

Artificial Intelligence Exploration (AIE) Opportunity
DARPA-PA-20-02-12
Ensuring Consistency of Systemic Information (ECoSystemic)

I. Opportunity Description

The Defense Advanced Research Projects Agency (DARPA) is issuing an Artificial Intelligence Exploration (AIE) Opportunity, inviting submissions of innovative basic research concepts in the technical domain of consistency in federated data stores.

The Ensuring Consistency of Systemic Information (ECoSystemic) Opportunity aims to develop innovative techniques to improve the mutual consistency of federated backups, together with processes for recovering a distributed system of potentially global scale promptly to a functional and mutually consistent restored state. Robust recovery of information systems has broad applicability in both military and commercial domains.

This AIE Opportunity is issued under the Program Announcement for AIE, DARPA-PA-20-02. All proposals in response to ECoSystemic, as described herein, will be submitted to DARPA-PA-20-02. If selected, a proposal will receive an award of an Other Transaction (OT) for the proposed project. The total award value for the combined Phase 1 base and Phase 2 option is limited to \$1,000,000. This total award value includes government funding and performer cost share, if required or if proposed.

To view the original DARPA Program Announcement for AIE visit beta.SAM.gov under solicitation number DARPA-PA-20-02:

<https://sam.gov/opp/667875ba2f464ccfa38688ea1a718fe7/view>

A. Objective and Technical Scope

The Artificial Intelligence Exploration (AIE) research will focus on (1) modeling resilience within this global-scale distributed system, and (2) identifying potential safeguards and responses to threats. In 2016 the U.S. Treasury highlighted the hypothetical case of a ransomware payload that freezes data operations for a large financial firm.¹ But, if individual firms are vulnerable to a common shock, there is nothing to prevent multiple key institutions from suffering an outage simultaneously. ECoSystemic seeks innovative techniques to improve the mutual consistency of federated backups, together with processes for recovering the system promptly to a consistent restored state. The U.S. financial sector is a good use-case, because of its strategic importance and extensive data federation.

The financial system is among the largest frameworks for distributed computing in the world. Individual components of the system are engineered – designed and built as internally coherent subsystems. But the financial system overall is not engineered. It is a vast, open system, in

¹ S. Bloom Raskin (2016), "[Remarks By Deputy Secretary Sarah Bloom Raskin at the Cybersecurity Docket's Incident Response Forum 2016](#)," U.S. Department of the Treasury.

constant flux, with humans in the loop for almost all critical decisions. Instead, another framework of law, regulation, and institutional rules and norms governs the financial system's activities. The primary synchronization points in financial markets are the formal clearing (reconciliation of inconsistencies across counterparties' books) and settlement (legal extinguishing of obligations by delivery of cash or securities) processes. Although trading – the negotiation of transactions – often occurs at microsecond time resolution, actual legal settlement of those transactions typically occurs two days later (T+2). There is a complex cost-benefit trade-off associated with faster settlement, making this an active research question.² When markets function well, arbitrage generates a tight cross-sectional consistency (the law of one price) among contemporaneous asset prices. When markets fail, various pathological outcomes are possible, depending on the nature and severity of the failure.

Importantly, the degree of consistency in this context is a property of the financial system at large. Consistency at this gross scale differs in key aspects from more familiar notions of consistency within a database (e.g., ACID transactions) or even consistency across multiple shared data clusters within a firm. Because financial data are federated across organizational boundaries, each node faces idiosyncratic geographic constraints, operational policies, and managerial controls. Under these conditions of radical federation, a critical characteristic of successful simultaneous recovery from diverse local backups, is that all nodes should return to a mutually consistent image of the overall system state.

The work proposed must include the development of:

- (a) A formal model of the structure of uncertainty in financial data sets, including the dimensions of potential mismeasurement and their statistical relationships,
- (b) An ensemble of metrics of inconsistency, related to the model of uncertainty in item (a), which would permit a formal assessment of the discrepancy among two or more financial data sets,
- (c) A description of procedures (algorithms) for deriving guarantees that the discrepancies among data sets fall within a given set of tolerances, and
- (d) A proof-of-concept implementation of the procedures in item (c).

Proposals should discuss methods for assessing violations of the assumptions underlying (a) through (c).

Proposers should specify the types of financial data their work will address (e.g., position and transactions in exchange-traded or over-the-counter securities or derivatives). Covering all possible types of financial data is beyond the scope of this effort, so proposers should pick representative examples, such that success would potentially generalize to cover a significant class of practical financial data.

² M. Khapko and M. Zoican (2020), "How fast should trades settle?" *Management Science*, 66(10), 4359–4919.

