Defense Advanced Research Projects Agency (DARPA)
2027 DoW Small Business Innovation Research (SBIR)
Annual Broad Agency Announcement (BAA)
Release 2
Proposal Submission Instructions

INTRODUCTION

DARPA's mission is to create and prevent technological surprise for national security. As part of this mission, DARPA makes high-risk, high-reward investments in science and technology that have the potential to disrupt current understandings and/or approaches. The topics that follow focus on technical domains important to DARPA's mission, pursuing innovative research concepts that fall within one of its technical offices. More information about DARPA's technical domains and research topics of interest can be found at https://www.darpa.mil/about/offices. DARPA offers free resources through DARPAConnect to help potential performers navigate DARPA, including "Tips for DARPA Proposal Success." Join DARPAConnect at www.DARPAConnect.us to leverage on-demand learning and networking resources.

The pace of discovery in both science and technology is accelerating worldwide, resulting in new fields of study and the identification of scientific areas ripe for small business utilization through the SBIR and Small Business Technology Transfer (STTR) programs. Small businesses are critical for developing technology to support national security. Proposers are encouraged to consider whether the Research/Research and Development (R/R&D) being proposed to Department of War (DoW) Components also has private sector potential, either for the proposed application or as a base for other applications.

Proposers responding to a topic in this BAA must follow all general instructions provided in the DoW SBIR Program BAA. DARPA requirements, in addition to/or deviating from the DoW SBIR Program BAA, are provided in the instructions below. All DARPA SBIR proposals must be submitted electronically through the DoW SBIR/STTR Innovation Portal (DSIP) as described in the Proposal Preparation and Submission sections of these instructions. It is recommended that organizations register as soon as possible upon identification of a proposal opportunity to avoid delays in the proposal submission process. Proposers are encouraged to submit proposals as early as possible to avoid unexpected delays due to a high volume of traffic during the final hours before a BAA closes. ***DARPA will not accept any late proposals.***

Proposers are encouraged to thoroughly review the DoW SBIR Program BAA and register for the DoW SBIR/STTR Innovation Portal (DSIP) Listserv to remain apprised of important programmatic and contractual changes.

- The DoW SBIR Program BAA is located at: https://www.dodsbirsttr.mil/submissions/solicitation-documents/active-solicitations. Please select the tab for the appropriate BAA cycle.
- Register for the DSIP Listserv at https://secure.campaigner.com/CSB/Public/Form.aspx?fid=667492&ac=g9gk.

Specific questions on the administration of the DARPA SBIR Program and these proposal preparation instructions should be directed to DARPA Small Business Programs Office at SBIR_BAA@darpa.mil. DSIP Topic Q&A will NOT be available for these DARPA topics. Technical questions related to improving the understanding of a topic's requirements must be submitted by **December 30, 2026.**

A small business concern may only submit one (1) proposal to each topic. If more than one proposal from a small business concern is received for a single topic, only the most recent proposal certified and submitted prior to the submission deadline will receive an evaluation. All prior proposals submitted by the small business concern for the same topic will be marked as non-responsive and will not receive an evaluation.

DIRECT TO PHASE II PROPOSAL GUIDELINES
Proposers should refer to the DARPA Direct to Phase II Proposal Instructions provided in Appendix A.

Current Release Award Structure by Topic

White Paper & Slide Deck Proposal

Topic Number	Direct to Phase II					
	Technical Volume		Award Amount	Period of Performance (PoP)	Option Amount	Option PoP
	White Paper	Slide Deck				
DPA27BZ02-DV001	20 pages	15 slides	$1,300,000	18 months	$500,000	6 months
DPA27BZ02-DV002	20 pages	15 slides	$1,500,000	18 months	$500,000	6 months
DPA27BZ02-DV003	20 pages	15 slides	$1,500,000	12 months	$500,000	6 months

Technical Volume (Volume 2) – White Paper & Slide Deck Format (35 pages)
If a proposer can provide adequate documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of the topic has been met and describes the potential commercial applications, the Direct to Phase II (DP2) authority allows DoW to make an award to a small business concern under Phase II of the SBIR program without regard to whether the small business concern was provided an award under Phase I of an SBIR program. This topic is accepting DP2 proposal submissions.

The white paper shall not exceed 20 pages, and the slide deck shall not exceed 15 pages. For information on the content of each of these elements of the Technical Volume and the commercialization strategy, please see Appendix A.

Content of the Technical Volume
Proposers should refer to the DARPA DP2 Proposal Instructions provided in Appendix A.

Cost Volume (Volume 3)
Please see the chart above for award amounts listed by topic. Proposers are required to use the applicable cost proposal template as instructed in Appendix A.

Content of the Cost Volume
Proposers should refer to the DARPA DP2 Proposal Instructions provided in Appendix A.

Company Commercialization Report (CCR) (Volume 4)
Completion of the CCR as Volume 4 of the proposal submission in DSIP is required. Please refer to the DoW SBIR Program BAA for full details on this requirement. DARPA will not consider information contained in the CCR during proposal evaluations.

Supporting Documents (Volume 5)
In addition to the documents required by DoW, small businesses may submit additional documentation to support the Technical Volume (Volume 2) and the Cost Volume (Volume 3) in Volume 5. See Appendix A for required certifications that must be included in Volume 5. For additional details, please refer to the DoW SBIR Program BAA.

Fraud, Waste and Abuse Training (Volume 6)
Fraud, Waste and Abuse training material can be found in the Volume 6 section of the proposal submission module in DSIP and must be thoroughly reviewed once per year to proceed with proposal submission.

Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Volume 7)
Small business concerns must complete the Disclosures of Foreign Affiliations or Relationships to Foreign Countries webform in Volume 7 of the DSIP proposal submission.

DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA)

Section 7 of the Small Business Innovation and Economic Security Act mandates agencies to offer TABA. DARPA will provide up to $6,500 per Phase I project and up to $25,000 for the initial Phase II award.

Note – TABA funding requests will be reviewed by the respective contracting officer and/or specialist at time of award to ensure compliance with TABA requirements. See the DoW SBIR Program BAA for more information and requirements for proposing TABA. To be considered for TABA funding, proposers must provide information about the provider in Vol 5 of their proposal.

MAJORITY OWNERSHIP IN PART BY MULTIPLE VENTURE CAPITAL, HEDGE FUND, AND PRIVATE EQUITY FIRMS

Proposers that are more than 50% owned by multiple venture capital operating companies (VCOC), hedge funds (HF), private equity firms (PEF), or any combination of these as set forth in 13 C.F.R. § 121.702, are eligible to submit proposals in response to DARPA topics advertised within this BAA.

For proposers that are a member of this ownership class, the following must be satisfied for proposals to be accepted and evaluated:

a. Prior to submitting a proposal, firms must register with the SBA Company Registry Database.
b. The proposer, within its submission, must submit the Majority-Owned VCOC, HF, and PEF Certification. A copy of the SBIR VC Certification can be found on https://www.dodsbirsttr.mil/submissions/solicitation-documents/supporting-documents. Include the SBIR VC Certification in the Supporting Documents (Volume 5).
c. Should a proposer become a member of this ownership class after submitting its proposal and prior to any receipt of a funding agreement, the proposer must immediately notify the Contracting Officer, register in the appropriate SBA database, and submit the required certification which can be found at the link referenced in sec b. above.

EVALUATION AND SELECTION

All proposals will be evaluated in accordance with the evaluation criteria listed in the DoW SBIR Program BAA. DARPA will conduct an evaluation of each conforming proposal. Proposals that do not comply with the requirements detailed in this BAA and the research objective(s) of the corresponding topic are considered non-conforming and, therefore, are not evaluated nor considered for award. This includes Direct to Phase II proposals that fail to meet the feasibility requirements outlined in the DARPA topic.

Using the evaluation criteria, the Government will evaluate each proposal in its entirety, documenting the strengths and weaknesses relative to each evaluation criteria. Based on these identified strengths and weaknesses, the Government will determine the proposal's overall selectability for funding. Proposals will not be evaluated against each other during the evaluation process but rather evaluated on their own individual merit to determine how well the proposal meets the criteria stated in this BAA and the corresponding DARPA topic.

Awards 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 DoW SBIR Program BAA and availability of funding.

For the purposes of this proposal evaluation process, a selectable proposal is defined as follows:

Selectable: A selectable proposal is a proposal that the Government has evaluated against the evaluation criteria listed in the DoW SBIR Program BAA and DARPA topic, and the strengths of the overall proposal outweigh its weaknesses. Additionally, there are no accumulated weaknesses that would require extensive negotiations and/or a resubmitted proposal.

