ADMINISTRATIVE NOTE:
NEW REQUIREMENTS/PROCEDURES

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BAA 04-14 PROPOSER INFORMATION PAMPHLET

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The Defense Advanced Research Projects Agency (DARPA) often selects its research efforts through the Broad Agency Announcement (BAA) process. The BAA will be posted directly to FedBizOpps.gov, the single government point-of-entry (GPE) for Federal government procurement opportunities over $25,000. The following information is for those wishing to respond to the Broad Agency Announcement.

Architectures for Cognitive Information Processing (ACIP), SOL BAA 04-14, Proposals Due: Initial Closing: March 19, 2004, Final Closing: January 21, 2005, POC: Mr. Robert Graybill, DARPA/IPTO; FAX: (703) 741-7804

PROGRAM OBJECTIVES AND DESCRIPTION. The Defense Advanced Research Projects Agency (DARPA) Information Processing Technology Office (IPTO) is soliciting proposals for the first phase of a new program in Architectures for Cognitive Information Processing (ACIP). The goal of the ACIP program is to develop a new generation of computing architectures (both hardware and software) that will enable revolutionary advances in cognitive information processing algorithms and systems for real-time DoD applications.

Current systems implementations of cognitive information processing typically rely on COTS processing elements originally designed for general-purpose data processing. To enable the effective deployment of powerful cognitive information processing systems in dynamic, real-time, data-intensive, multiple-mission-specific environments requires fundamental changes in system architecture components and integration. The ACIP program seeks to address this issue by developing processing architectures that are uniquely optimized for cognitive computing. Further, these solutions must be developed such that their future embedded implementation in DoD platforms and devices will be compatible with size, weight, and power constraints, and thus must be composed of highly integrated and efficient cognitive computing components and devices.

This announcement addresses Phase I of what is anticipated to be a three phase program. Phase I is a comprehensive concept study comprising requirement analysis, concept development and analysis, and technology assessment, all in the context of representative challenge problems. Specifically, Phase I will address the following technical topics:

(a) the definition of cognitive information processing components, algorithms, and systems to be considered;

(b) their architectural, computing and memory resource, communication bandwidth, and run-time requirements (this should include identification of key computational, memory, and communication bottlenecks, as well as dynamic run-time requirements);

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Deleted: 03-44, Proposals Due: Initial Closing: November 26, 2003, Final Closing: September 24, 2004, POC: Mr. Lee Badger, DARPA/IPTO; FAX: (703) 741-7804
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(c) advanced architecture concepts, goal-oriented programming techniques, models, and evaluation methodologies for addressing these requirements and identified bottlenecks, and for assessing the quality of the proposed solution; and

(d) a complete technology roadmap for research and development leading to deployed cognitive information processing systems on a dedicated computing architecture for multiple DoD missions.

This announcement solicits advanced architectural concepts that are thoroughly validated through analysis. Offerors should propose studies that address both cognitive information processing and advanced computer architectures with the following tightly-interrelated study components:

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1. A representative set of DoD relevant challenge problems that fairly represent the key classes of reasoning, learning, and knowledge representation techniques that may be used in fully integrated cognitive systems.
2. A description of a cognitive information processing system that addresses the above challenge problems and is sufficiently general to be applicable to a wide range of applications.

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3. A robust concept description of an integrated architecture, including hardware and software, that will efficiently support the proposed cognitive information processing system as well as a wide variety of other run-time components.
4. A detailed plan that elaborates how the cognitive information processing system and integrated architecture can be designed and implemented in a synergistic fashion to produce revolutionary architectural concepts and implementations, describes the members and roles of a multi-disciplinary team for execution, provides a detailed evaluation framework, success criteria, and milestones.

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As stated above, the proposed cognitive challenge problems must have sufficient diversity and scope to require revolutionary progress in both high-level algorithms and in computing architectures. The desire is to have a cognitive computing architecture that will support a reasonable spectrum of reasoning, learning, and knowledge representation techniques yet not so general purpose as to prohibit the end product's practical use in embedded applications. Example reasoning, learning, and knowledge representation tasks could include (but are not limited to) the following:

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1. Reasoning on large-scale problems. Various reasoning techniques, including resolution theorem proving; forward chaining, including RETE-type algorithms; backward chaining; logic programming; greedy local search for propositional satisfiability; and others have been developed. Typically, these techniques exhibit exponential behavior on the size of the input. Methods for effectively parallelizing such techniques or methods for applying dynamic reconfigurable architectures to increase the size of addressable problems are of interest.
2. Reasoning and inference on large knowledge bases. This might include parallel mechanisms for accelerating reasoning on large structures, techniques for mapping among and integrating disparate ontologies dealing with overlapping domains, methods for automatically incorporating new facts and verifying their self-consistency, partitioning

and distributing knowledge bases across processor elements, using very large main memory to store intermediate results (trading space for time), implementing solutions to commonly occurring sub-problems in dedicated hardware, and others.

3. Reasoning under uncertain conditions or under constrained reaction times. Approaches might include decision- and probability-theoretic techniques, inference using Bayesian networks, hidden Markov models, qualitative and default reasoning, belief (or loopy) propagation, and relational dependency networks, among others.
4. Planning and resource management in dynamically changing environments. Approaches could include state-space search, partial-order planning, scheduling with resource constraints, hierarchical planning, conditional and continuous planning, and multi-agent planning.
5. Learning, with prior knowledge, in complex, multi-dimensional environments. Learning is a rich and critical area with many techniques and approaches, including concept learning, learning decision trees, probabilistic relational models, artificial neural networks, Bayesian learning, instance-based learning, genetic algorithms, and combined inductive and analytical learning. Hybrid approaches that integrate multiple learning techniques with reasoning and knowledge representations to synergistically improve both knowledge and learning are of interest.

It is anticipated that for some of the above tasks, processing bottlenecks could include search operations, graph operations, data-driven training, front-end perceptual processing, and other operations. Memory access times and memory size may be major factors in scaling up to large-scale problems and systems. In addition, production systems may demand late or dynamic bindings.

Because cognitive algorithms typically provide solutions that do not scale well with problem size, this announcement seeks solutions that offer a synergistic combination of both algorithmic and architectural innovations. It is not sufficient to propose architectural solutions that modestly accelerate processing or memory access times for current cognitive systems (e.g., by factors of 10 - 100). Proposed solutions must address ambitious, real world DoD applications, of appropriate scale and complexity, that are beyond the scope of today's technology and may also require the use of emerging innovative reasoning, knowledge representation, and learning techniques or components.

