe the unique organism behavior or signal that will facilitate discrimination between the target M/UUVs and potential confounding objects.
4. Describe the envisioned TA2 detection technology and associated signal processing and data analysis (hardware and software).
5. Describe the concept of operations for the approach, including breakdown of system standoff as well as estimates for size, weight and power of the TA2 detector system when packaged for deployment.
6. Outline the specific testing environments for each phase.
7. Define the potential risks of the approach and propose mitigation strategies for each.
8. Provide specific qualitative and quantitative metrics specific to the approach.
9. Outline additional intermediary milestones at no greater than 6-month increments to demonstrate progress and a brief plan for their accomplishment.
10. Include plan for obtaining all permits required to conduct research. All research must comply with applicable environmental laws, rules and regulations for the state, territory, nation, and international waters where applicable.

**E. Ship Time Needs Information:** Provide information regarding estimated ship time requirements for all phases of the program (e.g. UNOLS vessel days or other vessel use estimates).

**F. Management and Capabilities:** Provide a brief summary of expertise of the team, including subcontractors and key personnel. It is expected that proposals will involve multidisciplinary teams that include expertise from multiple complementary disciplines, for example, biology, chemistry, engineering, oceanography and physics.

A Principal Investigator (PI) for the project must be identified, along with a description of the team organization including the breakdown by Technical Area. All teams are strongly encouraged to identify a Project Manager/Integrator to serve as the primary point of contact to communicate with the DARPA Program Manager, IV&V team, and Contracting Officer's Representative, coordinate the effort across co-performer, vendor, and subcontractor teams, organize regular performer meetings or discussions, facilitate data sharing, and ensure timely completion of milestones and deliverables.

Include a description of the team's organization including roles and responsibilities. Team member descriptions should address the Technical Plan, describe the time and percent effort divisions for members participating across multiple TAs, and delineate individuals to avoid duplication of efforts.

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 materials or data assumed to be available. Describe any specialized facilities to be used as part of the project, the extent of access to these facilities, and any biological containment, biosafety, and certification requirements.

**G. Cost and Schedule:** Provide a cost estimate for resources over the proposed timeline of the project, broken down by phase and major cost items (e.g., labor, materials, etc.). Include cost estimates for each potential subcontractor (may be a rough order of magnitude). Do not provide UNOLS ship time request costs in your budget. Non-UNOLS ship time should be included in the budget.

#### 4.2.2. Proposal Format

All full proposals must be in the format given below. Proposals shall consist of two volumes: 1) **Volume I, Technical and Management Proposal**, and 2) **Volume II, Cost Proposal**. All pages shall be printed on 8-1/2 by -inch paper with type not smaller than 12 point. Smaller font may be used for figures, tables and charts. The page limitation for full proposals includes all figures, tables, and charts. Volume I, Technical and Management Proposal, may include an attached bibliography of relevant technical papers or research notes (published and unpublished) which document the technical ideas and approach upon which the proposal is based. Copies of not more than three (3) relevant papers may be included with the submission. The Statement of Work, bibliography and attached papers are not included in the page counts given below. The submission of other supporting materials along with the proposals is strongly discouraged and will not be considered for review. **The maximum page count for Volume 1 is 40 pages.** A submission letter is optional and is not included in the page count. For proposal submission dates, see Part I., Overview Information. Volume I should include the following components:

**NOTE: Non-conforming submissions that do not follow the instructions herein may be rejected without further review.**

a. Volume I, Technical and Management Proposal

Section I. Administrative

A. Cover Sheet (LABELED “PROPOSAL: VOLUME I”):

1. BAA number HR001118S0027
2. Lead organization submitting proposal (prime contractor);
3. Type of organization, selected from among the following categories: “LARGE BUSINESS,” “SMALL DISADVANTAGED BUSINESS,” “OTHER SMALL BUSINESS,” “HBCU,” “MI,” “OTHER EDUCATIONAL,” OR “OTHER NONPROFIT”;
4. Proposer’s reference number (if any);
5. Other team members (if applicable) and type of business for each;
6. Proposal title;
7. Technical point of contact (Program Manager or Principle Investigator) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax, e-mail;
8. Administrative point of contact (Contracting Officer or Grant Officer) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax, e-mail;
9. Award instrument requested: cost-plus-fixed-fee (CPFF), cost-contract—no fee, firm-fixed-price, cooperative agreement, other transaction, or other type (specify);
10. Place(s) and period(s) of performance ;
11. Proposal validity period;
12. Total funds requested from DARPA, and the amount of cost share (if any); AND
13. Date proposal was submitted.

Information on award instruments is available at <http://www.darpa.mil/work-with-us/contract-management>.

B. Official Transmittal Letter.

C. Executive Summary Slides: Provide a five-slide summary in PowerPoint that effectively and succinctly conveys, using descriptive language and graphics, the main technical objectives, unique aspects to the technical approach, key personnel, and major milestones to accomplish the proposed project. The slide template is provided as **Attachment 2**. Use of this template is required.

Section II. Detailed Proposal Information

A. **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?
- How is it done today, and what are the limitations?
- What is innovative in your approach?
- What are the key technical challenges in your approach and how do you plan to overcome these?
- Who or what will be affected and what will be the impact if the work is successful?
- How much will it cost, and how long will it take?