For the purposes of this proposal evaluation process, a non-selectable proposal is defined as follows:

Non-Selectable: A proposal is considered non-selectable when the Government has evaluated the proposal against the evaluation criteria listed in the DoW SBIR Program BAA and DARPA topic, and the strengths of the overall proposal do not outweigh its weaknesses.

Proposing firms will be notified of selection or non-selection status for a Phase I or Direct to Phase II award within 90 calendar days of the closing date of the BAA. The Corporate Official (CO) indicated on the Proposal Cover Sheet will be notified by e-mail regarding proposal selection or non-selection. In accordance with the Small Business Administration (SBA) SBIR/STTR Policy Directive, Appendix I, paragraph 4, Method of Selection and Evaluation Criteria, subparagraph (d) Release of Proposal Review Information, DARPA will provide a technical evaluation narrative to the proposer for each proposal submitted in response to a topic. An informal feedback session may be requested by the proposing firm via e-mail at sbir@darpa.mil. The informal feedback is provided at the sole discretion of DARPA.

DARPA requires all proposals to be treated as source selection information and will 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 are expressly prohibited from performing DARPA-sponsored technical research and are bound by appropriate nondisclosure agreements. Input on technical aspects of the proposals may be solicited by DARPA from other Government and/or non-Government consultants/experts who are strictly bound by the appropriate nondisclosure requirements. No submissions in response to the BAA will be returned. Upon completion of the evaluation and selection process, an electronic copy of each proposal received will be retained at DARPA.

Proposal titles, abstracts, anticipated benefits, and keywords of proposals that are selected for contract award will undergo a DARPA Policy and Security Review. Proposal titles, abstracts, anticipated benefits, and keywords are subject to revision and/or redaction by DARPA. Final approved versions of proposal titles, abstracts, anticipated benefits, and keywords may appear on the SBA's SBIR/STTR award website (https://www.sbir.gov/awards).

Refer to the DoW SBIR Program BAA for procedures to protest this BAA. As further prescribed in the Revolutionary Federal Acquisition Regulation Overhaul (RFO Subpart 33.1), protests regarding the selection decision should be submitted to:

DARPA
Contracts Management Office (CMO)
675 N. Randolph Street
Arlington, VA 22203
E-mail: CMO_SBIRProtests@darpa.mil and sbir@darpa.mil

AWARD AND CONTRACT INFORMATION

1. General Award Information

Multiple awards are anticipated. DARPA may award RFO-based Government contracts (Firm- Fixed Price or Cost-Plus Reimbursement) or Other Transactions (OT) for Prototype agreement (under the authority of 10 U.S.C. § 4021) subject to approval of the Contracting Officer or Agreements Officer, respectively.

- Proposers must state their requested contract type in their proposal
    - If requesting a RFO-based Cost-Plus Reimbursement type contract, proposers shall include their Defense Contract Management Agency (DCMA) Final Determination Letter showing approval of the company's Accounting System.
    - If requesting a OT for Prototype, proposers shall include a completed OT in their proposal (Please see Model OT for Prototype provided on the DARPA Small Business site (https://www.darpa.mil/work-with-us/communities/small-business/sbir-sttr-topics). NOTE: Proposers at a minimum need to complete areas as color coded in the template. If proposers wish to negotiate any articles or attachments of the OT, please provide redlines and comments as to why each redline is proposed.
    - If requesting a OT for Prototype, proposers shall include completed OT Certifications, provided on the DARPA Small Business site at https://www.darpa.mil/work-with-us/communities/small-business/sbir-sttr-topics.
    - No additional action is required to be taken by proposers requesting a RFO- based Firm-Fixed Price type contract.

The resources made available for each topic issued 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 BAA and to make awards with or without communications with proposers. Additionally, the Government reserves the right to award all, some, one, or none of the options on the contract(s)/agreement(s) based on available funding and the performer's technical performance. 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. The Government reserves the right to remove a proposal from award consideration should the parties fail to reach an agreement on award terms, conditions, and price within a

reasonable time, and/or the proposer fails to provide requested additional information within three (3) business days.

It is DARPA's goal to award SBIRs and STTRs as expeditiously as possible. In an effort to do so, please review and ensure the DARPA SBIR/STTR Pre-Award Checklist located on the DARPA Small Business website at https://www.darpa.mil/work-with-us/communities/small-business/sbir-sttr-overview/ is completed prior to being selected for award.

In all cases, the Government Contracting/Agreements Officer reserves the right 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 DoW SBIR Program BAA.

All proposers should carefully read the following information about OT awards:

The flexibility of the OT award instrument is beneficial to the program because the performer will be able to apply its commercial best practices as required to carry out the research project that may be outside of the RFO process-driven requirements. Streamlined practices will be used, such as milestone-driven performance, intended to reduce time and effort on award administration tasks and permit performers to focus on the research effort and rapid prototyping. Because of this ability, OTs provide the Agreements Officer the flexibility to create an award instrument that contains terms and conditions that promote commercial transition, reduce some administratively burdensome acquisition regulations, and meet SBIR/STTR program goals.

Please see https://acquisitioninnovation.darpa.mil/what-are-ots for more information on OTs.

2. Cybersecurity Maturity Model Certification (CMMC)

Firms engaging in Controlled Unclassified Information (CUI), Export Controlled (EXPT), or International Traffic in Arms Regulations (ITAR) work for DARPA must have CMMC Level 2 self-assessment certification. Please see https://www.sprs.csd.disa.mil/nistsp.htm for more information. Many resources exist to assist companies with meeting this criterion, one of which is Project Spectrum (http://www.projectspectrum.io). Users can create accounts and gain access to useful tools, including educational videos and material, as well as a cyber self-assessment.

3. Transition and Commercialization Support Program (TCSP)

DARPA will provide services to Phase II or DP2 awardees upon contract execution through TCSP at no cost to awardees. The TCSP goal is to maximize the potential for SBIR/STTR companies to move their technology beyond Phase II and into other research and development programs for further maturity or into solutions or products for DoW acquisition programs, other Federal programs, and/or the commercial market. Please visit https://www.darpa.mil/work-with-us/communities/small-business/transition-commercialization for more information on DARPA TCSP.

ADDITIONAL INFORMATION

DARPA intends to use electronic mail for all correspondence regarding these topics. Questions related to the technical aspect of the research objectives and awards specifically related to a topic should be e-mailed to SBIR_BAA@darpa.mil. **Please reference the topic number in the subject line**. All questions

must be in English and must include the name, e-mail address, and the telephone number of a point of contact.

DARPA will attempt to answer questions in a timely manner; however, questions submitted within seven (7) calendar days of the proposal due date listed herein may not be answered. DARPA will post a consolidated Frequently Asked Questions (FAQ) document. To access the posting please visit: https://www.darpa.mil/work-with-us/communities/small-business/sbir-sttr-topics. Under the topic number summary, there will be a link to the FAQ. The FAQ will be updated on an ongoing basis until one week prior to the proposal due date.

Technical support for the DoW SBIR/STTR Innovation Portal (DSIP) is available Monday through Friday, 9:00 a.m. – 5:00 p.m. ET. Requests for technical support must be emailed to DoDSBIRSupport@reisystems.com with a copy to SBIR_BAA@darpa.mil.

DARPA SBIR DOW 2027 BAA
Topic Index
Release 2

DPA27BZ02-DV001	Hyperdimensional Neurosymbolic Cyber Course-of-Action Planning and Replanning under Deception
DPA27BZ02-DV002	Autonomous Metacognitive Collection Orchestration for Multi-Domain Intelligence
DPA27BZ02-DV003	Human Universal Remote

DPA27BZ02-DV001 TITLE: Hyperdimensional Neurosymbolic Cyber Course-of-Action Planning and Replanning under Deception

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Super Intelligence, Quantum and Battlefield Information Dominance

COMPONENT TECHNOLOGY PRIORITY AREA(S): Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (self)

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate prototype technologies that enable human planners and distributed cyber reasoning elements to generate, compare, explain, and rapidly replan cyber courses of action (COAs) under obfuscation, partial observability, degraded communications, and changing mission constraints using hyperdimensional and neurosymbolic representations that support compact memory, compositional reasoning, analogical retrieval, and low-overhead knowledge sharing.

DESCRIPTION: Future cyber operations will be conducted in contested environments in which observations are incomplete, timing is compressed, adversaries actively manipulate defender beliefs, and the state of the mission cannot be fully observed from any single node or operator position. In such settings, success depends not only on detecting malicious behavior, but on understanding what actions remain feasible, what dependencies govern those actions, which alternatives best satisfy mission objectives, and how plans should be revised as assumptions fail or new opportunities emerge.
Current cyber tools do not adequately support this planning problem. Many existing capabilities focus on alerting, anomaly scoring, static attack-path enumeration, or post hoc analytics. These functions are valuable, but they do not provide operators with an integrated capability to construct, compare, and revise cyber COAs as the environment changes. Rule-based playbooks can be brittle under novelty and obfuscation. Optimization and reinforcement-learning approaches may generate recommendations but often provide limited interpretability and can be difficult to adapt when observations are sparse, manipulated, or only partially relevant. Large-model assistants may accelerate interaction, but by themselves do not provide a persistent, auditable, machine-interpretable planning state suitable for operational use.