Offerors should provide a complete description of the proposed system architecture, from innovative compute cores, cache and other memory structures, and interconnects/connectivity structures to operating system, languages, and programming environments that will efficiently support a dynamic and diverse set of runtime-directed cognitive components. The proposed solution should offer a deeply integrated co-design of computing architecture, programming models, multiple virtual machine models, supporting software, and specific driving application requirements, but should be sufficiently general to address a range of applications. Solutions are envisioned to include the following:

- Cognitive processing modules that streamline operations involved in reasoning, knowledge representation, and learning

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- Innovative memory structures and hierarchies suited for unconventional data retrieval and storage
- High-bandwidth connectivity fabric or connectivity on demand (offerors are urged to become familiar with DARPA Microsystems Technology Office (MTO) initiatives in 3-D interconnect, optical and packaging technologies)
- Innovative architectural concepts that are runtime configurable or that support multiple virtual machine models that provide a dynamic spectrum of reasoning and learning modules on demand or upon request of the meta-reasoning subsystem
- A "living" management framework for specifying, controlling, and managing system modules, interfaces, and architectural reconfiguration during runtime and over the course of the system's lifetime
- Supporting software, to include operating systems, languages, compilers, composable runtime environments, and necessary middleware components
- Comprehensive programming environments (software tools, utilities, and services that enable efficient application development and high productivity)
- Dynamic reconfigurability/morphability and resource management at all appropriate levels in the system

Consideration should be given to novel scalable parallel processing concepts; large-scale intelligent memory structures; in-place, fast, data-structured memory access and computation; power-minimization techniques; embeddable packaging; and system scaling.

An important element of the ACIP program is the Living Framework Forum (LFF), which will be established during the program to promote and pursue common cognitive computing development environments, tools, common runtime module interfaces and metadata structures across multiple ACIP efforts. It is intended that the LFF will provide an enduring basis for wide community adoption, sharing of cognitive components, and effective use by multiple groups.

ACIP research efforts will be executed in the context of representative cognitive challenge problems. Offerors must address two or more well-defined DoD cognitive applications, including one embedded application for in-context evaluation of proposed solutions. Representative problems could include, but are not limited to intelligent resource management, unmanned combat platforms, intelligent analyst assistants, cognitive sensor systems, and unattended distributed sensors systems. It is expected that proposers will consider those future applications that require systems to "know what they're doing." For example, today's route planners are designed well in advance of actual operational use and therefore can not handle unanticipated events nor learn from them. However, consideration of alternate military applications and commercial spin-off applications is encouraged. In addition, ACIP research efforts should actively leverage complementary concurrent IPTO and MTO cognitive algorithms, demonstrations, architectures, and device research where possible.

It is essential that the technologies, components, architectures, and frameworks developed in the course of this research be general enough to be viable across a fairly broad range of

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applications. ACIP aims to create powerful and reusable cognitive computing architectures, technologies, and techniques that will support both current cognitive approaches and innovative techniques under development by other complementary cognitive research projects rather than point solutions.

TEST AND EVALUATION. Performers will test and evaluate their technologies using their own facilities and report results at ACIP PI meetings, potential IPTO sponsored cognitive workshops, and Living Framework Forums. Within each effort, the performer must quantify the capability to be realized through the proposed cognitive architecture concepts. Specific multilevel metrics and goals relevant to DoD missions and the cognitive functional component requirements, constraints, and development goals being pursued must be established. Advances in cognitive computing capabilities must be quantified against today's systems. Concise clearly stated Phase I success criteria and metrics must be spelled out in the proposal and will be used to track the maturity of the concepts developed under Phase I.

An Independent Metrics and Evaluation Team (IMET) will be formed to work with the ACIP teams to develop a common set of spanning kernels and metrics. This will enable a common evaluation process and analysis/evaluation for the ACIP program supported by this common library of kernels and metrics. All ACIP contractors will be expected to work collaboratively with this separately funded and neutral ACIP effort.

PROGRAM SCOPE DARPA. Proposed research should investigate innovative approaches and techniques that lead to or enable revolutionary advances in the state-of-the-art. Proposals are not limited to the specific strategies listed above, and alternative visions will be considered. However, proposals should be for research that substantially contributes towards the goals stated. Specifically excluded is research that primarily results in minor evolutionary improvement to the existing state of practice or focuses on special-purpose systems or narrow applications.

The full ACIP program is anticipated to be comprised of three phases: 1) Early Architecture Concepts and In-Context Evaluation, 24 months; 2) Full-Scale Implementation and Demonstration, 48 months; 3) Cognitive Technology System Transitions to DoD, 24 months.

Phase I, the focus of this announcement has the following expected deliverables:

- Architecture and runtime requirements derived from a comprehensive spanning set of current and emerging reasoning, knowledge, and learning components that are representative of the types and scale of future candidate DoD cognitive information processing applications;
- Participation in the Living Framework Forum and a draft Living Framework document;
- Architecture concepts, models and supporting analysis;
- Composable runtime concepts;
- Device, software, and user development environment concepts and technology roadmap;
- Suggested Phase II challenge problem, evaluation metrics and success criteria;
- Interim and final technical concept description document;

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- DARPA/IPTO Quarterly Status Reports and Annual Project Summary Report.

GENERAL INFORMATION

Proposals not meeting the format described in this pamphlet may not be reviewed. Proposals **MUST NOT** be submitted by fax or e-mail; any so sent will be disregarded. This notice, in conjunction with the BAA 04-14 FBO Announcement and all references, constitutes the total BAA. A Frequently Asked Questions (FAQ) list may be provided. The URL for the FAQ will be specified on the DARPA/IPTO BAA Solicitation page. No additional information is available, nor will a formal Request for Proposal (RFP) or other solicitation regarding this announcement be issued. Requests for same will be disregarded. All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA. Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs) are encouraged to submit proposals and join others in submitting proposals. However, no portion of this BAA will be set aside for HBCU and MI participation due to the impracticality of reserving discrete or severable areas of this research for exclusive competition among these entities.

SECURITY INFORMATION

NOTE: The Government anticipates that proposals submitted under this BAA will be unclassified. In the event that a proposer chooses to submit a classified proposal or submit any documentation that may be classified, the following information is applicable. Security classification guidance on a DD Form 254 will not be provided at this time since DARPA is soliciting ideas only. After reviewing incoming proposals, if a determination is made that the award instrument may result in access to classified information, a DD Form 254 will be issued and attached as part of the award. Proposers choosing to submit a classified proposal must first receive permission from the Original Classification Authority to use their information in replying to this BAA. Applicable classification guide(s) should be submitted to ensure that the proposal is protected appropriately.