B. Structure

Proposals submitted to DARPA-PA-20-02-12 in response to this AIE opportunity must be UNCLASSIFIED and have an 8-page limit. Proposals must address two independent and sequential project phases [a Phase 1 Feasibility Study (base) and a Phase 2 Proof of Concept (option)]. The periods of performance for these phases are 12 months for the Phase 1 (base) effort and 6 months for the Phase 2 (option) effort. Combined, Phase 1 and Phase 2 efforts for this AIE opportunity should not exceed 18 months. The Phase 1 (base) award value is limited to \$667,000. The Phase 2 (option) award value is limited to \$333,000. The total award value for the award is limited to \$1,000,000. This total award value includes government funding and performer cost share, if required.

C. Schedule/Milestones

Phase 1 fixed milestones for this program, to be delivered as written reports, are the following (proposers may provide additional detail, specific to their proposed project, as necessary):

- Month 1: Select market examples and related data sets
- Month 3: Produce evaluation plan including planned metrics of inconsistency
- Month 6: Produce initial uncertainty model and data on dimensions of mismeasurement
- Month 9: Produce initial inconsistency measurement framework to formally assess the discrepancies between two or more financial data sets
- Month 12: Present results to date and implementation plan

Phase 2 fixed milestones for this program must include, at a minimum, the following (proposers should provide additional detail, specific to their proposed project, as necessary):

- Month 15: Preliminary proof-of-concept for algorithmic approach to guarantee discrepancies fall within a tolerance range
- Month 18: Presentation of proof-of-concept results and lessons learned from implementation of approach

All proposals must include the following meetings and travel in the proposed schedule and costs:

To foster collaboration between teams and disseminate program developments, a two-day Principal Investigator (PI) meeting will be held approximately every six months. For budgeting purposes, plan for four (4) two-day meetings over the course of 18 months with the locations alternating between the east coast and west coast of the United States. There will be two meetings in Phase 1 (kick-off and at six months), and two meetings in Phase 2. In both phases of the effort, there will be one meeting in the Washington, D.C. area and one at a location to be determined. These meetings should be attended not just by PI(s), but also by any key students or developers who have been involved in the project.

Regular teleconference meetings will be scheduled with the government team for progress reporting as well as problem identification and mitigation. Proposers should also anticipate at least one site visit per phase by the DARPA program manager during which they will have the opportunity to demonstrate progress towards agreed-upon milestones.

D. Deliverables

Performers will be expected to provide at a minimum all reports and data required by the individual Phase 1 and Phase 2 milestones. Additionally, proposers should propose deliverables specific to the objectives of the individual efforts and milestone requirements. These may include registered reports, experimental protocols, publications, intermediate, and final versions of software libraries, code, and APIs, including documentation and user manuals, and/or a comprehensive assemblage of design documents, models, modeling data and results, model validation data, and algorithm-generated lexicons or grammar rules.

II. Award Information

Selected proposals that are successfully negotiated will result in award of an OT for Prototype project. See Section 3 of DARPA-PA-20-02 for information on awards that may result from proposals submitted in response to this notice.

Proposers must review the model OT for prototype agreement provided as an attachment to DARPA-PA-20-02 prior to submitting a proposal. DARPA has provided the model OT in order to expedite the negotiation and award process and ensure DARPA achieves the goal of AIE, which is to enable DARPA to initiate a new investment in less than 90 days from idea inception. The model OT is representative of the terms and conditions that DARPA intends to award for all AIE awards. The task description document, schedule of milestones and payments, and data rights assertions requested under Volumes 1, 2, and 3 will be included as attachments to the OT agreement upon negotiation and award.

Proposers may suggest edits to the model OT for consideration by DARPA and provide a copy of the model OT with track changes as part of their proposal package. Suggested edits may not be accepted by DARPA. The Government reserves the right to remove a proposal from award consideration should the parties fail to reach an agreement on OT award terms and conditions. If edits to the model OT are not provided as part of the proposal package, DARPA assumes that the proposer has reviewed and accepted the award terms and conditions to which they may have to adhere and the sample OT agreement provided as an attachment, indicating agreement (in principle) with the listed terms and conditions applicable to the specific award instrument.

In order to ensure that DARPA achieves the AIE goal of award within 90 calendar days from the posting date (August 2, 2021) of this announcement, DARPA reserves the right to cease negotiations when an award is not executed by both parties (DARPA and the selected organization) on or before October 29, 2021.

III. Eligibility

See Section 4 of the AIE Program Announcement (DARPA-PA-20-02) for information on who may be eligible to respond to this notice.

IV. AIE Opportunity Responses

Responses to this AIE opportunity must be submitted as full proposals to DARPA-PA-20-02 as described therein. All proposals must be unclassified.

A. Proposal Content and Format

All proposals submitted in response to this notice must comply with the content and format instructions in Section 5 of DARPA-PA-20-02. All proposals must use the templates provided as Attachments to the PA and the “Schedule of Milestones and Payments” Excel Attachment and “Task Description Document” Attachment provided with this AIE Opportunity and follow the instructions therein.