This topic seeks a new class of cyber planning technologies built around hyperdimensional, vector-symbolic, neurosymbolic, or closely related compositional reasoning methods. Of particular interest are approaches that maintain explicit internal representations of cyber objectives, prerequisites, access dependencies, branching opportunities, constraints, anticipated adversary reactions, and uncertainty in forms that are robust, updateable, and inspectable by both machines and operators. Hyperdimensional and related high-dimensional symbolic representations are of interest when they enable compact encoding of structured cyber context; efficient binding of entities, roles, temporal order, and dependencies; similarity-based retrieval across partially matching situations; graceful degradation under incomplete or deceptive observations; and deployment in resource-constrained or communications-constrained environments where retraining-heavy or centralized approaches are poor fits.

This topic seeks prototype capabilities that support cyber COA planning and replanning as structured decision processes rather than static checklists. Desired systems should represent plans through inspectable mission graphs, task webs, tiled workspaces, or comparable compositional artifacts in which each element captures sub-objectives, preconditions, dependencies, candidate actions, supporting evidence, uncertainty, timing, cost, reversibility, and mission relevance. The system should generate multiple feasible COAs for a stated objective, compare alternatives using explicit decision criteria, identify key assumptions and information gaps, and recommend revisions when new evidence changes branch viability or reveals newly feasible options.

A responsive solution should not treat hyperdimensional or neurosymbolic reasoning as novelty for its own sake. Instead, the proposer should clearly show how the chosen representation materially improves cyber planning performance in one or more of the following ways:

- compact encoding of evolving cyber context and plan structure without exhaustive recomputation;
- compositional updates as new observations, constraints, or objectives arrive;
- retrieval of relevant prior plan fragments or analogous situations under partial mismatch;
- maintenance of competing plan branches or hypotheses under obfuscation and ambiguity;
- lightweight exchange of decision-relevant symbolic or semantic representation among distributed agents or operator cells;
- interpretable rationale linking recommended actions to plan structure, assumptions, and uncertainty.

Representative operational settings of interest may include distributed mission networks, cyber support to software-reliant tactical platforms, planning for AI-enabled mission systems whose data or control pathways may be degraded or manipulated, or collaborative cyber planning cells operating with intermittent connectivity and incomplete common operating pictures. In these settings, no single operator or software agent may possess the entire relevant state. Accordingly, solutions should support selective sharing of compact, decision-relevant abstractions rather than requiring full-state synchronization, centralized fusion, or cloud-dependent reasoning.
The topic is especially interested in technologies that support one or more of the following planning functions:

- representation of cyber objectives, constraints, prerequisites, opportunities, and dependencies in machine-reasonable structured form;
- generation of multiple feasible COAs rather than a single opaque recommendation;
- comparison and ranking of alternative COAs using explicit criteria such as mission value, exposure, time-to-effect, reversibility, resource burden, and uncertainty;
- rapid replanning when observations are incomplete, delayed, deceptive, or contradictory, or when mission priorities change;
- distributed coordination through compact semantic or symbolic representation appropriate for degraded communications;
- operator-facing explanation that identifies why a plan is recommended, what assumptions drive it, what alternatives remain available, and what additional information would most improve the decision.

This topic is not seeking generic dashboards, static attack-graph visualizers, anomaly detectors, signature-only defenses, or chatbot-style assistants that provide recommendations without persistent structured state and auditable reasoning. Likewise, the topic is not primarily seeking exploit-generation tools, malware development, or automated offensive cyber execution. Proposed efforts should remain centered on interpretable planning and replanning support for cyber decision-making in contested environments. Proposals should clearly define the operational user, the planning loop being supported, the boundaries of autonomy, and the expected decision advantage over current practice. Proposals should also explain why

the chosen hyperdimensional, neurosymbolic, or related representation is superior to conventional rule tables, static graph models, retraining-heavy black-box approaches, or exhaustive search in the proposer's target setting.
Relevant evaluation measures may include, but are not limited to:
time to first viable COA;

- quality and diversity of top-k recommended COAs;
- calibration of predicted plan utility or mission success likelihood;
- replanning latency after injected contradictory, incomplete, or deceptive evidence;
- robustness to novel tactics, techniques, and procedures or unseen mission contexts;
- bandwidth and compute burden for distributed coordination;
- memory, latency, and power performance on representative constrained hardware;
- operator comprehension, trust, workload, and explanation usefulness;
- performance relative to appropriate baseline approaches such as rule-based playbooks, static graph methods, optimization-only planners, reinforcement learning without explicit symbolic structure, or large-language-model-based planning assistants without grounded internal state.

PHASE I: This topic solicits Direct-to-Phase-II (DP2) proposals only. Phase I proposals will not be accepted. Offerors must demonstrate Phase I-equivalent feasibility established outside of the SBIR program. DP2 feasibility documentation should substantiate meaningful prior technical maturity in one or more of the following relevant areas:

- hyperdimensional, vector-symbolic, or neurosymbolic reasoning applied to cyber or mission-planning problems;
- structured cyber COA generation or comparison;
- adaptive replanning under uncertainty, obfuscation, or partial observability;
- distributed reasoning or semantic state sharing under bandwidth or communications constraints;
- operator-facing planning interfaces with interpretable rationale or recommendation support.

Feasibility evidence may include technical reports, white papers, architecture documents, prototype screenshots or videos, publications, patents, test data, cyber-range results, performance measurements, human-user studies, or other documentation sufficient to establish scientific merit, technical feasibility, and implementation maturity.
DP2 feasibility packages should clearly describe:

- the operational problem and target user;
- the core representational and reasoning approach;
- the existing prototype components or demonstrated technical building blocks;
- performance relative to baseline or alternative methods where available;
- major technical risks and mitigation strategy;
- a credible path to an integrated Phase II prototype demonstration in an operationally relevant environment.

PHASE II: Phase II efforts will focus on developing, integrating, and demonstrating an operational prototype for hyperdimensional/neurosymbolic cyber COA planning and replanning under obfuscation. The prototype should enable planners or operators to construct or inspect planning structures, generate and compare multiple candidate COAs, revise recommendations as evidence evolves, and coordinate across distributed reasoning elements under realistic constraints.
At a minimum, the Phase II prototype should demonstrate:

- machine-interpretable representation of cyber objectives, sub-objectives, prerequisites, actions, constraints, dependencies, and uncertainty;
- generation of multiple feasible COAs for at least one representative cyber mission objective;
- comparison and ranking of COAs using explicit decision criteria and interpretable rationale;
- rapid replanning after injected ambiguity, contradiction, obfuscation, or mission change;

- lightweight knowledge exchange among distributed agents or planning cells using compact symbolic or semantic representations;
- operator-facing outputs suitable for human review, modification, intervention, and after-action analysis.

Of particular interest are prototypes that expose modular interfaces, documented APIs, and data structures suitable for future integration with cyber ranges, digital twins, mission rehearsal environments, or government evaluation infrastructure.

Phase II Base (18 months) – Schedule / Milestones / Deliverables

- Month 1: Kickoff briefing and Systems Requirements Review. Deliverables should include updated technical approach, operational scenarios, user roles, architecture, evaluation metrics, baseline comparison plan, key technical risks, and mitigation strategy.
- Month 3: Initial architecture package and end-to-end steel-thread demonstration. Prototype should show ingestion of representative planning context, construction of an initial structured mission graph or equivalent planning artifact, and generation of at least one candidate COA with operator-viewable rationale. Deliverables should include representation strategy, initial data model, and draft user workflow.
- Month 6: Prototype v1 demonstrating generation and comparison of multiple COAs using hyperdimensional/neurosymbolic internal representations. Deliverables should include documented architecture, interface specifications, initial quantitative metrics, and updated test and evaluation plan.
- Month 9: Interim demonstration of rapid replanning in at least one contested scenario involving incomplete, delayed, conflicting, or deceptive observations. The system should show how plan structure, recommended alternatives, and uncertainty change in response to new evidence. Deliverables should include interim performance report and comparison against at least one relevant baseline.
- Month 12: Demonstration of distributed reasoning or coordination under degraded or intermittent communications using compact decision-relevant symbolic or semantic summaries. Deliverables should quantify communications burden, update behavior, and planning performance relative to an appropriate centralized or non-symbolic baseline.
- Month 15: Operationally relevant demonstration with multiple COAs, dynamic mission constraints, and operator-in-the-loop plan revision. Deliverables should include updated APIs, user guidance, architecture documentation, and interim human-factors or usability assessment.
- Month 18: Final Phase II demonstration and report. Deliverables should include documented prototype software, system design documentation, scenario definitions, evaluation results, baseline comparisons, operator guidance, known limitations, and recommended transition path.