SUBMISSION PROCESS

This Broad Agency Announcement (BAA) requires completion of a **BAA Cover Sheet** for each Proposal prior to submission. This cover sheet can be accessed at the following URL:

http://www.dyncorp-is.com/BAA/index.asp?BAAid=04-14

After finalizing the **BAA Cover Sheet**, the proposer must print the **BAA Confirmation Sheet** that will automatically appear on the web page. Each proposer is responsible for printing the BAA Confirmation Sheet and attaching it to every copy. The Confirmation Sheet should be the first page of the Proposal. If a proposer intends on submitting more than one Proposal, a unique UserId and password must be used in creating each BAA Cover Sheet. Failure to comply with these submission procedures may result in the submission not being evaluated.

Deleted: PROGRAM OBJECTIVES AND DESCRIPTION. The Defense Advanced Research Projects Agency (DARPA) is soliciting proposals for DARPA's Information Processing Technology Office to perform research, requirements and constraint analysis, architecture concept development and design, architectural modeling, in-context evaluations, and concept evaluations to support the initial phase of the Architectures for Cognitive Information Processing (ACIP) program. It is the intent of the DARPA IPTO office to develop cognitive information processes that will bring enabling embedded intelligence capabilities to aid the warfighter, as well as DoD supporting functions and activities – enabling machines that think to aid human performance. Current intelligent processing implementations depend on the use of existing COTS computing architectures that were developed and are best suited for numeric processing applications. To enable the performance of cognitive capabilities in real-time, dynamic, data-intensive, embedded environments and scenarios an underlying processing infrastructure optimized to perform the required cognitive processing is essential. The Architectures for Cognitive Information Processing (ACIP) program seeks to address these deficiencies by developing processing architectures and structures that are uniquely optimized for cognitive computing. The overarching goals of the ACIP program are to develop architectures, processing approaches, and supporting development tools and environments to enable the efficient implementation of embedded realtime cognitive processing and the application of cognitive processing to dynamic, real-world, embedded utilization. This announcement addresses the first phase of the ACIP program. The first phase ... [1]

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Proposers must submit the original and **3** copies of the full proposal *and* **2** electronic copies (i.e., **2** separate disks) of the full proposal (in PDF or Microsoft Word 2000 for IBM-compatible format on a 3.5-inch floppy disk, 100 MB Iomega Zip disk or cd). **Mac-formatted disks will not be accepted**. Each disk must be clearly labeled with BAA 03-44, proposer organization, proposal title (short title recommended) and "Copy <n>___ of 2". The full proposal (original and designated number of hard and electronic copies) must be submitted in time to reach DARPA by 12:00 PM (ET) **Friday, March 19, 2004,** in order to be considered during the initial evaluation phase. However, **BAA 04-14, ACIP** will remain open until 12:00 NOON (ET) **January 21, 2005.** Thus, proposals may be submitted at any time from issuance of this BAA through **January 21, 2005.** While the proposals submitted after the **Friday, March 19, 2004,** deadline will be evaluated by the Government, proposers should keep in mind that the likelihood of funding such proposals is less than for those proposals submitted in connection with the initial evaluation and award schedule. DARPA will acknowledge receipt of submissions and assign control numbers that should be used in all further correspondence regarding proposals.

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Restrictive notices notwithstanding, proposals may be handled for administrative purposes by support contractors. These support contractors are prohibited from competition in DARPA technical research and are bound by appropriate non-disclosure requirements. Input on technical aspects of the proposals may be solicited by DARPA from non-Government consultants /experts who are also bound by appropriate non-disclosure requirements. However, non-Government technical consultants/experts will not have access to proposals that are labeled by their offerors as "Government Only". Use of non-government personnel is covered in FAR 37.203(d).

NEW REPORTING REQUIREMENTS/PROCEDURES: The Award Document for each proposal selected and funded will contain a mandatory requirement for submission of DARPA/IPTO Quarterly Status Reports and an Annual Project Summary Report. These reports, described below, will be electronically submitted by each awardee under this BAA via the DARPA/IPTO Technical – Financial Information Management System (T-FIMS).

The T-FIMS URL will be furnished by the government upon award. Detailed data requirements can be found in the Data Item Description (DID) DI-MISC-81612 available on the Government's ASSIST database (http://assist.daps.dla.mil/quicksearch/). Sample instructions that specify how information in the DID may be collected (content and frequency requirements) can be found in Appendix A. An outline of T-FIMS report requirements is as follows:

(a) Status Report: Due at least three (3) times per year – Jan, Apr, & Oct
  1) Technical Report
    a) Project General Information
    b) Technical Approach
      - Accomplishments
      - Goals
      - Significant changes / improvements
    c) Deliverables

d) Transition Plan
e) Publications
f) Meetings and Presentations
g) Project Plans
h) Near term Objectives

2) Financial Report
3) Project Status / Schedule

(b) Project Summary (PSum): Due once each fiscal year in July

1) All Sections of the Status Report
2) QUAD Chart
a) Visual Graphic
b) Impact
c) New Technical Ideas
d) Schedule

PROPOSAL FORMAT

Proposals shall include the following sections, each starting on a new page (where a "page" is 8-1/2 by 11 inches with type not smaller than 12 point) and with text on one side only. The submission of other supporting materials along with the proposal is strongly discouraged. Sections I and II (excluding the submission cover/confirmation sheet and section M) of the proposal shall not exceed 40 pages. Maximum page lengths for each section are shown in braces { } below.

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Section I. Administrative

The BAA Confirmation Sheet {1 page} described under "Submission Process" will include the following:

A. BAA number;
B. Technical topic area;
C. Proposal title;
D. Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address;
E. Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address;
F. Summary of the costs of the proposed research, including total base cost, estimates of base cost in each year of the effort, estimates of itemized options in each year of the effort, and cost sharing if relevant;
G. Contractor's type of business, selected from among the following categories: "WOMEN-OWNED LARGE BUSINESS," "OTHER LARGE BUSINESS," "SMALL DISADVANTAGED BUSINESS [*Identify ethnic group from among the following: Asian-Indian American, Asian-Pacific American, Black American, Hispanic American, Native American, or Other*]," "WOMEN-OWNED SMALL BUSINESS,"

"OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," "OTHER NONPROFIT", or "FOREIGN CONCERN/ENTITY."