Information not explicitly requested in DARPA-PA-20-02, its attachments, or this notice may not be evaluated.

B. Proposal Submission Instructions

Responses to DARPA-PA-20-02-12 shall be submitted through electronic upload to DARPA’s Broad Agency Announcement (BAA) Portal (<https://baa.darpa.mil>).

DARPA will acknowledge receipt of complete submissions via email and assign identifying numbers that should be used in all further correspondence regarding those submissions. If no confirmation is received within two (2) business days, please contact ECoSystemic@darpa.mil to verify receipt.

When planning a response to this AIE Opportunity, proposers should consider the submission time zone and that some parts of the submission process may take from one (1) business day to one (1) month to complete (e.g., registering for a Data Universal Numbering System (DUNS) number or Tax Identification Number (TIN)).

Electronic Upload

First-time users of the DARPA BAA Portal must complete a two-step account creation process. The first step consists of registering for an extranet account by going to the URL listed above and selecting the “Account Request” link. Upon completion of the online form, proposers will receive two separate emails; one will contain a user name, and the second will provide a temporary password. Once both emails have been received, the second step requires proposers to go back to the submission website and log in using that user name and password. After accessing the extranet, proposers may then create a user account for the DARPA Submission website by selecting the “Register your Organization” link at the top of the page. Once the user account is created, proposers will be able to see a list of solicitations open for submissions, view submission instructions, and upload/finalize their proposal.

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

All full proposals submitted electronically through the DARPA Submission website must meet the following requirements: (1) uploaded as a zip file (.zip or .zipx extension); (2) only contain the document(s) requested herein; (3) only contain unclassified information; and (4) must not exceed 100 MB in size. Only one zip file will be accepted per full proposal. Full proposals not uploaded as zip files will be rejected by DARPA. Technical support for the DARPA Submission website is available during regular business hours, Monday – Friday, 9:00 a.m. – 5:00 p.m. EDT. Requests for technical support must be emailed to BAAT_Support@darpa.mil with a copy to ECoSystemic@darpa.mil. Questions regarding submission contents, format, deadlines, etc., should be emailed to ECoSystemic@darpa.mil. Questions/requests for support sent to any other email address may result in delayed/no response.

Since proposers may encounter heavy traffic on the webserver, DARPA discourages waiting until the day proposals are due to request an account and/or upload the submission. Note: Proposers submitting a proposal via the DARPA Submission site MUST (1) click the “Finalize” button in order for the submission to upload; AND (2) do so with sufficient time for the upload to complete prior to the deadline. Failure to do so will result in a late submission.

C. Proposal Due Date and Time

Proposals in response to this notice are due no later than Tuesday, August 31, 2021, 12:00 noon (ET). Full proposal packages as described in Section 5 of DARPA-PA-20-02 must be submitted per the instructions outlined therein *and received by DARPA* no later than the above time and date. Proposals received after this time and date may not be reviewed.

Proposers are warned that the proposal deadline outlined herein is in Eastern Standard Time and will be strictly enforced. When planning a response to this notice, proposers should consider that some parts of the submission process may take from one business day to one month to complete (e.g., registering for a Data Universal Numbering System (DUNS) number or Tax Identification Number (TIN)).

DARPA will acknowledge receipt of complete submissions via email and assign identifying numbers that should be used in all further correspondence regarding those submissions. If no confirmation is received within two (2) business days, please contact ECoSystemic@darpa.mil to verify receipt.

V. Proposal Evaluations and Selection

Proposals will be evaluated and selected in accordance with Section 6 of DARPA-PA-20-02. Proposers will be notified of the results of this process as described in Sec. 7.1 of DARPA-PA-20-02.

VI. Administrative and National Policy Requirements

Section 7.2 of the AIE Program Announcement (DARPA-PA-20-02) provides information on Administrative and National Policy Requirements that may be applicable for proposal submission as well as performance under an award.

VII. Point of Contact Information

Mark Flood, Program Manager, DARPA/I2O, ECosystemic@darpa.mil

VIII. Frequently Asked Questions (FAQs)

All technical, contractual, and administrative questions regarding this notice must be emailed to ECosystemic@darpa.mil. Emails sent directly to the program manager or any other address may result in delayed or no response.

All questions must be in English and must include name, email address, and the telephone number of a point of contact. DARPA will attempt to answer questions publicly in a timely manner; however, questions submitted within 7 days of the proposal due date listed herein may not be answered.

DARPA will post an FAQ list under the AIE Opportunity on the DARPA/I2O Opportunities page at: <http://www.darpa.mil/work-with-us/opportunities>. The list will be updated on an ongoing basis until one week prior to the proposal due date. In addition to the FAQ specific to this notice, proposers should also review the Program Announcement for AIE General FAQ list on the DARPA/DSO Opportunities page under the Program Announcement for AIE (DARPA-PA-20-02).