Phase II Option (6 months)
If included, the Option period may focus on prototype maturation in a more operationally realistic environment, expanded scenario diversity, stronger red-team challenge problems, or additional integration with government-relevant infrastructure.
Illustrative Option activities may include:

- scaling to larger mission graphs or larger distributed planning teams;
- expanded evaluation against state-of-the-art baseline methods;
- integration with a government-identified cyber range, digital twin, or mission-planning environment;
- demonstration of unseen-scenario generalization and robustness.

Illustrative Option deliverables may include:

Month 21: Expanded prototype demonstration with additional scenario complexity, broader coordination requirements, or stronger adversarial challenge conditions.
Month 24: Final Option-period demonstration and final report documenting performance, scalability, limitations, integration guidance, and transition recommendations.

PHASE III DUAL USE APPLICATIONS: Military applications include cyber mission planning, decision support for software-reliant and AI-enabled systems, decision support for cyber operators in contested environments, planning support for distributed mission networks, cyber range training and rehearsal, and support to broader multi-domain operational planning where cyber actions and dependencies must be reasoned about explicitly.

Commercial applications include enterprise cyber planning, incident response decision support, critical infrastructure resilience, industrial control system operations, managed security operations, complex remediation planning, cloud-edge cyber coordination, and other settings in which organizations must compare and revise multi-step cyber response options under uncertainty, incomplete information, and time pressure.

The resulting technology is intended to provide an interpretable and operationally relevant planning capability rather than a standalone analytic. Transition opportunities may exist wherever rapid comparison and replanning of cyber action sequences are required under constrained communications, partial observability, or high operator workload.

REFERENCES:

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KEYWORDS: Cyber operations, course of action planning, replanning, obfuscation, partial observability, hyperdimensional computing, neurosymbolic reasoning, vector-symbolic architectures, distributed planning, human-machine teaming,

DPA27BZ02-DV002 TITLE: Autonomous Metacognitive Collection Orchestration for Multi-Domain Intelligence

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Super Intelligence, Quantum and Battlefield Information Dominance

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software, Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (self)

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate an autonomous, metacognitive artificial-intelligence capability that orchestrates multi-modal intelligence collection across asynchronous sensing streams and produces traceable, causally-informed recommendations for multi-domain operations. The capability shall decide what evidence to collect, when, and why; weigh expected information gain against hard operational constraints including emissions, bandwidth, power, time-to-decision, and access posture; generate Pareto-optimal option-sets accompanied by “why / why-not” traces reproducible from internal system state; and locally refine its internal representation under denial, deception, or distribution shift without offline retraining. Operator interaction is confined to pre-mission intent specification and after-action audit of the decision record, enabling a human-machine formation in which the capability operates at machine speed inside a commander-specified envelope and the human sets intent, constraints, and rules of engagement at mission entry and reviews the auditable decision record at mission exit.

DESCRIPTION: Modern intelligence, surveillance, and reconnaissance (ISR) enterprises ingest multi-source indicator streams whose native tempos span four or more orders of magnitude. Overhead imagery (EO/IR, SAR, MSI, HSI) arrives at revisit cadences of minutes to hours; RF and SIGINT detections resolve in seconds to minutes; maritime AIS and acoustic returns update continuously at sub-second tempos; and open-source, supply-chain, and pattern-of-life indicators mature over hours to weeks. A single decision of operational consequence, such as whether a vessel of interest is a combatant or a civilian fisher, or whether an observed buildup presages a near-term operation or reflects routine activity, typically turns on whether causally related evidence drawn from several of these phenomenologies can be assembled, reasoned about, and surfaced fast enough and cheaply enough to matter.

Classical early- and late-fusion pipelines assume temporally aligned inputs and emit single snapshot outputs, useful when cadences match and brittle when they differ by orders of magnitude or when a depended-on sensor is denied. Reinforcement- and active-learning policies can select next observations but treat operational constraints as reward-shaped scalars the optimizer can trade away, and require retraining cycles measured in weeks when priority intelligence requirements or adversary tactics shift in hours. Neuro-symbolic and causal methods contribute structure and interpretability, yet in practice operate over hand-authored graphs and synchronous data, with post-hoc explanations rather than forward-looking traces. Agentic large-language-model orchestrators produce narrative rationalizations whose internal state cannot be audited, and whose plans cannot be inspected for constraint feasibility before

execution. What is missing across all of these approaches is a structured, auditable, constraint-feasible substrate whose rationale for each recommendation is transparent, reproducible, and directly inspectable from internal state.

This topic seeks novel approaches to artificial metacognition: an orchestration substrate that reasons about its own reasoning while reasoning about the world. A metacognitive substrate maintains a structured model of evidence-to-outcome relationships across heterogeneous modalities and tempos; tracks its own uncertainty, prediction error, and representational coherence; computes expected information gain for candidate collection actions under hard operational constraints; returns option-sets rather than single collapsed policies; and, when denial, deception, or distribution shift is detected, locally refines its internal model rather than triggering a full retraining cycle. The resulting capability is the computational backbone of a human-machine formation: the autonomous system acts at machine speed inside a bounded operating envelope, while the human commander sets objectives, constraints, and rules of engagement before the mission and reviews the auditable decision record after.

Candidate substrate families for the metacognitive layer include hyperdimensional computing and vector-symbolic architectures; neuro-symbolic architectures that couple learned encoders with symbolic or probabilistic inference; and graph-based reasoning over typed knowledge graphs, causal graphs, and structured inference engines. Hybrids across these approaches are encouraged. This topic is deliberately substrate-agnostic within that class. Offerors are expected to justify their choice on quantitative grounds. Any viable substrate shall provide:

- Compositional, inspectable operators (algebraic, logical, graph-based, or probabilistic) that support real-time assembly and decomposition of multi-source evidence structures, rather than end-to-end learned embeddings whose compositional semantics cannot be examined.
- Bounded degradation under partial, corrupted, delayed, or adversarially manipulated input, quantified against a mainstream deep-learning baseline.
- Transparent, reproducible reasoning operations that yield auditable explanations directly from internal system state, rather than post-hoc narrative produced by a prompted language model.
- Efficient operation under sparse and few-shot regimes, with measurable performance at small label budgets on novel scenario classes.
- A credible path to tactical-edge deployment on Size-Weight-and-Power-constrained platforms.

Recent work across these areas has independently demonstrated subsets of these properties, including graph-structured anomaly reasoning, compositional multi-modal scene understanding, and interpretable edge AI with online adaptation.

Converging them into a single autonomous metacognitive orchestration substrate is the objective of this topic. Approaches that rely on monolithic end-to-end deep networks without compositional or causal structure, or on narrative-only explanations produced by prompted language models, fall outside the scope of this topic.

The program seeks novel approaches to key technical challenges, including:

- Representing and reasoning over time-lagged causal dependencies across multi-modal sensor streams whose native tempos span four or more orders of magnitude, under missing, late, corrupted, and adversarially manipulated inputs.
- Computing expected information gain over candidate collection actions while treating operational constraints (emissions, bandwidth, power, time-to-decision, access) as hard-binding semantic variables rather than reward-shaped scalars, and producing Pareto-optimal option-sets rather than single collapsed policies.

- Self-monitoring the system's own confidence, prediction error, and representational coherence; detecting adversarial denial, deception, and distribution shift as learning signals; and triggering targeted local refinement of the internal model without offline retraining.
- Generating forward-looking "why / why-not" traces, reproducible from internal system state, that link each recommendation to its supporting evidence chain, the constraints it satisfies, the alternatives it dominated, and the expected futures it forecasts, supporting downstream review by a subject-matter expert (SME) or within a human-machine formation.
- Probabilistic root-cause analysis of observed outcomes, tracing back through the internal representation to identify contributing evidence across domains and timescales, with ranked alternative hypotheses and quantified confidence.

PHASE I: This SBIR topic is open to Direct-to-Phase-II (DP2) proposals only. Phase I proposals will not be accepted or reviewed. DP2 feasibility shall be substantiated through prior work completed outside of the SBIR program. Acceptable evidence includes peer-reviewed publications, pre-prints, patents, prototype demonstrations with video or data artifacts, technical reports, and test-and-measurement data. Proposers shall demonstrate scientific and technical merit and feasibility across the criteria below, each with quantitative side-by-side comparison against at least one mainstream baseline (classical fusion, reinforcement or active learning, agentic-LLM orchestration, or equivalent) on a shared task.