Section II. Detailed Proposal Information

This section provides the detailed discussion of the proposed work necessary to enable an in-depth review of the specific technical and managerial issues. Specific attention must be given to addressing both risk and payoff of the proposed work that make it desirable to DARPA.

[IMPORTANT NOTE: WITH THE EXCEPTION OF E, C THROUGH H HAVE BEEN REVISED.] Page-counts are maximums.

A. {1 Page} Innovative claims for the proposed research.
This page is the centerpiece of the proposal and should succinctly describe the unique proposed contribution.

B. {1 Page} Proposal Roadmap
The roadmap provides a top-level view of the content and structure of the proposal. It contains a synopsis (or "sound bite") for each of the nine areas defined below. It is important to make the synopses as explicit and informative as possible. The roadmap must also cross-reference the proposal page number(s) where each area is elaborated. The nine roadmap areas are:

1. Main goals of the proposed research (stated in terms of new, operational capabilities for assuring that critical information is available to key users).

2. Tangible benefits to end users (i.e., benefits of the capabilities afforded if the proposed technology is successful).

3. Critical technical barriers (i.e., technical limitations that have, in the past, prevented achieving the proposed results).

4. Main elements of the proposed approach.

5. Rationale that builds confidence that the proposed approach will overcome the technical barriers. ("We have a good team and good technology" is not a useful statement.)

6. Nature of expected results (unique/innovative/critical capabilities to result from this effort, and form in which they will be defined).

7. The risk if the work is not done.

8. Criteria for scientifically evaluating progress and capabilities on an annual basis.

9. Cost of the proposed effort for each performance year.

C. {2 Pages} Research Objectives:

1. Problem Description. Provide concise description of problem area addressed by this research project.

2. Research Goals. Identify specific research goals of this project. Identify and quantify expected performance improvements from this research. Identify new capabilities enabled by this research. Identify and discuss salient features and capabilities of developmental hardware and software prototypes**. Provide a set of metrics and success criteria for the concepts proposed under Phase I.**

3. Expected Impact. Describe expected impact of the research project, if successful, to problem area.

D. Technical Approach:

1. {12 Pages} Detailed Description of Technical Approach. Provide detailed description of technical approach that will be used in this project to achieve research goals. **Specifically identify and discuss the innovative aspects of the ACIP technical approach for two or more diverse (full scale) reasoning techniques integrated as part of a complete cognitive system comprised of reasoning, knowledge representation, and learning subsystems. This section should clearly articulate the need for innovative architecture advances in-context of full scale applications, the proposed innovative solution, and the payoff relative to today's COTS computing solutions. Full spectrum (major classes) of techniques for reasoning, knowledge representation, and learning and their architectural impact should be discussed. Note: An optional technical viewgraph summary in MS Power Point format (maximum of 8 vgs) may also be included as part of the Technical Volume and will not be considered as part of the volume page count.**

2. {2 Pages} Comparison with Current Technology. Describe state-of-the-art approaches and the limitations within the context of the problem area addressed by this research.

E. {3 Pages} Statement of Work (SOW) written in plain English, outlining the scope of the effort and citing specific tasks to be performed, references to specific subcontractors if applicable, and specific contractor requirements.

F. Schedule and Milestones:

1. {1 Page} Schedule Graphic. Provide a graphic representation of project schedule including detail down to the individual effort level. This should include but not be limited to, a multi-phase development plan, which demonstrates a clear understanding of the proposed research; and a plan for periodic and increasingly robust experiments

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over the project life that will show applicability to the overall program concept. Show all project milestones. Use absolute designations for all dates.

2. {3 Pages} Detailed Individual Effort Descriptions. Provide detailed task descriptions for each individual effort and/or subcontractor in schedule graphic.

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G. {2 Pages} Deliverables Description. List and provide detailed description for each proposed deliverable. Include in this section all proprietary claims to results, prototypes, or systems supporting and/or necessary for the use of the research, results, and/or prototype. If there are no proprietary claims, this should be stated. The offeror must submit a separate list of all technical data or computer software that will be furnished to the Government with other than unlimited rights (see DFARS 227.) Specify receiving organization and expected delivery date for each deliverable.

H. {2 Pages} Technology Transition and Technology Transfer Targets and Plans. Discuss plans for technology transition and transfer. Identify specific military and commercial organizations for technology transition or transfer. Specify anticipated dates for transition or transfer.

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I. {3 Pages} Personnel and Qualifications. List of key personnel, concise summary of their qualifications, and discussion of proposer's previous accomplishments and work in this or closely related research areas. Indicate the level of effort to be expended by each person during each contract year and other (current and proposed) major sources of support for them and/or commitments of their efforts. DARPA expects all key personnel associated with a proposal to make substantial time commitment to the proposed activity.

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J. {1 Page} Facilities. Description of the facilities that would be used for the proposed effort. If any portion of the research is predicated upon the use of Government Owned Resources of any type, the offeror shall specifically identify the property or other resource required, the date the property or resource is required, the duration of the requirement, the source from which the resource is required, if known, and the impact on the research if the resource cannot be provided. If no Government Furnished Property is required for conduct of the proposed research, the proposal shall so state.

K. {1 Page} Experimentation Plans. Offerors should identify experiments to test the hypotheses of their approaches and be willing to work with other contractors in order to develop joint experiments in a common testbed environment. Offerors should expect to participate in teams and workshops to provide specific technical background information to DARPA, attend semi-annual Principal Investigator (PI) meetings, and participate in numerous other coordination meetings via teleconference or Video Teleconference (VTC). Funding to support these various group experimentation efforts should be included in technology project bids.

L. {5 Pages} Cost. Cost proposals shall provide a detailed cost breakdown of all direct costs, including cost by task, with breakdown into accounting categories (labor, material, travel, computer, subcontracting costs, labor and overhead rates, and equipment), for the entire

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contract and for each **calendar year, divided into quarters**. Where the effort consists of multiple portions that could reasonably be partitioned for purposes of funding, these should be identified as contract options with separate cost estimates for each.

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M. Contractors requiring the purchase of information technology (IT) resources as Government Furnished Property (GFP) **MUST** attach to the submitted proposals the following information:

1. A letter on Corporate letterhead signed by a senior corporate official and addressed to **<PM's Title & Name>,** DARPA/IPTO, stating that you either can not or will not provide the information technology (IT) resources necessary to conduct the said research.