**B. Goals and Impact:** Clearly describe what the team is trying to achieve and the difference it will make (qualitatively and quantitatively) if successful. Describe the innovative aspects of the project in the context of existing capabilities and approaches, clearly delineating the uniqueness and benefits of this project in the context of the state of the art, alternative approaches, and other projects from the past and present. Describe how the proposed project is revolutionary and how it significantly rises above the current state of the art. Describe the deliverables associated with the proposed project and any plans to commercialize the technology, transition it to a customer, or further the work.

**C. Technical Plan:** Outline and address technical challenges inherent in the approach and possible solutions for overcoming potential problems. This section should provide appropriate measurable milestones (quantitative if possible) at intermediate stages of the program to demonstrate progress and a plan for achieving the milestones. The technical plan should demonstrate a deep understanding of the technical challenges and present a credible (even if risky) plan to achieve the program goal. Discuss mitigation of technical risk. Discuss permit compliance as relates to program tasks. Proposals should:

- Identify and describe the organisms to be used as the sensing elements and describe their distribution globally as well as within their native environment (include any known temporal or seasonal changes in distribution). For synthetic biological approaches, describe the organism, the intended modification(s), the safeguard plans, and envisioned improvement in signal detectability achieved by the approach.
- Discuss which target size(s) your full system will be able to detect.
- Describe the unique organism behavior or signal that will facilitate discrimination between the target M/UUVs and potential confounding objects.
- Describe the envisioned TA2 detection technology and associated signal processing and data analysis (hardware and software).
- Describe the concept of operations for the approach, including breakdown of system standoff as well as estimates for size, weight and power of the TA2 detector system when packaged for deployment.

- Outline the specific testing environments for each phase.
- Define the potential risks of the approach and propose mitigation strategies for each.
- Provide specific qualitative and quantitative metrics specific to the approach.
- Outline additional intermediary milestones at no greater than 6-month increments to demonstrate progress and a brief plan for their accomplishment.
- Include plan for obtaining all permits required to conduct research. All research must comply with applicable environmental laws, rules and regulations for the state, territory, nation, and international waters where applicable.

**D. Management Plan:** Provide a brief summary of expertise of the team, including subcontractors and key personnel. It is expected that proposals will involve multidisciplinary teams that include expertise from multiple complementary disciplines, for example, biology, chemistry, engineering, oceanography and physics. Resumes do not count against the proposal page count. A Principal Investigator (PI) for the project must be identified, along with a description of the team organization including the breakdown by Technical Area. All teams are strongly encouraged to identify a Project Manager/Integrator to serve as the primary point of contact to communicate with the DARPA Program Manager, IV&V team, and Contracting Officer's Representative, coordinate the effort across co-performer, vendor, and subcontractor teams, organize regular performer meetings or discussions, facilitate data sharing, and ensure timely completion of milestones and deliverables. Provide a clear description of the team's organization including an organization chart that includes, as applicable: the programmatic relationship of team members; the unique capabilities of team members; the task responsibilities of team members, the teaming strategy among the team members; and key personnel with the amount of effort to be expended by each person during each year. Team member descriptions should address the Technical Plan, describe the time and percent effort divisions for members participating across multiple TAs, and delineate individuals to avoid duplication of efforts. 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 materials or data assumed to be available. Describe any specialized facilities to be used as part of the project, the extent of access to these facilities, and any biological containment, biosafety, and certification requirements. Describe any formal teaming agreements that are required to execute this program.

**E. Capabilities:** Describe organizational experience in relevant subject area(s), existing intellectual property, and any Government-furnished materials or information. Describe any specialized facilities to be used as part of the project, the extent of access to these



facilities, and any biological containment, biosafety, and certification requirements. Discuss any work in closely related research areas and previous accomplishments.

- F. Statement of Work (SOW):** The SOW should provide a detailed task breakdown, citing specific tasks for each Technical Area, and their connection to the milestones and program metrics. Each phase of the program should be separately defined. The SOW must not include proprietary information. It is encouraged, though not required, to use the SOW template provided as **Attachment 3**. SOW is not included in the Volume 1 page count.

For each task, provide:

- A description of the approach to be taken that includes metrics, methods, and an assessment plan.
- Identification of the primary organization responsible for task execution (prime contractor, subcontractor(s), consultant(s), by name).
- Measurable milestone(s), deliverable(s), demonstration(s), or other event/activity signifying task completion.
- A definition of all deliverables (e.g., data, reports, software) to be provided to the Government in support of the proposed tasks.

- G. 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.

- H. Ship Time Request** (if applicable): Provide the year, desired location, and number of days on station for Coastal/Local Class UNOLS Ships. For proposals including non-UNOLS vessels, indicate the ship information, number days on station, and the assurance that all institutional policies and procedures will be followed.

Provide the UNOLS Coastal/Local Class ship time request (STR) at [https://strs.unols.org/Public/diu\\_login.aspx](https://strs.unols.org/Public/diu_login.aspx), select “DARPA” in agency pulldown menu, add all other appropriate information and manage the request per the UNOLS process. If non-UNOLS vessels are proposed, please indicate the ship, ship days and assure that all institutional policies and procedures are followed for use of these vessels (costs for UNOLS ships are not to be included in proposal).