- Structured reasoning over asynchronous multi-source evidence. Evidence of a compositional or causally-structured representation, built using hyperdimensional and vector-symbolic architectures (HDC/VSA), neuro-symbolic, graph-based reasoning, or a hybrid, operating across at least two heterogeneous modalities whose native tempos differ by two or more orders of magnitude. The proposer shall characterize the substrate using metrics appropriate to the chosen family (for example, similarity-based retrieval and compositional-capacity metrics for HDC/VSA; inference accuracy and rule-coverage for neuro-symbolic; path-query accuracy and graph-completion metrics for graph-based) and quantify performance under at least 20 percent missing or delayed inputs.
- Cost-aware, forward-looking action selection. Evidence of an information-gain or value-of-information planning capability, implemented by any appropriate technique including adaptive submodular optimization, constrained partially-observable Markov decision processes, information-theoretic sensor selection, or equivalent, that incorporates at least one operational cost term (power, emissions, bandwidth, or latency) and produces multiple candidate actions or an option-set rather than a single collapsed policy, with quantitative information-per-cost gains over a uniform, random, or reactive baseline.
- Auditable decision outputs grounded in internal state. Example decision outputs accompanied by traces, reproducible from internal system state, that identify which evidence and which reasoning pathway drove each recommendation and, where applicable, which alternatives were dominated and why.

The DP2 feasibility documentation package shall include a consolidated technical report summarizing the criteria above with quantitative metrics; substantiating publications, reports, or artifacts; video or data artifacts demonstrating operation on at least one multi-domain task with asynchronous inputs; a risk register identifying the highest technical and programmatic risks with mitigations; and a Phase II transition plan.

PHASE II: The goal of Phase II is to mature the DP2-validated capability into an operationally representative prototype of an autonomous metacognitive orchestration engine for multi-domain intelligence collection, suitable for integration into a human-machine formation. The prototype shall be demonstrated against at least one mainstream baseline family (classical fusion, reinforcement or active learning, or agentic-LLM orchestration) on shared tasks. The capability shall advance from TRL 4 at

award to TRL 6 by the end of Phase II. Phase II is a 24-month period with all required capabilities, targets, and capstone demonstrations completed within this period.
DP2 proposals should:

- describe a proposal to achieve the aforementioned goals;
- present a technical plan and approach, with notable risks and mitigations; and
- detail proposed metrics, baselines, and scenarios for final evaluation, aligned with the quantitative targets.

Staged modality scope. The Phase II effort is staged by modality count. In Months 1 through 12, the prototype shall operate across at least two heterogeneous modalities whose native tempos differ by two or more orders of magnitude, demonstrating the full required capability set on that two-modality configuration. In Months 12 through 24, the prototype shall scale to at least four heterogeneous modalities and shall be evaluated against active adversarial denial and deception, integration with one analytic or data-fabric environment identified during the period, hardening for tactical-edge deployment on Size-Weight-and-Power-constrained platforms in denied, degraded, intermittent, and limited-bandwidth (DDIL) settings, and human-machine-formation integration.

At the end of Phase II the integrated prototype shall demonstrate:

- Asynchronous multi-source ingest. Streaming ingest from at least four disparate modalities through modular encoder interfaces, with demonstrated tolerance to missing, late, corrupted, and spoofed streams.
- Compositional reasoning at multiple abstraction levels. A hierarchical structured representation, built in the proposer's chosen substrate family, that supports primitive (sensor-level), composite (cross-sensor spatio-temporal), and semantic (contextual) abstractions, updated continuously from telemetry.
- Cost-aware, forward-looking collection planning. Computation of expected information gain over candidate collection actions, discounted by tunable cost terms including at minimum emissions or signature, power, latency, and bandwidth, with generation of Pareto-optimal option-sets rather than single collapsed policies.
- Auditable decision traces. Forward-looking "why / why-not" explanations for each recommendation, reproducible from internal system state, identifying supporting evidence, constraints satisfied, and dominated alternatives. Narrative-only explanations produced by prompted language models are not acceptable.
- Real-time re-orchestration without offline retraining. Replanning under sensor loss, intermittent denial, deception injection, or changes in specified objectives and weights, at plan-refresh latency below 3 minutes.
- Probabilistic root-cause analysis. Tracing observed outcomes back to contributing evidence across modalities and timescales, with ranked alternative hypotheses and quantified confidence.
- Metacognitive self-assessment and adaptation. Detection of internal reasoning drift, adversarial manipulation, or distribution shift, and targeted local refinement of the internal representation without offline retraining. Preserved or improved performance across at least five repeated exposures to the same class of adversarial perturbation, relative to a baseline that must retrain to recover, is the primary evidence of this capability.
- Human-machine-formation integration. Modular, open-schema APIs for option-sets, explanations, and constraints, suitable for integration with analytic and data-fabric environments used by a human-machine formation, together with a documented commander-intent interface for pre-mission specification and an after-action audit interface for post-mission review.

Baselines and the capstone scenario set will be finalized with the Program Manager at kickoff. At least one capstone scenario shall involve active adversarial denial or deception. Quantitative goals to be met or exceeded by the end of Phase II include:

- Time-to-decisive-cue at least 35 percent faster than a reactive fusion baseline at fixed sensing budget.
- Information-gain per unit energy at least 2 times over a reactive fusion baseline on an energy-instrumented testbed.
- Operational-constraint violation rate (including emissions-control posture) below 5 percent under adversarial stress.
- Plan-refresh latency below 3 minutes under induced sensor loss, deception injection, or mid-mission objective change.
- Subject-matter expert coherence rating of "why / why-not" traces at or above 85 percent against doctrine-aligned rubrics.

The following schedule of milestones and deliverables is provided to establish expectations for the Phase II effort. Proposers shall execute a Research and Development plan as described in their proposal, including the following:

- Month 1. Kickoff briefing (with annotated slides) to the DARPA Program Manager (PM), including any updates to the proposed plan and technical approach, risks and mitigations, schedule with planned capability milestones and deliverables, proposed metrics and baselines, specification of open-schema interfaces for option-sets, explanations, and constraints, and the planned human-machine-formation integration approach.
- Month 3. Architecture Design Review. Formal specification of the structured representation, value-of-information planner, and metacognitive self-assessment layer. Baseline benchmarks on one multi-domain scenario involving two modalities at asynchronous tempos and two operational cost terms. Quarterly technical progress report.
- Month 6. Two-modality prototype demonstration with asynchronous ingest and primitive-level structured reasoning; initial cost-aware planning with two cost terms and option-set generation; quantitative comparison against the reactive fusion baseline on time-to-cue and information-per-cost. Quarterly technical progress report.
- Month 9. Interim technical progress briefing (with annotated slides) to the DARPA PM. Demonstration of constraint-aware re-orchestration under induced sensor loss and mid-mission objective change; first SME evaluation of "why / why-not" traces against doctrine-aligned rubrics; updated risks, mitigations, and technical plan for the second half of Phase II.
- Month 12. Two-modality Critical Design Review. Integrated demonstration of the required capability set on the two-modality configuration with asynchronous ingest, meeting or approaching the 35 percent time-to-decisive-cue, 2x information-per-watt, and below-3-minute plan-refresh targets. Documented transition plan from two-modality to four-modality scope. Quarterly technical progress report.
- Month 15. Four-modality ingest and primitive-through-semantic reasoning demonstration. Quantitative results on representational capacity, noise tolerance, and inference latency on four modalities. First integration with an analytic or data-fabric environment identified during the first half of Phase II.
- Month 18. Metacognitive adaptation demonstration. Scripted denial-and-deception injection. Quantitative demonstration of performance preservation or improvement across at least five repeated adversarial exposures without external retraining, compared against a baseline that must retrain to recover. Quarterly technical progress report.

Option Milestones

- Month 21. Human-machine-formation integration and tactical-edge hardening. Full quantitative-target evaluation on at least two capstone scenarios, including at least one with active adversarial denial or deception. Commander-intent and after-action-audit interfaces exercised with SMEs. Quarterly technical progress report.

- Month 24. Final technical progress briefing (with annotated slides) to the DARPA PM. Capstone across four modalities on at least three scenarios drawn from the kickoff-agreed set. Final Phase II Report documenting architecture, algorithms, evaluation methodology, quantitative results against all Phase II quantitative goals, API specifications, user and administrator manuals, adversarial-robustness characterization, commercialization plan, and a Phase III transition plan with named non-SBIR funding source(s).