2. An explanation of the method of competitive acquisition or a sole source justification, as appropriate, for each IT resource item.

3. If the resource is leased, a lease purchase analysis clearly showing the reason for the lease decision.

4. The cost for each IT resource item.

IMPORTANT NOTE: IF THE OFFEROR DOES NOT COMPLY WITH THE ABOVE STATED REQUIREMENTS, THE PROPOSAL WILL BE REJECTED.

Awards made under this BAA may be subject to the provisions of the Federal Acquisition Regulation (FAR) Subpart 9.5, Organizational Conflict of Interest. All offerors and proposed subcontractors must affirmatively state whether they are supporting any DARPA technical office(s) through an active contract or subcontract. All affirmations must state which office(s) the offeror supports, and identify the prime contract number. Affirmations should be furnished at the time of proposal submission. All facts relevant to the existence or potential existence of organizational conflicts of interest, as that term is defined in FAR 2.101, must be disclosed in Section II, I. of the proposal, organized by task and year. This disclosure shall include a description of the action the Contractor has taken, or proposes to take, to avoid, neutralize, or mitigate such conflict.

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Section III. Additional Information

A bibliography of relevant technical papers and research notes (published and unpublished) that document the technical ideas, upon which the proposal is based, may be included in the proposal submission. Provide one set for the original full proposal and one set for each of the **3** full proposal hard copies. Please note: The materials provided in this section, and submitted with the proposal, will be considered for the reviewer's convenience only and not considered as part of the proposal for evaluation purposes.

EVALUATION AND FUNDING PROCESSES

Proposals will not be evaluated against each other, since they are not submitted in accordance with a common work statement. DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons. For evaluation purposes, a proposal is the document described in PROPOSAL FORMAT Section I and Section II (see below). Other supporting or background materials submitted with the proposal will be considered for the reviewer's convenience only and not considered as part of the proposal.

Evaluation of proposals will be accomplished through a scientific review of each proposal using the following criteria, which are listed in descending order of relative importance:

(1) Overall Scientific and Technical Merit: The overall scientific and technical merit must be clearly identifiable and compelling. The technical concepts should be clearly defined and developed. The technical approach must be sufficiently detailed to support the proposed concepts and technical claims. Evaluation will also consider the effectiveness of the system integration and management plan.

(2) Innovative Technical Solution to the Problem: Offerors should apply new and/or existing technology in an innovative way that supports the objectives of the proposed effort. The proposed concepts and systems should show breadth of innovation across all the dimensions of the proposed solution. Offerors must also specify quantitative experimental methods and metrics for measuring progress of the effort.

(3) Potential Contribution and Relevance to DARPA/IPTO Mission: The offeror must clearly address how the proposed effort will meet the goals of the undertaking and how the proposed effort contributes to significant advances to DARPA/IPTO.

(3) Offeror's Capabilities and Related Experience: The qualifications, capabilities, and demonstrated achievements of the proposed principals and other key personnel for the primary and subcontractor organizations must be clearly shown.

(5) Plans and Capability to Accomplish Technology Transition: The offeror should provide a clear strategy and plan for transition to military forces (and commercial sector, where applicable). Offerors should consider involving potential military transition partners, as appropriate, in any proposed experiments, tests and demonstrations. Offerors should also provide a plan for transition of appropriate technology components and information to the user community.

(6) Cost Realism: The overall estimated costs should be clearly justified and appropriate for the technical complexity of the effort. Evaluation will consider the value of the research to the government and the extent to which the proposed management plan will effectively allocate resources to achieve the capabilities proposed.

The Government reserves the right to select for award all, some, or none of the proposals received. Proposals identified for funding may result in a contract, grant, cooperative agreement, or other transaction depending upon the nature of the work proposed, the required

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Deleted: <#>Overall Scientific and Technical Merit: The overall scientific and technical merit must be clearly identifiable and compelling. The technical concept should be clearly defined, developed and defensibly innovative. Emphasis should be placed on the technical excellence of the development and experimentation approach. ¶
¶
(2) . Innovative Technical Solution to the Problem: Proposed efforts should apply new or existing technology in an innovative way such as is advantageous to the objectives. The plan on how offeror intends to get developed technology artifacts and information to the user community should be considered. The offeror shall specify quantitative experimental methods and metrics by which the proposed technical effort's progress shall be measured.¶
¶
<#>Potential Contribution and Relevance to DARPA/IPTO Mission: The offeror must clearly address how the proposed effort will meet the goals of the undertaking and how the proposed effort contributes to significant advances to the DARPA/IPTO mission of preventing strategic surprise. ¶
¶
<#>Offeror's Capabilities and Related Experience: The qualifications, capabilities, and demonstrated achievements of the proposed principals and other key personnel for the primary and subcontractor organizations must be clearly shown.¶
¶
(5) . Plans and Capability to Accomplish Technology Transition: The offeror should provide a clear explanation of how the technologies to be developed will be transitioned to capabilities for military forces. Technology transition should be a major consideration in the design of experiments, particularly considering the potential for involving potential transition organizations in the experimentation process.¶
¶
(6) . Cost Realism: The overall estimated cost to accomplish the effort should be clearly shown as well as the substantiation of the costs for the technical complexity described. Evaluation will consider the value to Government of the research and the extent to which the proposed management plan will effectively allocate resources to achieve the capabilities proposed. Cost is considered a substantial evaluation criterion but is secondary to techni ... [3]

degree of interaction between parties, and other factors. If warranted, portions of resulting awards may be segregated into pre-priced options.

The administrative addresses for this BAA are:

Fax: 703-741-7804 Addressed to: DARPA/IPTO, BAA 04-14
Electronic Mail: baa04-14@darpa.mil
Electronic File Retrieval: http://www.darpa.mil/ipto/Solicitations/solicitations.htm
Mail to: DARPA/IPTO
ATTN: BAA 04-14
3701 N. Fairfax Drive
Arlington, VA 22203-1714

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Appendix A - Sample Instructions for Application of DiD MI-DISC-81612 or Analog

REMARKS.