- I. CUI Risk Mitigation Plan** (Required for proposers who anticipate generating work that may be considered CUI in accordance with Section 1.5 “Controlled Unclassified

Information”): Provide a detailed plan for how the organization and its subcontractors will meet CUI safeguarding requirements. The plan should provide a detailed strategy to protect CUI without unnecessarily compartmentalizing information flow within or among performer teams. This plan must describe safeguard procedures for generating sensitive program deliverables (e.g., operating characteristics of sensors being used and the targets being detected; unique relationship between targets and biological sensors; and tactics, techniques, and procedures (TTPs) of targets used during testing to create real-world scenarios).

Section III. Additional Information (Note: Does not count towards page limit)

A resume or “biosketch” is required for key personnel.

A brief bibliography of relevant technical papers and research notes (published and unpublished) which document the technical ideas upon which the proposal is based. Copies of not more than three (3) relevant papers can be included in the submission.

a. Volume II, Cost Management Proposal

Cover Sheet (LABELED “PROPOSAL: VOLUME II”) with Appendix 1:

1. BAA number (HR001118S0027);
2. Lead Organization Submitting proposal;
3. Type of organization, selected among the following categories: “LARGE BUSINESS”, “SMALL DISADVANTAGED BUSINESS”, “OTHER SMALL BUSINESS”, “HBCU”, “MI”, “OTHER EDUCATIONAL”, OR “OTHER NONPROFIT”;
4. Proposer’s reference number (if any);
5. Other team members (if applicable) and type of business for each;
6. Proposal title;
7. Technical point of contact (Program Manager or Principal Investigator) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), electronic mail (if available);
8. Administrative point of contact (Contracting Officer or Grant Officer) to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), and electronic mail (if available);
9. Award instrument requested: cost-plus-fixed-fee (CPFF), cost-contract—no fee, cost sharing contract – no fee, or other type of procurement contract (*specify*), cooperative agreement, or other transaction;
10. Place(s) and period(s) of performance;
11. Total proposed cost separated by basic award and option(s) (if any);
12. Name, address, and telephone number of the proposer’s cognizant Defense Contract Management Agency (DCMA) administration office (*if known*);

13. Name, address, and telephone number of the proposer's cognizant Defense Contract Audit Agency (DCAA) audit office (*if known*);
14. Date proposal was prepared;
15. DUNS number (<http://www.dnb.com/get-a-duns-number.html>) ;
16. Taxpayer ID number (<https://www.irs.gov/Individuals/International-Taxpayers/Taxpayer-Identification-Numbers-TIN>);
17. CAGE code (<https://cage.dla.mil/Home/UsageAgree>);
18. Proposal validity period

**Note that nonconforming proposals may be rejected without review.**

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

The Government encourages proposers to complete an editable MS excel budget template that covers items 1.a, 1.c – 1.f, 3, 4, 5 and 6 discussed below. This template document is provided as Attachment 4 to this BAA. If you choose to use **Attachment 4**, submit the MS Excel template in addition to Volume I and II of your proposal. Volume II must include all other items discussed below that are not covered by the editable MS excel budget template. Proposers are welcome to utilize an alternative format, provided the information requested below is clearly and effectively communicated. The Government strongly encourages that the proposer provide a detailed cost breakdown to include:

- (1) Total program cost broken down by Phases (1, 2 and 3) in Contractor Fiscal Year to include:
  - a. Direct Labor – Including individual labor categories with associated labor hours and direct labor rates. If selected for award, be prepared to submit supporting documentation to justify labor rates. (i.e., screenshots of HR databases, comparison to NIH or other web-based salary database);
  - b. Consultants – If consultants are to be used, proposer must provide a copy of the consultant's proposed SOW as well as a signed consultant agreement or other document which verifies the proposed loaded daily / hourly rate, hours and any other proposed consultant costs (e.g., travel);
  - c. Indirect Costs – Including Fringe Benefits, Overhead, General and Administrative Expense, Cost of Money, Fee, etc. (must show base amount and rate), if available, provide current Forward Pricing Rate Agreement or Forward Pricing Rate Proposal. If not available, provide 2 years historical data to include pool and expense costs used to generate the rates. For academia, provide DHHS or ONR negotiated rate package or, if calculated by other than a rate, provide University documentation identifying G&A and fringe costs by position;

- d. Travel – Provide the purpose of the trip, number of trips, number of days per trip, departure and arrival destinations, number of people, estimated rental car and airfare costs, and prevailing per diem rates as determined by gsa.gov, etc.; Quotes must be supported by screenshots from travel websites;
  - e. Other Direct Costs – Itemized with costs including tuition remission, animal per diem rates, health insurance/fee; back-up documentation is to be submitted to support proposed costs;
  - f. Ship Time – Provide the costs associated with any non-UNOLS ship time use;
  - g. Equipment Purchases – Itemization with individual and total costs, including quantities, unit prices, proposed vendors (if known), and the basis of estimate (e.g., quotes, prior purchases, catalog price lists, etc.); any item that exceeds \$5,000 must be supported with back-up documentation such as a copy of catalog price lists or quotes prior to purchase (NOTE: For equipment purchases, include a letter stating why the proposer cannot provide the requested resources from its own funding), and;
  - h. Materials – Itemization with costs, including quantities, unit prices, proposed vendors (if known), and the basis of estimate (e.g., quotes, prior purchases, catalog price lists, etc.); any item that exceeds \$5,000 must be supported with back-up documentation such as a copy of catalog price lists or quotes prior to purchase.
- (2) A summary of total program costs by phase and task;
  - (3) A summary of projected funding requirements by month;
  - (4) An itemization of any information technology (IT) purchase (including a letter stating why the proposer cannot provide the requested resources from its own funding), as defined in FAR Part 2.101;
  - (5) An itemization of Subcontracts. **All subcontractor cost proposal documentation must be prepared at the same level of detail as that required of the prime.** Subcontractor proposals should include Interdivisional Work Transfer Agreements (IWTA) or evidence of similar arrangements (an IWTA is an agreement between multiple divisions of the same organization);
  - (6) The source, nature, and amount of any industry cost-sharing. Where the effort consists of multiple portions which could reasonably be partitioned for purposes of funding, these should be identified as options with separate cost estimates for each;
  - (7) Identification of pricing assumptions of which may require incorporation into the resulting award instrument (e.g., use of Government Furnished Property/Facilities/Information, access to Government Subject Matter Expert/s, etc.);
  - (8) Any Forward Pricing Rate Agreement, DHHS rate agreement, other such approved rate information, or such documentation that may assist in expediting negotiations (if available); and
  - (9) Proposers with a Government acceptable accounting system who are proposing a cost-type contract must submit the DCAA document approving the cost accounting system.