Capstone scenarios. The prototype shall be demonstrated on at least three scenarios drawn from the categories below, agreed with the Program Manager at kickoff. At least one shall involve active adversarial denial or deception.

Scenario 1. Multi-modal collection under emissions control. Orchestrate collection across EO/IR, SAR, RF, and AIS (or equivalent) modalities under a restrictive emissions-control posture with variable spectrum availability. Demonstrate improved information-gain-per-cost against the proposer's chosen baseline, emissions posture enforced as a hard constraint, bounded degradation under spectrum denial, and recovery when access is restored. Include a scripted injection of a contact-of-interest whose correct classification requires cross-referencing at least three modalities.

Scenario 2. Cross-INT corroboration within a human-machine formation. Support development of a decision product that requires corroboration across at least three independent modalities against a commander-specified hold-fire confidence threshold. Demonstrate that the engine autonomously sequences supporting collection (for example, tasks a revisit to disambiguate an ambiguous cue), returns option-sets at varying confidence, latency, and signature trade-offs, surfaces a reproducible decision trace for downstream review within the human-machine formation, and declines to cross the threshold when corroboration is insufficient, articulating why.

Scenario 3. Denial-and-deception resilience with metacognitive adaptation. Against scripted adversarial injection of coordinated deceptive indicators (spoofed tracks, falsified pattern-of-life, counterfeit logistics signatures, misleading RF emissions), detect semantic incoherence through metacognitive self-assessment and autonomously refine the internal representation to compensate. Demonstrate that performance is preserved or improved across at least five repeated adversarial exposures, measured against a baseline that must retrain to recover.

The awardee shall participate in at least one simulation exercise or demonstration event during the 24-month period of performance, coordinated with the Program Manager.

PHASE III DUAL USE APPLICATIONS: Phase III work will be oriented toward transition and commercialization. Funding is obtained from the private sector, a non-SBIR Government source, or both, to develop the prototype into a viable product or non-R&D service for sale in military or private-sector markets. Military applications include autonomous orchestration of persistent multi-domain ISR collection; multi-INT corroboration and decision support for Joint and Combined Joint All-Domain Command and Control (JADC2 / CJADC2) mission threads; cross-domain indications and warning at theater scale; and human-machine-formation decision tooling for multi-domain formations operating under emissions, bandwidth, and access constraints. The capability's constraint-aware, causally-informed, and auditable reasoning directly supports Department of Defense Responsible AI principles and downstream Operational Test and Evaluation, Mission Assurance, and Authority-to-Operate review processes for AI capabilities that influence collection, tasking, and other consequential decisions. Naval Information Warfare Center Pacific (NIWC Pacific) is a representative candidate Government transition venue. Additional transition opportunities will be identified during execution.

Commercial applications are broad and immediate. The underlying capability (constraint-aware, auditable orchestration of heterogeneous asynchronous multi-source evidence, with operator-retunable objectives and without retraining cycles) is directly applicable to commercial satellite-constellation tasking and cross-mission sensor-resource management; maritime-domain-awareness products for port authorities, coast guards, and commercial insurers; critical-infrastructure monitoring across electricity, water, transportation, and pipeline sectors; supply-chain security and provenance verification; public-health biosurveillance; sensor-resource management for commercial autonomous fleets; and enterprise security-operations-center augmentation in which heterogeneous multi-modal indicators must be correlated under cost, latency, and regulatory constraints.

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KEYWORDS: Metacognitive AI; Causal Reasoning; Compositional Reasoning; Graph-Based Reasoning; Neuro-Symbolic AI; Hyperdimensional Computing; Human-Machine Formation; Multi-INT Orchestration; Persistent ISR; Value of Information; Explainable AI; Auton

DPA27BZ02-DV003 TITLE: Human Universal Remote

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Super Intelligence

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software,Biotechnology,Human-Machine Interfaces,Integrated Network Systems-of-Systems, Microelectronics

PROJECTED CMMC LEVEL REQUIREMENT: Level 2 (Self)

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: The objective of the Human Universal Remote DP2 SBIR topic is to further develop surface electromyography (sEMG) sensors, piezoelectric micromachined ultrasonic transducers (PMUTs), or other non-invasive sensor modalities as a user interface for warfighter multi-system operations1-6. The cited references serve as representative baselines of the state-of-the-art human machine interfaces and do not limit the scope of acceptable technical approaches.

The vision is for a single warfighter to execute simultaneous, multi-domain tasks without compromising their primary physical posture or situational awareness. For example, controlling a drone while handling a rifle, or sending/receiving audible, out of line-of-sight communications via radio without speaking. The envisioned system may combine micro-scale ultrasonic cellular stimulation, ultrasound and EMG sensor fusion, and deep learning driven gesture recognition. The system must translate and discern between sub-millimeter muscle contractions and intentional, full-range movements to trigger external system commands. In a series of readiness tests, performers will develop the sensor suite and processing framework to serve as a hands-free, eyes-free human-machine interface for multi-system warfighter operations.

DESCRIPTION: Surface electromyography (sEMG) is a proven technique for detecting biomedical voltage measurements from the skin generated by the electrical current of muscle fibers during skeletal muscle contraction and relaxation. These signals, which reflect neuromuscular activity, typically range in amplitude from 0 to 10 millivolts and operate at frequencies between 20 and 450 Hz. While historically used to restore hand function for transradial amputees via non-invasive fiber membrane potential measurement, this topic proposes leveraging state-of-the-art sEMG in concert with other non-invasive muscle sensing modalities to significantly enhance the operational capability of the warfighter. For example, ultrasound is a high-resolution non-invasive sensing modality capable of probing deep muscle tissues and providing complementary information to electromyographic signals. This topic is divided into two distinct, parallel Technical Areas (TAs) that must be addressed concurrently. Proposers must deliver an integrated solution spanning both domains:

Technical Area 1 (TA1): Microphone
Signal capture will focus on the non-invasive detection and extraction of EMG signals and/or electrical, acoustic deep muscle sensing signals from the user. The approach should include the utilization of signals for arm control as both a command and as biological sensors to understand where muscle activity is

occurring and to function as an active indicator of warfighter stress. Hardware systems developed under this Technical Area must reliably detect, isolate, and extract these microvolt-to-millivolt level biopotential signals directly from the warfighter's skin without invasive techniques. Proposers should address the following TA1 criteria:

TA1 Criteria	Description
Array design	Single or multimodal sensor arrays that conform to the forearm or targeted muscle groups
Form factor	Integrates with standard-issue warfighter apparel without causing skin irritation or impeding range of motion over extended wear
Ruggedization	Maintain a high signal-to-noise ratio under stress: • Sweat • Dynamic movement & collision resistance • Electromagnetic interference
Dual-use sensing	Capture intent-driven neuromuscular firing patterns to facilitate hands-free control of external systems while serving as passive biological monitoring of muscle fatigue, physical overexertion, and cognitive stress
Calibration	The system must be designed for recalibration once during initial outfitting of the sensor array onto the warfighter. Calibration techniques should require minimal to no additional cognitive load and take as much time as to be doable during mission briefing.

Technical Area 2 (TA2): Speaker

This Technical Area focuses on translating decoded physiological intent into standardized, platform-agnostic output modalities. The system must reliably differentiate between passive muscle strain and active, intentional micro- and macro-gestures to generate high-confidence external commands. The approach should include command output that translates the processed signals into an actionable trigger via standard communications channels designed for easy integration into Team Awareness Kit (TAK). To prevent over-engineering to a singular use case or platform, the generated signaling protocol should be standardizable for use across multiple external systems. At a minimum, the platform should be built with at least one communications channel using radiofrequency (RF). Example platforms include enabling users to task robotic systems, low-level ISR drones, comms drones, trigger communications, and generate visual indicators directly on a TAK display. Proposers should address the following TA2 criteria:

TA2 Criteria	Description
Compute	Implement low latency machine learning or pattern-recognition algorithms capable of running on power-constrained processors
Modular Output	Generate control packets transmittable via RF waveforms such as Bluetooth

Multi-Platform	Validate the versatility of decoded gesture triggers (pick 2): • Android TAK (ATAK) Control • Communication Device Control • Communication Transmission • Unmanned System Tasking (Air, Ground, Water, etc.)

PHASE I: Since this is a DP2 topic ONLY, a successful proposal must already contain evidence of a working prototype. The success criteria for a working prototype are the following:

- Working non-invasive sEMG sensor array that employs a computationally efficient machine-learning based control algorithm driven by input from a high-density array of electrodes.
- Functioning hardware that interfaces with a machine learning algorithm capable of real-time gesture classification.
- A developed training and calibration software interface that prompts users through gesture protocols, records performance metrics, measures gesture classification accuracy, and misclassification error rates.