- REPORTING PERIOD TERMINOLOGY
  - QUARTERLY REPORTING PERIODS:
    - JUL-SEP: COVERS PERFORMANCE FROM 1 JULY - 30 SEPTEMBER
    - OCT-DEC: COVERS PERFORMANCE FROM 1 OCTOBER - 31 DECEMBER
    - JAN-MAR: COVERS PERFORMANCE FROM 1 JANUARY - 31 MARCH
    - APR-JUN: COVERS PERFORMANCE FROM 1 APRIL - 30 JUNE

- ELECTRONIC SUBMISSION. THE CONTRACTOR SHALL ACCESS THE DARPA EXTRANET REPORTING PAGE TO BE FURNISHED AND ELECTRONICALLY SUBMIT ALL REQUIRED REPORTING INFORMATION ACCORDING TO ALL SPECIFICATIONS BELOW.

- POST-AWARD INITIAL SUBMISSION REQUIREMENT: SUBMIT WITHIN 30 CALENDAR DAYS OF AWARD ALL DATA ITEMS IN 1. PROJECT INFORMATION.

- MINIMAL INITIAL REPORT: IF AWARD OCCURS WITHIN 30 CALENDAR DAYS OF END OF QUARTERLY REPORTING PERIOD SUBMIT DATA ITEMS 2.10 ISSUES OR CONCERNS AND 3.2 PROJECT PLANS, ONLY, IN FIRST REPORT. DUE DATE FOR MINIMAL FIRST REPORT IS WITHIN 15 CALENDAR DAYS OF END OF QUARTERLY REPORTING PERIOD THAT INCLUDES AWARD DATE.

- GENERAL QUARTERLY SUBMISSION REQUIREMENTS
  - FREQUENCY: BLOCK 10. INPUT FOUR (4) TIMES YEARLY, ONCE FOR EACH OF THE QUARTERLY REPORTING PERIODS CITED ABOVE, FOR DURATION OF CONTRACT.
  - REPORTING PERIOD: BLOCK 11. REPORT ON PERFORMANCE DURING THE MOST RECENT QUARTERLY REPORTING PERIOD.
  - DUE DATE: BLOCK 12 AND BLOCK 13. SUBMIT WITHIN FIFTEEN (15) CALENDAR DAYS AFTER THE END OF MOST RECENT QUARTERLY REPORTING PERIOD, BEGINNING 1414X, I.E.
    - FOR REPORTING PERIOD JUL-SEP, DUE DATE IS OCTOBER 15

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- FOR REPORTING PERIOD OCT-DEC, DUE DATE IS JANUARY 15
- FOR REPORTING PERIOD JAN-MAR, DUE DATE IS APRIL 15
- FOR REPORTING PERIOD APR-JUN, DUE DATE IS JULY 15

- QUARTERLY CONTENT REQUIREMENTS
  - IF CURRENT SUBMISSION IS FINAL SUBMISSION FOR THIS CDRL ITEM INCLUDE ALL PARAGRAPHS OF REFERENCED DATA ITEM DESCRIPTION (DID), ELSE
    - FOR THE APR-JUN QUARTERLY REPORT, INCLUDE ALL PARAGRAPHS OF REFERENCED DID
      FOR 3.2.1. PLANNED ACTIVITIES, IN ADDITION TO REPORTING PLANNED ACTIVITIES FOR NEXT QUARTER, INCLUDE A TOP-LEVEL BULLET LIST OF PLANNED ACTIVITIES FOR TIME PERIOD BEGINNING 1 OCTOBER OF CURRENT YEAR AND ENDING 31 DECEMBER OF NEXT YEAR.
    - FOR ALL OTHER QUARTERLY REPORTS, INCLUDE ALL PARAGRAPHS OF THE REFERENCED DID EXCEPT FOR DID PARAGRAPH 1.2 PROJECT DESCRIPTION (AND ALL SUB-ELEMENTS OF 1.2)

- GENERAL MONTHLY SUBMISSION REQUIREMENTS
  - FREQUENCY: BLOCK 10. INPUT TWELVE (12) TIMES YEARLY FOR DURATION OF CONTRACT.
  - REPORTING PERIOD: BLOCK 11. REPORT ON PERFORMANCE DURING PREVIOUS MONTH.
  - DUE DATE: BLOCK 12 AND BLOCK 13. SUBMIT WITHIN FIFTEEN (15) CALENDAR DAYS AFTER END OF PREVIOUS MONTH.

- MONTHLY CONTENT REQUIREMENTS
  - FOR DURATION OF CONTRACT, SUBMIT REFERENCED DID ITEMS 2.3 INCURRED EXPENSES THIS PERIOD AND 2.4 INCURRED EXPENSES TO DATE, AS LUMP SUM TOTAL ONLY.

- CONCURRENT SUBMISSION REQUIREMENTS
  - FOR DURATION OF CONTRACT SUBMIT 2.5 INVOICES THIS PERIOD AND 2.6 INVOICES TO DATE, AS INVOICES ARE SUBMITTED FOR PAYMENT. PERIOD IN 2.5 DENOTES TIME SINCE LAST SUBMISSION OF INVOICE(S).

- FORMAT
  - GENERAL FORMAT INSTRUCTIONS: COMPLY WITH ALL INSTRUCTIONS DELINEATED ON THE DARPA EXTRANET REPORTING PAGE.

- SPECIAL FORMAT INSTRUCTIONS: SUBMIT 3.1.7, PUBLICATIONS THIS PERIOD, IN ADOBE ACROBAT (PDF) FILE FORMAT. SUBMIT 1.2.3.1, SCHEDULE GRAPHIC IN EITHER POWERPOINT (PPT), JPG, TIFF, OR PDF FILE FORMAT. SUBMIT 1.2.6, QUAD-CHART, IN MICROSOFT POWERPOINT (PPT) FILE FORMAT.

- INPUT OF PROPRIETARY INFORMATION:
  - PROPRIETARY INFORMATION MAY BE ENTERED ONLY FOR THE FOLLOWING ITEMS AND ONLY IN THOSE AREAS DESIGNATED FOR SUCH INPUT ON THE DARPA EXTRANET REPORTING PAGE
    - 1.2.2.1 DETAILED DESCRIPTION OF TECHNICAL APPROACH
    - 1.2.2.2 COMPARISON WITH CURRENT TECHNOLOGY
    - 3.1.2 TECHNICAL ACCOMPLISHMENTS THIS PERIOD
    - 3.2.1 PLANNED ACTIVITIES

- CLASSIFICATION: THE ENTIRE REPORT SHALL BE UNCLASSIFIED.

- INCLUDE THIS R&D PROJECT SUMMARY ON THE FINAL DD FORM 250.