#### 4.2.3. Additional Proposal Information

##### 4.2.3.1. Proprietary Markings

Proposers are responsible for clearly identifying proprietary information. Submissions containing proprietary information must have the cover page and each page containing such information clearly marked with a label such as “Proprietary” or “Company Proprietary.”

NOTE: “Confidential” is a classification marking used to control the dissemination of U.S. Government National Security Information as dictated in Executive Order 13526 and should not be used to identify proprietary business information.

**4.2.3.2. Unclassified Submissions**

DARPA anticipates that submissions received under this BAA will be unclassified. However, should a proposer wish to submit classified information, an *unclassified* email must be sent to the BAA mailbox requesting submission instructions from the Technical Office PSO. If a determination is made that the award instrument may result in access to classified information, a SCG and/or DD Form 254 will be issued by DARPA and attached as part of the award.

**4.2.3.3. Human Research Subjects/Animal Use**

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

**4.2.3.4. Small Business Subcontracting Plan**

Pursuant to Section 8(d) of the Small Business Act (15 U.S.C. § 637(d)) and FAR 19.702(a)(1), each proposer who submits a contract proposal and includes subcontractors might be required to submit a subcontracting plan with their proposal. The plan format is outlined in FAR 19.704.

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

All electronic and information technology acquired or created through this BAA must satisfy the accessibility requirements of Section 508 of the Rehabilitation Act (29 U.S.C. § 749d)/FAR 39.2.

**4.2.3.6. Intellectual Property**

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

***For Procurement Contracts***

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

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

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

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

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

**4.2.4. Submission Information**

DARPA will acknowledge receipt of all submissions and assign an identifying control number that should be used in all further correspondence regarding the submission. DARPA intends to use electronic mail correspondence regarding HR001118S0027. Submissions may not be submitted by fax or e-mail; any so sent will be disregarded.

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

For (abstract and) proposal submission dates, see Part I., Overview Information. Submissions received after these dates and times may not be reviewed.

**For Proposers Submitting Proposal Abstracts or Full Proposals believed to contain CUI as Hard Copies/On CD-ROM:**

Proposers must submit an original hardcopy and one (1) electronic copy of the abstract or proposal in PDF (preferred) on a CD-ROM to the mailing address listed in Part I. Each copy must be clearly labeled with HR001118S0027, proposer organization, technical point of contact, and proposal title (short title recommended).

Please note that submitters via hardcopy/CD-ROM will still need to visit <https://baa.darpa.mil> to register their organization concurrently to ensure the BAA office can verify and finalize their submission

**For Proposers Submitting Proposal Abstracts or Full Proposals Requesting Procurement Contracts or OTs through DARPA's BAA Submission Portal:**

Abstracts and Full Proposals sent in response to HR001118S0027 may be submitted via DARPA's BAA Website (<https://baa.darpa.mil>). Visit the website to complete the two-step registration process. Submitters will need to register for an Extranet account (via the form at the URL listed above) and wait for two separate e-mails containing a username and temporary password. After accessing the Extranet, submitters may then create an account for the DARPA BAA website (via the "Register your Organization" link along the left side of the homepage), view submission instructions, and upload/finalize the abstract. Proposers using the DARPA BAA Website may encounter heavy traffic on the submission deadline date; it is highly advised that submission process be started as early as possible.

All unclassified concepts submitted electronically through DARPA's BAA Website must be uploaded as zip files (.zip or .zipx extension). The final zip file should be no greater than 50 MB in size. Only one zip file will be accepted per submission. Classified submissions and proposals requesting cooperative agreements should NOT be submitted through DARPA's BAA Website (<https://baa.darpa.mil>), though proposers will likely still need to visit <https://baa.darpa.mil> to register their organization (or verify an existing registration) to ensure the BAA office can verify and finalize their submission.

Technical support for BAA Website may be reached at [BAAT\\_Support@darpa.mil](mailto:BAAT_Support@darpa.mil), and is typically available during regular business hours, (9:00 AM- 5:00 PM EST Monday – Friday).

Proposers using the DARPA BAA Website may encounter heavy traffic on the submission deadline date; it is highly advised that submission process be started as early as possible.