The above information should be presented in such a manner that it is evident that the proposer's prototype technology can be tailored to meet the criteria in Phase II.

PHASE II: A successful proposal will address the overarching technical areas with performer-defined metrics over the course of 18 months or less. The program is structured with readiness tests at Month 12 and Month 18. Proposers will be expected to define at least one deliverable per month to meet incremental technical milestones to sufficiently advance the technology to meet the Controlled Environment Readiness and Environmental Resilience tests. Proposals should outline a work plan to technically advance the design to meet the demonstration scenarios within the provided timeline.

Controlled Environment Readiness Test – Jam Session
This readiness test will serve as the gatekeeper metric to prove the system can successfully transition from controlled development environments into unpredictable operational settings. The system must be tested on a diverse cohort of previously untrained and unexposed human subjects. The software calibration must adapt to varied anatomical structures, body mass indexes, and physiological signal variations without developer intervention. Testing will occur during a series of continuous baseline of physical activities. These activities will include high-exertion tasks designed to introduce physical noise to test rejection of background muscle activity. While performing the baseline physical activities, subjects will be prompted to execute specific micro- and macro-command gestures. The system must dynamically isolate and decode these intentional commands from the background physiological "noise" of the active baseline tasks.

Session Criteria	**Description**
Gesture accuracy	92% true-positive command recognition across the user pool
False alarm	2% accidental command triggers during continuous baseline physical activities
Calibration	Calibration and training in under 30 minutes

Environmental Resilience – Arena Concert
The Month 18 evaluation will transition the system from controlled laboratory settings into an austere field environment at a representative military training installation (e.g., Marine Corps Base Camp Pendleton), subjecting the user to the following parameters while executing gestures for one command output that translates the processed signals into an actionable trigger via RF and/or ATAK integrations:

- Ingress Protection (IP) rating IP68
- In tandem with standard military uniform/dress
- Chemical, biological, radiological, and nuclear (CBRN) protective gear
- High-exertion physical activity/collision testing
- Simulated weapon manipulation

Gesture Output can include any of the following, for example:

- Audible communication without speaking and out of line-of-sight
  - Ground and Water Testing
- Autonomous system tasking of any variety
- TAK manipulation
- Radio control
- Demonstration of ability to remove radio from weapons space

Concert Criteria	**Description**
Gesture accuracy	92% true-positive command recognition across the user pool
False alarm	2% accidental command triggers during physical activities
Calibration	Calibration and training in under 30 minutes

PHASE III DUAL USE APPLICATIONS: Phase III will be oriented toward military transition and further commercialization.

- Military: Autonomous system tasking, enabling raid teams to communicate without speaking, and providing visuals and status through fatal funnel.
- Commercial: Accessibility technology, quantitative biomechanical baselines to monitor neuromuscular health for rehabilitation, open-source code for personal drone piloting and gaming applications.

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KEYWORDS: Human Remote Control, Human Universal Remote, Autonomous System Tasking, Wearables, EMG, Human/Machine Teaming, Human/Machine Interface, Biosignal Translation

APPENDIX A: DARPA DIRECT TO PHASE II (DP2) PROPOSAL INSTRUCTIONS

I. Introduction

A complete proposal submission consists of:

Volume 1: Proposal Cover Sheet
Volume 2: Technical Volume (feasibility documentation and technical proposal)
Volume 3: Cost Volume
Volume 4: Company Commercialization Report
Volume 5: Supporting Documents
- a. Subcontract Pricing Considerations (if applicable)
- b. Data Rights Assertions (if applicable)
- c. Verification of Eligibility of Small Business Joint Ventures (Attachment 3), if applicable
- d. Required TABA documentation (if applicable)
- e. Other supporting documentation

A completed proposal submission in DSIP does NOT indicate that the mandatory supporting documents have been uploaded. It is the responsibility of the proposing small business concern to ensure that the mandatory documents listed above have been uploaded and included with the proposal submission.

Volume 6: Fraud, Waste and Abuse Training
Volume 7: Disclosures of Foreign Affiliations or Relationships to Foreign Countries

The DoW SBIR/STTR Innovation Portal (DSIP) provides a structure for building the proposal volumes and submitting a consolidated proposal package. If this is your first time submitting an SBIR or STTR proposal using DSIP, please review detailed training guides at https://www.dodsbirsttr.mil/submissions/learning-support/training-materials. It is the responsibility of the proposing firm to ensure that a complete proposal package is certified and submitted by the close date listed in the topic to which they are responding. ***DARPA cannot accept late proposals.***

To assist in proposal development, templates for Volume 2: Technical Volume and Volume 3: Cost Volume have been provided as attachments to the announcement posted at https://www.dodsbirsttr.mil/submissions/login., and are also available on the DARPA Small Business site at https://www.darpa.mil/work-with-us/communities/small-business/sbir-sttr-topics. Use of these templates is mandatory.

Proposers should ensure that they have an accurate and active entity registration on SAM.gov, and those engaging in International Traffic in Arms Regulations (ITAR) or Controlled Unclassified Information (CUI) work for DARPA must have Level 2 CMMC certification. Please see https://www.sprs.csd.disa.mil/nistsp.htm for more information. Many resources exist to assist companies with meeting this criterion, one of which is Project Spectrum (http://www.projectspectrum.io). Users can create accounts and gain access to useful tools, including educational videos and material, as well as a cyber self-assessment.

II. Proprietary Information

Proposers that include in their proposals data that they do not want disclosed to the public for any purpose, or used by the Government except for evaluation purposes, shall follow instructions in the DoW SBIR Program BAA regarding marking propriety proposal information.

III. DP2 Proposal Instructions

a. Classification and Marking of Proposal Submission

1. **All proposals are required to be UNCLASSIFIED or CUI. Do not include any classified information in your proposal submission.**

2. Do not include any proprietary information (PROPIN) on the Proposal Coversheet (Volume 1), as this may be released publicly, if selected for award.

3. PROPIN or any other CUI information may be included in the Technical Volume (Volume 2), as needed. Ensure that the document is marked appropriately as CUI with the appropriate CUI Control Block on the first page of Volume 2.

4. The Cost Volume (Volume 3) should be marked CUI for PROPIN as it includes the proposer's budget/cost information.

5. Volumes 4-7 should be marked as appropriate based on content included in each volume. For additional CUI marking information refer to https://www.archives.gov/cui/registry/category-list to properly identify the categories of CUI.

b. Proposal Cover Sheet (Volume 1)

The Cover Sheet must include a brief technical abstract of no more than 3000 characters that describes the proposed R&D project with a discussion of anticipated benefits and potential commercial applications. Do not include proprietary or classified information in the Proposal Cover Sheet. If your proposal is selected for award, the technical abstract and discussion of anticipated benefits may be publicly released.

c. Format of the Technical Volume (Volume 2) – White Paper & Slide Deck

1. The Technical Volume must include two parts, PART ONE: white paper and PART TWO: slide deck, combined as a single Portable Document Format (PDF) for upload to DSIP. See **Sec II** of the Direct to Phase II Template – Volume 2: Feasibility Documentation and Technical Proposal at https://www.darpa.mil/work-with-us/communities/small-business/sbir-sttr-topics.

2. Type of file: The Technical Volume must be a single PDF file, including graphics. Perform a virus check before uploading the Technical Volume file. If a virus is detected, it may cause rejection of the proposal. Do not lock or encrypt the uploaded file. Do not include or embed active graphics such as videos, moving pictures, or other similar media in the document.

1. Length: The length of each part of the technical volume (white paper and slide deck) will be specified by the corresponding topic. The Government will not consider pages in excess of the page count limitations.

2. Layout: Number all pages of your proposal consecutively. Font size should not be smaller than 10-point on standard 8-1/2" x 11" paper with one-inch margins. The header on each page of the Technical Volume should contain your company name, topic number, and proposal number assigned by DSIP when the Cover Sheet was created. The header may be included in the one-inch margin.

d. Content of the Technical Volume (Volume 2) – White Paper & Slide Deck

White Paper (NTE 20 pages). Provide the following information:
Goals and Impact: Clearly describe what is being proposed and what difference it will make (qualitatively and quantitatively), including a brief discussion on how this directly relates to the topic.

1. Phase I Feasibility: This topic is accepting Direct to Phase II proposals ONLY. To be eligible, proposers must demonstrate that the documented feasibility work as required in the topic has been achieved outside of the SBIR/STTR programs.

2. Technical Plan: Outline and address all technical areas and challenges inherent in the approach and possible solutions for overcoming potential problems. Provide specific objectives, metrics, and milestones at intermediate stages to demonstrate a plan for accomplishment of the project objectives. Propose additional appropriate qualitative and quantitative metrics specific to the approach, as needed. Intermediary milestones should occur at no greater than 1-month increments.