PROGRAM OBJECTIVES AND DESCRIPTION. The Defense Advanced Research Projects Agency (DARPA) is soliciting proposals for DARPA's Information Processing Technology Office to perform research, requirements and constraint analysis, architecture concept development and design, architectural modeling, in-context evaluations, and concept evaluations to support the initial phase of the Architectures for Cognitive Information Processing (ACIP) program. It is the intent of the DARPA IPTO office to develop cognitive information processes that will bring enabling embedded intelligence capabilities to aid the warfighter, as well as DoD supporting functions and activities – enabling machines that think to aid human performance. Current intelligent processing implementations depend on the use of existing COTS computing architectures that were developed and are best suited for numeric processing applications. To enable the performance of cognitive capabilities in real-time, dynamic, data-intensive, embedded environments and scenarios an underlying processing infrastructure optimized to perform the required cognitive processing is essential. The Architectures for Cognitive Information Processing (ACIP) program seeks to address these deficiencies by developing processing architectures and structures that are uniquely optimized for cognitive computing. The overarching goals of the ACIP program are to develop architectures, processing approaches, and supporting development tools and environments to enable the efficient implementation of embedded realtime cognitive processing and the application of cognitive processing to dynamic, real-world, embedded utilization. This announcement addresses the first phase of the ACIP program. The first phase will address the definition of cognitive computing components requirements specification and runtime requirements; definition of architecture concepts, models and evaluations; development of a concept device specification and technology roadmap; development of composable run-time concepts, and the definition of a living framework approach.

The intent of the ACIP program is to drive the development of a new class of cognitive information computing architectures, data structures, development frameworks, and implementations that efficiently address and instantiate cognitive computing for information processing systems and real-time DoD missions. ACIP will incorporate biological, cognitive algorithm, and DOD mission challenge clues as inputs to establish the concepts of the effort. ACIP will address specific topic areas such as cognitive architectures, alternate representations, composable runtime software, active processing and memory retrieval hardware, and living frameworks to create cognitive information processing solutions. These solutions will be influenced and incorporate concurrent IPTO initiatives in the areas of functional demonstrations and algorithm developments and MTO initiatives addressing physical interconnect and packaging advances. An overall goal of the ACIP Focal Challenge is to provide the computing infrastructure and realtime implementations to enable the IPTO overall goal of "systems that know what they are doing".

The ACIP BAA Focal Challenge will place special emphasis on real and efficient cognitive physical implementations, not just functionality, by developing and demonstrating cognitive information computing system architectures, cognitive

computing frameworks, and implementation development environments within DoD application contexts. ACIP will close the cognitive system engineering design loop between algorithms and physical computing structures and lay the foundations for cognitive innovation. Current intelligent processing implementations depend on the use of existing COTS computing architectures that are best suited for numeric processing applications. Today's knowledge representations, abstraction (processing objects), architectures, and implementations are adhoc, awkward and inefficient. Transformation from today's cognitive techniques running on conventional computers is required to develop innovative DoD cognitive computing solutions. To realize the impact and promise of cognitive information processing approaches, computing architectures and development frameworks attuned to cognitive processing fundamentals need to be established that will implement uniquely cognitive structures efficiently. Cognitive computing systems will require: decoupling of languages from underlying structures, composable runtime systems, higher level goal/motive oriented descriptive languages, agile micro-architectures, adaptive morphware, and multi-dimensional memory structures. Cognitive solutions in areas such as cognitive architectures, composable runtime software, alternative representations, active processing and memory retrieval hardware, and a living framework must be addressed. Without a special emphasis on the total "cognitive information processing" context and structures, cognitive techniques and implementations will always be limited by the use of COTS computing architectures that are inefficient for cognitive processing. ACIP will develop revolutionary and efficient cognitive computing architectures and fundamental computing infrastructures including the abstraction representation/storage/retrieval necessary to efficiently implement real-time DoD cognitive approaches and systems. ACIP will create the computing capabilities to meet the goal of computing systems that adapt to emerging threats.

The intent of the ACIP program is to establish cognitive computing capabilities that significantly advance the state of the art and enable efficient computing at all levels of cognitive processing – cognitive threads, cognitive modules, and cognitive systems, and provide the underlying cognitive computing infrastructure and architectures to support efficient cognitive implementations. These developments will be evaluated in terms of complexity, cost, and platform constraints. An important element of the ACIP program will be a Cognitive Information Framework Forum (CIFF) that will be established to promote and pursue common cognitive computing development environments, tools, and evaluation methods across multiple ACIP efforts and provide an enduring basis for wide community use and application.

In order to focus and establish context for the ACIP program, ACIP will pursue processing requirements, realtime constraints, and innovative architectural concepts incorporating concurrent IPTO cognitive processing activities and within in-context DoD mission areas. Such representative areas could include, but are not limited to: resource management, unmanned combat platforms, intelligent analyst assistant, and unattended distributed sensors systems. Such in-context mission areas could provide the context or challenge space relevant to the development of ACIP. Equivalent alternate in-context mission areas will also be considered.

Resource management could address aided and self-management of system computing resources in terms of system introspection. This would include aided and self-aware system computing resource management and optimization and include robustness and validation and verification of system configurations in a dynamic mission environment. Unmanned combat platform missions could address the dynamic use of system resources for mission performance and optimization. This could include dynamic system resource decisions, allocation, and optimization across mission requirements and performance options as well as the aided and self-aware performance of mission requirements within a dynamically changing mission environment. Intelligence analyst assistant development could address the cognitive architectures and computing requirements necessary to perform aided and self-aware analysis such as signal and image analysis. The cognitive organization, coordination, and utilization of diverse and disparate information sources could be addressed. Automated analysis activities would be enabled. Unattended ground sensor activities could include the aided or self-aware dynamic utilization and optimization of varied sensor and computational resources for adaptive sensor fusion, intelligent and optimized interpretation computation based on system resources and conditions, and reactive and proactive exploitation of conditions and system resources. Overall this area could address the computing architectures, data structures and organization, and implementation frameworks to support adaptive and self-aware cognitive interactive processing utilizing an assemblage of sensors, computing, and communications resources across dynamic mission conditions for optimized mission performance. These four application areas are examples that could define constrained challenge spaces, the identification of key derived requirements and the basis for the developmental research testbeds. The ability to support crisis constrained runtime "cognitive " responses is vital for DoD systems. The goal is to demonstrate for these specific examples "systems that know what they are doing." Successful pursuit, implementation, and integration of ACIP technologies, components, and architectures into a working overall system is paramount.