Failure to comply with the submission procedures may result in the submission not being evaluated. DARPA will acknowledge receipt of complete submissions via email and assign control numbers that should be used in all further correspondence regarding proposals.

**For Full Proposals Requesting Cooperative Agreements:**

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

Grants.gov Submissions: Grants.gov requires proposers to complete a one-time registration process before a proposal can be electronically submitted. First-time registration can take between three business days and four weeks. For more information about registering for Grants.gov, see <http://www.darpa.mil/work-with-us/additional-baa>.



Hard-copy Submissions: Proposers electing to submit cooperative agreement proposals as hard copies must complete the SF 424 R&R form (Application for Federal Assistance,) available on the Grants.gov website [http://apply07.grants.gov/apply/forms/sample/RR\\_SF424\\_2\\_0-V2.0.pdf](http://apply07.grants.gov/apply/forms/sample/RR_SF424_2_0-V2.0.pdf)

Failure to comply with the submission procedures may result in the submission not being evaluated. DARPA will acknowledge receipt of complete submissions via email and assign control numbers that should be used in all further correspondence regarding proposals.

#### **4.2.5. Disclosure of Information and Compliance with Safeguarding Covered Defense Information Controls**

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

DFARS 252.204-7000, “Disclosure of Information”

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

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

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

Compliance with the above requirements includes the mandate for proposers to implement the security requirements specified by National Institute of Standards and Technology (NIST) Special Publication (SP) 800-171, “Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations” (see <https://doi.org/10.6028/NIST.SP.800-171r1>) that are in effect at the time the BAA is issued, or as authorized by the Contracting Officer, not later than December 31, 2017.

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

### **4.3. FUNDING RESTRICTIONS**

Not applicable.

### **4.4. OTHER SUBMISSION REQUIREMENTS**

Not applicable.

## **5. Application Review Information**

### **5.1. EVALUATION CRITERIA**



Proposals will be evaluated using the following criteria, listed in descending order of importance: 5.1.1 Overall Scientific and Technical Merit; 5.1.2 Potential Contribution and Relevance to the DARPA Mission; 5.1.3 Cost Realism; and 5.1.4 Realism of Proposed Schedule.

#### **5.1.1. Overall Scientific and Technical Merit**

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

The proposed technical team has the expertise and experience to accomplish the proposed tasks. Task descriptions and associated technical elements provided are complete and in a logical sequence with all proposed deliverables clearly defined such that a final outcome that achieves the goal can be expected as a result of award. The proposal identifies major technical risks and planned mitigation efforts are clearly defined and feasible. If applicable, the CUI risk mitigation plan effectively presents a strategy for safeguarding controlled unclassified information.

#### **5.1.2. 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.

#### **5.1.3. 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).

#### **5.1.4. Realism of Proposed Schedule**

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

### **5.2. REVIEW OF PROPOSALS**

#### **5.2.1. Review Process**

It is the policy of DARPA to ensure impartial, equitable, comprehensive proposal evaluations based on the evaluation criteria listed in Section 5.1. and to select the source (or sources) whose offer meets the Government's technical, policy, and programmatic goals.

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

Award(s) will be made to proposers whose proposals are determined to be the most advantageous to the Government, consistent with instructions and evaluation criteria specified in the BAA herein, and availability of funding.

### **5.2.2. Handling of Source Selection Information**

DARPA policy is to treat all submissions as source selection information (see FAR 2.101 and 3.104), and to disclose their contents only for the purpose of evaluation. Restrictive notices notwithstanding, during the evaluation process, submissions may be handled by support contractors for administrative purposes and/or to assist with technical evaluation. All DARPA support contractors performing this role are expressly prohibited from performing DARPA-sponsored technical research and are bound by appropriate nondisclosure agreements. Subject to the restrictions set forth in FAR 37.203(d), input on technical aspects of the proposals may be solicited by DARPA from non-Government consultants/experts who are strictly bound by the appropriate non-disclosure requirements.

### **5.2.3. Federal Awardee Performance and Integrity Information (FAPIIS)**

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

## **5.3. PHASE 1 DOWN-SELECTION PROCESS**

As mentioned in Section 1.1.3, a down-selection will occur at the end of Phase 1. The down-selection process will be based on the performer's ability to meet the following down-select metrics:

- Achieve threshold performance subset of metrics:
  - 95% object detection at 1 meter
- Demonstrate viable path towards meeting Phases 2 and 3 metrics in Phase 1 report

The performance will be determined by the IV&V test partner during testing in Month 15, with results provided to DARPA and to all teams by Month 16. The Phase 1 report is due to DARPA in Month 16. In addition, teams will be subject to the below priority weighting during performance evaluation:

- 50% technical: Most reasonable technical path to achieving Phases 2 and 3 metrics
- 25% management: Effective intra-team working relationships across co-/sub-PIs
- 25% cost: clear ability to achieve Phases 2 and 3 objectives within proposed budget

The performer teams with the highest weighted scores will be considered for progression to Phase 2. Teams selected for advancement to Phase 2 will be notified in Month 18.

## **6. Award Administration Information**

### **6.1. SELECTION NOTICES**

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

#### **6.1.1. Proposal Abstracts**

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.