3. Management and Capabilities: Designate key personnel who will be involved in the Phase II effort. Provide a summary of expertise of the team, including subcontractors and key personnel. Describe the organizational experience in this technology area, previous work not directly related to the proposed effort, but similar, 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.

4. Transition and Commercialization Plan:
   a) Describe the commercial product or DoW system to be developed.
   b) Discuss the potential end users – DoW, Federal, and/or private sector customers. Discuss your business model for this technology (i.e., how you anticipate generating revenue with this technology?). Who are you selling to directly or indirectly, a supplier, an integrator, or an end user?
   c) Describe your company's funding history. Discuss how much additional funding above this proposed effort (include additional required technology development, staffing requirements, infrastructure requirements, IP strategy costs, etc.) that will be required to bring this technology to market and how you anticipate going about getting that funding (e.g., Govt S&T contracts, investment).
   d) Describe the timeline to maturity for sales or transition to an end user. Describe your IP strategy.
   e) Describe the technology, market, team and business risks associated with this proposed effort and your plan to mitigate these risks.

Slide Deck (not to exceed 15 slides). Provide the following information (convert the completed deck to a PDF and attach it to the white paper):

1. What are you trying to do and how does this directly relate to the topic?

2. Technology and commercial product: Specifically, what are you proposing to produce – software, system, application? Be specific on what your proposed technology development is targeting as an end state.

3. How is the technology approached today? Who is doing the research, development and delivering products/services? What are the current limitations in the technology and commercial marketplaces?

4. Technical and commercial value proposition: How have you substantiated the feasibility of your approach? What is innovative in your approach and how does it compare to the state-of-the-art? Why do you think it will be successful both from a technical and commercial perspective? If you are successful, what difference will it make? Discuss your proposed business model – how do you expect to generate revenue from your technology?

5. Technical and commercial risks: What are the key technical and commercial challenges and how do you plan to address/overcome these?

6. Technical and commercial market analysis: Who will care and what will the impact be if you are successful? What/who are the markets/industries/integrators/stakeholders that would/should care?

7. Cost, schedule and milestones: Provide a summary of your cost volume. Provide a summary of your schedule and milestones. How much will your proposed effort cost in total? How long will it take? What are your technical milestones for achieving the proposed efforts? What are your transition and commercialization plan milestones? Discuss how much funding will be required to bring your proposed technology to market and execute your proposed transition and commercialization plan. Include any funding raised to date and expected plans for raising any additional required funding (Government contracting revenue, product sales, internal R&D investment, loan, angel or Venture Capital investment, etc.). Describe timeline to maturity for operational use or commercial sales.

8. Management: Overview of team, facilities and qualifications.

9. Technical summary quad chart: Use template provided at https://www.darpa.mil/work-with-us/communities/small-business/sbir-sttr-topics.

10. Commercialization summary quad chart: Use the DARPA Transition and Commercialization Strategy Plan (TCSP) Quad template, located at https://www.darpa.mil/work-with-us/communities/small-business/transition-commercialization/.

NOTE: All letters of recommendation, CVs, and Data Rights Assertions (see Direct to Phase II Template – Volume 2: Technical Volume at https://www.darpa.mil/work-with-us/communities/small-business/sbir-sttr-topics for details on data rights assertions) can be loaded in Volume 5: Supporting Documents.

e. Format of Cost Volume (Volume 3)

Proposers are required to use the Direct to Phase II – Volume 3: Cost Proposal Template (Excel Spreadsheet) provided at https://www.darpa.mil/work-with-us/communities/small-business/sbir-sttr-topics. The Cost Volume (and supporting documentation) DOES NOT count toward the page limit of the Technical Volume.

Subcontractors should use this document for unsanitized cost proposals and send them to SBIR_BAA@darpa.mil.

f. Content of the Cost Volume (Volume 3)

Some items in the Cost Breakdown Guidance below may not apply to the proposed project. If such is the case, there is no need to provide information on every item.

ALL proposed costs should be accompanied by documentation to substantiate how the cost was derived. For example, if contractors:

- Propose direct labor costs, contractors could provide current paystubs for proposed employees, or a rate agreement with DCMA, etc.
- Propose consultant costs, contractors could provide historical invoices, current contract with consultant, etc.
- Propose to purchase materials or equipment; you could provide historical invoices, current quotes, market research for those items, etc.

The above list is purely for informational purposes and does not limit the proposer from proposing other costs. Again, however, all costs must be accompanied by substantiating documentation.

Proposers do not necessarily have to propose the cheapest item or supplier, but you should explain your decision to choose one item or supplier over another. It is important to provide enough information to allow contracting personnel to understand how the proposer plans to use the requested funds. If selected for award, failure to include the documentation with your proposal will delay contract negotiation, and the proposer will be asked to submit the necessary documentation to the Contracting Officer to substantiate costs (e.g., cost estimates for equipment, materials, and consultants or subcontractors). It is important to respond as quickly as possible to the Contracting Officer's request for documentation.

Cost Breakdown Guidance:

- List all key personnel by name as well as by number of hours dedicated to the project as direct labor. Special tooling and test equipment and material cost may be included. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the Government or acquired with Government funds will be vested with DARPA; unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DARPA.
- Cost sharing is permitted for proposals under this announcement; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.
- All subcontractor costs and consultant costs must be detailed at the same level as prime contractor costs in regard to labor, travel, equipment, etc. All subcontractor costs must be substantiated with Subcontractor Pricing Considerations. Enter this information in the Explanatory Material section of the online cost proposal form. **NOTE: If proposing subcontractors, contractors must satisfy the requirement of RFO Part 15.404-8(b)(3), Subcontract Pricing Considerations, stated below:**

  (b) The prime contractor or subcontractor shall-
  (1) Conduct appropriate cost or price analyses to establish the reasonableness of proposed subcontract prices;
  (2) Include the results of these analyses in the price proposal

- The Supporting Documents Volume (Volume 5) may be used for this documentation.

- If Subcontractors will be performing Fundamental Research under the effort, please incorporate the following into proposal: 1) a separate SOW outlining the specific work that the proposer finds to qualify as Fundamental Research; OR 2) Within Prime contractor SOW identify which tasks are to be performed that are fundamental research.
- For more information about cost proposals and accounting standards, see the DCAA publication titled "Audit Process Overview – Information for Contractors" available at http://www.dcaa.mil.

g. Company Commercialization Report (Volume 4)

The Company Commercialization Report (CCR) allows companies to report funding outcomes resulting from prior SBIR and STTR awards. The Company Commercialization Report (CCR) is required for Phase I and Direct to Phase II proposals. Please refer to the DoW SBIR Program BAA for full details on this requirement. Information contained in the CCR will not be considered by DARPA during proposal evaluations.

h. Supporting Documents (Volume 5)

In addition to required DoW documentation and certifications, small businesses may also submit additional documentation to support the Technical Volume (Volume 2) and the Cost Volume (Volume 3) in Volume 5. See Appendix A Introduction and the SBIR Annual Program Broad Agency Announcement (BAA) at https://www.dodsbirsttr.mil/submissions/solicitation-documents/active-solicitations for **required** certifications that must be included in Volume 5.

i. Fraud, Waste and Abuse (Volume 6)

The Fraud, Waste and Abuse (FWA) training is required for Phase I and Direct to Phase II proposals. FWA training provides information on what represents FWA in the SBIR/STTR program, the most common mistakes that lead to FWA, as well as the penalties and ways to prevent FWA in your firm. This training material must be thoroughly reviewed once per year. Plan ahead and leave ample time to complete this training based on the proposal submission deadline. Knowingly and willfully making any false, fictitious, or fraudulent statements or representations may be a felony under the Federal Criminal False Statement Act (18 U.S.C. § 1001), punishable by a fine of up to $10,000, up to five years in prison, or both. Understanding the indicators and types of fraud, waste and abuse that can occur is critical for the SBIR/STTR awardees' role in preventing the loss of research dollars.

j. Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Volume 7)
In accordance with Section 4 of the SBIR and STTR Extension Act of 2022 and the SBA SBIR/STTR Policy Directive, the DoW will review all proposals submitted in response to this BAA to assess security risks presented by small business concerns seeking a Federally funded award. Small business concerns must complete the Disclosures of Foreign Affiliations or Relationships to Foreign Countries webform in Volume 7 of the DSIP proposal submission (NOTE: PDF uploads will no longer be accepted). Full proposal submissions cannot be certified and submitted by the Corporate Official until Volume 7 is fully completed and the webform is submitted.

For additional details, please refer to the DoW SBIR Program BAA.