#### **6.1.2. Full Proposals**

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

### **6.2. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS**

#### **6.2.1. Meeting and Travel Requirements**

There will be a program kickoff meeting in a location central to the performer teams (assume central US for budgeting purposes), and all key participants are required to attend. Performers should also anticipate regular program-wide meetings and periodic site visits at the DARPA Program Manager's discretion. Proposers shall include within the content of their proposal details and costs of any travel or meetings they deem to be necessary throughout the course of the effort. Performers should anticipate monthly and quarterly meetings, including teleconference calls, in-person program reviews, and site visits by the DARPA Program Manager and/or Government team. For travel budgeting purposes, proposers may assume program reviews mid phase (Phases 1 and 2) as well as phase kick-off (Phases 2 and 3) with alternating locations in Arlington, VA and a west coast location.

Teams must also present details and costs of any travel necessary for the purpose of testing. This testing must include, at a minimum, support as-needed for the independent verification and validation (IV&V) final Phase 1 test, final Phase 2 test, and final Phase 3 test, in addition to any other non-local internal testing deemed necessary to develop the overall technology. For travel budgeting purposes, proposers should assume that the end-of-phase testing will take place at IV&V designated tank facilities for Phase 1, or coastal locations for Phases 2 and 3, either on the east coast in the greater DelMarVa (Delaware, Maryland and Virginia) area or on the west coast in the central California area, as determined by biological organism locations. No international travel should be proposed.

### **6.2.1. 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 <http://www.darpa.mil/work-with-us/additional-baa>.

### **6.2.2. 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 <http://www.darpa.mil/work-with-us/additional-baa>.

### **6.2.3. 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](http://www.sam.gov). Supplementary representations and certifications can be found at <http://www.darpa.mil/work-with-us/additional-baa>.

### **6.2.4. Terms and Conditions**

A link to the DoD General Research Terms and Conditions for Grants and Cooperative Agreements and supplemental agency terms and conditions can be found at <http://www.darpa.mil/work-with-us/contract-management#GrantsCooperativeAgreements>.

## **6.3. REPORTING**

The number and types of reports will be specified in the award document, but will include as a minimum monthly financial and technical status reports. The reports shall be prepared and submitted in accordance with the procedures contained in the award document and mutually agreed on before award. Reports and briefing material will also be required as appropriate to document progress in accomplishing program metrics.

A phase end report containing the phase accomplishments (Phases 1 and 2), analysis of IV&V testing results, as well as the plan for the following phase (Phases 2 and 3) will be required prior to entering into the next phase. In particular, the end of Phase 1 report must provide sufficient detail on development steps and risk mitigation plans to ensure success in developing the integrated Phase 2 system, to be considered for performer down-selection. Code reports will also be required as outlined in the deliverables, which should outline the algorithms used and the overall software architecture employed to characterize the biological signal.

In addition, mid-term reports in Phases 1 and 2 will be required to provide results of the mid-phase demonstrations and address plans for the remainder of the phase. A final report that summarizes the project and tasks will be required at the conclusion of the performance period for the award, notwithstanding the fact that the research may be continued under a follow-on vehicle.

## **6.4. ELECTRONIC SYSTEMS**

#### **6.4.1. Wide Area Work Flow (WAWF)**

Performers will be required to submit invoices for payment directly to <https://wawf.eb.mil>, unless an exception applies. Performers must register in WAWF prior to any award under this BAA.

#### **6.4.2. i-EDISON**

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

### **7. Agency Contacts**

Administrative, technical or contractual questions should be sent via e-mail to [PALS@darpa.mil](mailto:PALS@darpa.mil)

#### Points of Contact

The BAA Coordinator for this effort may be reached at:

[PALS@darpa.mil](mailto:PALS@darpa.mil)

DARPA/BTO

ATTN: HR001118S0027

675 North Randolph Street

Arlington, VA 22203-2114

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

### **8. Other Information**

DARPA will host a Proposers Day in support of the PALS program on **March 2, 2018** at the Executive Conference Center in Arlington, VA. The purpose is to provide potential proposers with information on the PALS program, promote additional discussion on this topic, address questions, provide a forum to present their capabilities, and to encourage team formation.

Interested proposers are not required to attend to respond to the PALS BAA, and relevant information and materials discussed at Proposers Day will be made available to all potential proposers in the form of a FAQ posted on the DARPA Opportunities Page. The event will be webcast for those who would like to participate remotely.

DARPA will not provide cost reimbursement for interested proposers in attendance.

An online registration form and various other meeting details can be found at the registration website, <http://events.sa-meetings.com/PALSProposersDay>

To encourage team formation, interested proposers are encouraged to submit information to be shared with all potential proposers through the Proposers Day website and the DARPA Opportunities Page. This information may include contact information, relevant publications, and a slide or poster to summarize the proposer's interests.

Participants are required to register no later than **February 23, 2018 12:00 PM ET**. This event is not open to the Press. The Proposers Day will be open to members of the public who have registered in advance for the event; **there will be no onsite registration**.

All foreign nationals, including permanent residents, must complete and submit a DARPA Form 60 "Foreign National Visit Request," which will be provided in the registration confirmation email.

Proposers Day Point of Contact:

[DARPA-SN-18-29@darpa.mil](mailto:DARPA-SN-18-29@darpa.mil)

ATTN: DARPA-SN-18-29

675 North Randolph Street

Arlington, VA 22203-2114

**9. APPENDIX 1 – Volume II Checklist**

**Volume II, Cost Proposal  
Checklist and Sample Templates**

**The following checklist and sample templates are provided to assist the proposer in developing a complete and responsive cost volume. Full instructions appear in Section 4.2.2 beginning on Page 30 of HR001118S0027. This worksheet must be included with the coversheet of the Cost Proposal.**

1. Are all items from Section 4.2.2 (Volume II, Cost Proposal) of HR001118S0027 included on your Cost Proposal cover sheet?  
 YES       NO      **Appears on Page(s)** [Type text]  
If reply is “No”, please explain:
  
2. Does your Cost Proposal include (1) a summary cost buildup by phase, (2) a summary cost buildup by Year, and (3) a detailed cost buildup of for each phase that breaks out each task and shows the cost per month?  
 YES       NO      **Appears on Page(s)** [Type text]  
If reply is “No”, please explain:
  
3. Does your cost proposal (detailed cost buildup #3 above in item 2) show a breakdown of the major cost items listed below:  
Direct Labor (Labor Categories, Hours, Rates)  
 YES       NO      **Appears on Page(s)** [Type text]  
  
Indirect Costs/Rates (i.e., overhead charges, fringe benefits, G&A)  
 YES       NO      **Appears on Page(s)** [Type text]  
  
Materials and/or Equipment  
 YES       NO      **Appears on Page(s)** [Type text]  
  
Subcontracts/Consultants  
 YES       NO      **Appears on Page(s)** [Type text]  
  
Other Direct Costs  
 YES       NO      **Appears on Page(s)** [Type text]  
  
Travel  
 YES       NO      **Appears on Page(s)** [Type text]  
If reply is “No”, please explain:
  
4. Have you provided documentation for proposed costs related to travel, to include purpose of trips, departure and arrival destinations and sample airfare?  
 YES       NO      **Appears on Page(s)** [Type text]



If reply is "No", please explain:

5. Does your cost proposal include a complete itemized list of all material and equipment items to be purchased (a priced bill-of-materials (BOM))?  
 YES       NO      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

6. Does your cost proposal include vendor quotes or written engineering estimates (basis of estimate) for all material and equipment with a unit price exceeding \$5000?  
 YES       NO      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

7. Does your cost proposal include a clear justification for the cost of labor (written labor basis-of-estimate (BOE)) providing rationale for the labor categories and hours proposed for each task?  
 YES       NO      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

8. Do you have subcontractors/consultants? If YES, continue to question 9. If NO, skip to question 13.  
 YES       NO      **Appears on Page(s)** [Type text]

9. Does your cost proposal include copies of all subcontractor/consultant technical (to include Statement of Work) and cost proposals?  
 YES       NO      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

10. Do all subcontract proposals include the required summary buildup, detailed cost buildup, and supporting documentation (SOW, Bill-of-Materials, Basis-of-Estimate, Vendor Quotes, etc.)?  
 YES       NO      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

11. Does your cost proposal include copies of consultant agreements, if available?  
 YES       NO      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

12. If requesting a FAR-based contract, does your cost proposal include a tech/cost analysis for all proposed subcontractors?  
 YES       NO      **Appears on Page(s)** [Type text]

If reply is "No", please explain:

13. Have all team members (prime and subcontractors) who are considered a Federally Funded Research & Development Center (FFRDC), included documentation that clearly demonstrates work is not otherwise available from the private sector AND provided a letter on letterhead from the sponsoring organization citing the specific authority establishing their eligibility to propose to government solicitations and compete with industry, and compliance with the associated FFRDC sponsor agreement and terms and conditions.

YES       NO      **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

14. Does your proposal include a response regarding Organizational Conflicts of Interest?

YES       NO      **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

15. Does your proposal include a completed Data Rights Assertions table/certification?

YES       NO      **Appears on Page(s)** [Type text]

If reply is “No”, please explain:

## 10. APPENDIX 2 – Platform Space, Weight, Power, and Communications

Starting in Phase 2, Technical Area 2 teams will be responsible for integrating their hardware and software components onto a deployable platform, designed for a 30-day (Phase 2) or 60-day (Phase 3) endurance. Details of this platform are open to the performer but must be outlined in the proposal with sufficient detail as to assess technical feasibility. To provide some bounds on system parameters, the following guidelines must be met on the overall space, weight, and power (SWAP) as well as communications allocated to the system.

Teams must, at a minimum, integrate with a floating surface platform, such as a research buoy. This platform must provide satellite link connectivity to transmit alert messages back to a user (for testing purposes, the IV&V team), specifically through the Iridium short-burst data (SBD) network transport protocol. It must also contain a GPS receiver with 5-meter accuracy (RTK-GPS / differential GPS not required). Other communications technologies for communication to the end user are not allowed (e.g., wide-area networks (WAN), IEEE 802.11 wireless networks, 4G LTE or other cell phone networks, shore-to-system cables, etc.).

Teams may choose to outfit this single surface platform with all necessary detector hardware, data storage, energy storage, and data processing capabilities, if appropriate for their design. Alternatively, teams may elect to move some components to a detached, off-board platform; for example, if teams require a detector to be upward-looking in order to observe their biological organism, the detector may need to be placed on or tethered to the seafloor. In this case, the system components can be allocated across the surface and off-board platforms, and the surface platform must be moored in order to maintain proximity to the subsurface components. If implementing the split design, teams must implement a wireless underwater communications strategy for sending information from the off-board platform(s) back to the surface platform, leveraging commercial off-the-shelf (COTS) technologies (e.g. modulated ultrasound or hydroacoustic modem). No power or communications tethers will be allowed between the surface and off-board system components, with the exception of suspended drogues or subsurface floats that are coupled to the surface platform.

Teams are only allowed one (1) surface platform and three (3) off-board platforms as part of a single “system”, with the component SWAP below, not to exceed these values for each of the surface platform and up to three subsurface components<sup>1</sup>:

- Component volume of 0.064 cubic meters per platform
- Component mass of 25 kg per platform
- Available energy of 6.2 MJ (1.7 kW-hr) per platform, to be shared among required PALS components, support components, necessary datalinks across surface / off-board platforms, and GPS receiver / Iridium link for surface platform only

Energy harvesting will be allowed in the form of COTS solar panels or wind turbines ONLY. Energy harvesting will not be allowed on the off-board platforms. Exotic energy harvesting systems, including but not limited to wave energy, thermoelectrics, and piezoelectrics, will not be allowed.

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<sup>1</sup> Notionally derived from components on a Pacific Gyre SVP drifter (<https://www.pacificgyre.com/svp-gps-data-buoys.aspx>)

## 11. APPENDIX 3 – Sensitivity and Specificity Definition

For the purposes of the program metrics described in Section 1.2, and provided in *Table 3*, the terms used rely on definitions as they relate to the statistical measurement of a binary classification test, not as they are used in other fields (e.g., the sensitivity of an electronic device<sup>2</sup>). For instance, the program is concerned with the overall system's ability to detect and discriminate targets, but it is not necessarily concerned with the magnitude of the signal required by the system's sensor(s) in order to achieve this detection.

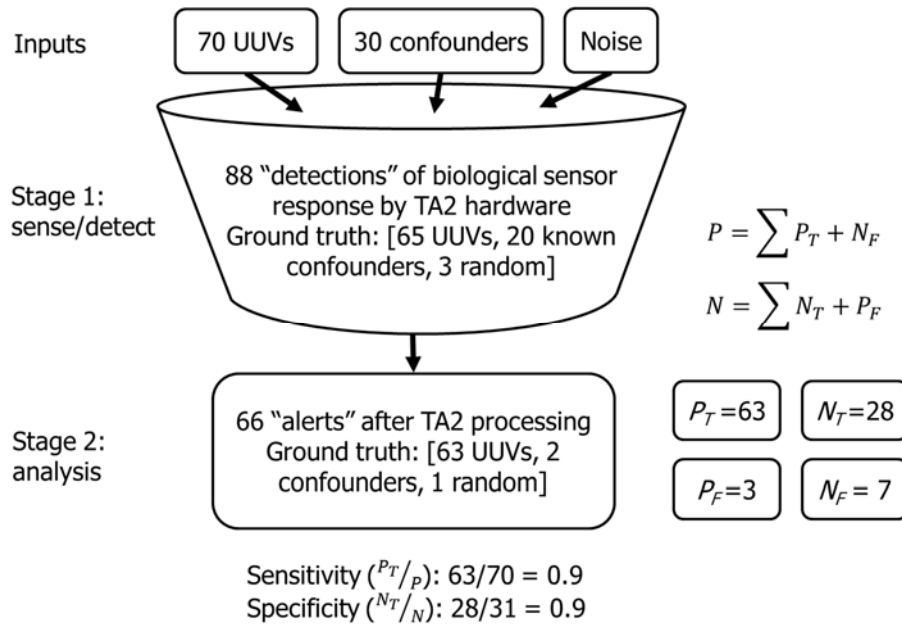
In order to determine the sensitivity and specificity, the following definitions and formulas are used:

- Given that:
  - $P = \text{total \# of positive test objects (i.e. \# of targets)} = TP + FN$ 
    - $TP = \text{\# of true positives (i.e. targets identified as targets)}$
    - $FN = \text{\# of false negatives (i.e. targets identified as confounders, or targets not detected)}$
  - $N = \text{total \# of negative test objects (i.e. \# of non-targets)} = TN + FP$ 
    - $FP = \text{\# of false positives (i.e. confounders or noise identified as targets)}$ ,
    - $TN = \text{\# of true negatives (i.e. confounders identified as confounders / confounders ignored/not detected)}$
- Then:
  - **Sensitivity** = True Positive Rate (TPR) =  $TP/P$ 
    - The proportion of positive results that are correctly identified as such (number of true positives divided by total number of positives)
    - Related to the ability to correctly detect actual targets, where a higher sensitivity indicates greater confidence that a target was detected and properly discriminated
  - **Specificity** = True Negative Rate (TNR) =  $TN/N$ 
    - The proportion of negative results that are correctly identified as such (number of true negatives divided by the total number of negatives)
    - Related to the ability to disregard confounders, where a higher specificity indicates greater confidence that actual targets were not missed

To further illustrate this point, an example using the nominal results of a representative, controlled test is provided below:

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<sup>2</sup> The minimum magnitude of input signal required to produce a specified output signal having a specified signal-to-noise ratio, or other specified criteria



**Figure 4:** Representative sensitivity and specificity calculations

Note that in the PALS system, an interim set of statistics regarding the biological organism’s acquisition of the target or confounder signal can also be compiled. This interim data is not factored into the program metrics but should be logged for system debugging purposes, and can be used to gain insight into subsystem (biological organism, detection, or analysis) performance.