It is essential that the technologies, components, architectures, and frameworks developed in the course of this research be general enough to be viable across a broad range of applications (portability across cognitive applications) - the goal (as is the goal of the entire BAA) is to create powerful and reusable cognitive computing architectures, technologies, and techniques rather than simply to create a limited implementation that serves only as a single point demonstration

TEST AND EVALUATION. Performers will test and evaluate their technologies using their own facilities and report results at PI meetings. In addition, performers will provide software distributions and will document all test and evaluation choices and procedures (hardware, software environment, scenario, etc.) with enough clarity for a third party to repeat the evaluations. Regarding test and evaluation, an Independent Evaluation Team (IET) will collaborate with performers to foster out-of-the-box thinking and sharing of results among performers and the larger research community.

Within each effort, the performer must quantify the capability demonstrated and the capability to be realized through the cognitive processing approaches and capabilities

being developed. Specific metrics and goals relevant to DoD missions and the cognitive requirements, constraints, and development goals being pursued must be established. Advances in cognitive computing capabilities must be quantified against the established metrics and goals.

The ACIP program will provide all contractors with selected kernels that will compose an evaluation and development set for cognitive computing activities. This will also enable a common evaluation process and analysis/evaluation for the ACIP program and support a common library of kernels and metrics for use by ACIP participants. All ACIP contractors will be expected to work collaboratively with these separately funded and neutral ACIP efforts.

PROGRAM SCOPE DARPA. Proposed research should investigate innovative approaches and techniques that lead to or enable revolutionary advances in the state-of-the-art. Proposals are not limited to the specific strategies listed above, and alternative visions will be considered. However, proposals should be for research that substantially contributes towards the goals stated. Specifically excluded is research that primarily results in minor evolutionary improvement to the existing state of practice or focuses on special-purpose systems or narrow applications.

The proposed ACIP program is intended to be broken into three phases for an anticipated total of a 108 month total performance period. Phase I, addressed in this BAA, will be a 33 month effort consisting of the development of cognitive computing components requirements, specifications and runtime requirements; architectural concepts, models, and evaluations; concept device specification and technology roadmap development, establishing composable runtime concepts; and developing a living framework draft. Each proposed cognitive architectural development effort will include the investigation and association of efforts with cognitive learning reasoning and knowledge modules, development of cognitive processing approaches within cognitive DoD applications, development of cognitive architectures and processing structures optimized to address identified cognitive module processing requirements, DoD application requirements, and realtime constraints via innovative architectural concepts. These efforts will develop early architectural concepts and perform in-context evaluations. Deliverables will include cognitive computing requirements specification and runtime requirements; architecture concepts, models, and evaluation; concept device specification with an associated technology roadmap; and the development of composable runtime concepts. Validated multi-level metrics and kernels will be developed for lower implementations at 21 months into the program and for a system level implementation at 33 months. Draft device specification and an implementation technology roadmap shall be delivered at 15 months with the final device specifications and technology roadmap delivered at 33 months. These shall be established within the context of DoD mission applications. Phase I is planned to be followed by a 48 month Phase II implementation, evaluation, and demonstration of the cognitive architectures developed in Phase I of the ACIP program. A Phase III 30 month effort is then planned for the implementation of full scale DoD ACIP system proof of concept efforts. Phase II is contingent on the results and performance of ACIP Phase I and ACIP Phase III is contingent of the results and

performance of ACIP Phase II. Throughout Phase I the analysis and development of cognitive computing approaches, architectures, and implementations shall be pursued. In addition during the Phase I effort the evaluation of baseline kernels and metrics that represent cognitive computing within the context of DoD mission areas will be a critical set of activities. These evaluations will be critical in determining the value of an ACIP contractor's effort proceeding into ACIP Phase II. At 33 months the cognitive computing requirements, cognitive modules derived, approach, architectures, and initial implementation approaches developed will be presented and reviewed. These results will be evaluated as potential efforts to proceed with ACIP Phase II. The activities performed in Phase I will establish the viability of the cognitive computing approaches being proposed and developed and the viability and extensibility of the approaches developed. In conjunction with the cognitive architectures definition and architecture development, Living Frameworks will be pursued. At 9 months the architectural concepts for a Living Framework will be developed. At 21 months a Living Framework draft will be presented. At 33 months the baseline concepts necessary for a Living Framework to support cognitive architectures shall be completed and presented. Ongoing Living Framework definitions shall be developed and distributed among the Phase I efforts. Each contracted effort selected for ACIP Phase I shall support and provide inputs to Living Framework development activities and provide inputs to support the Living Framework baseline.

Selection of potential ACIP Phase II performers will be based on Phase I performance and proposed Phase II cognitive computing architecture development, implementation, and demonstration. Potential down selection of Phase I activities may occur at the transition into Phase II. Phase II will provide the actual development, implementation, and initial demonstration of the long term innovative cognitive computing approaches, structures, architectures, and supporting development frameworks developed in ACIP Phase I within in-context DoD mission areas. Phase II is anticipated to be a 48 month effort. Phase III will depend on the success of ACIP Phase II and will be composed of a 30 month full scale implementation of an ACIP system proof of concept. As in Phase I, during ACIP Phase II and II there will be a separate Living Framework activity to support the utilization of the cognitive processing being developed. Milestones for ACIP Phase II and II will be specifically developed based on the results of ACIP Phase I. Performers shall work closely and continuously throughout the ACIP program with the Living Framework development performers working cooperatively to provide the most flexible, supportive, and viable framework across the DoD mission area examples.

Concurrent with the ACIP Phase I cognitive architecture development efforts, and as mentioned above, this BAA also solicits proposals for the support and development of a Living Framework or Cognitive Information Framework Forum (CIFF). The CIFF will pursue and develop common cognitive information living frameworks, interfaces, functionality, adaptation, and modularity across cognitive development activities and provide a common cognitive computing architecture framework for real-time DoD systems. All ACIP cognitive development activities will be participants in the CIFF and work with the CIFF contractor(s) to support the development of the common cognitive computing environment. The proposer for CIFF activities would provide overall forum

leadership and work to compose and develop cognitive frameworks, interfaces, tools, and elements across the ACIP program. The CIFF contractor would provide cognitive information computing Early Living Framework architectural concepts at 9 months, a Living Framework draft at 21 months, and baseline Living Framework concepts at 33 months. The CIFF would be carried into a Phase II and III ACIP efforts to provide common support to the cognitive architectures being pursued.

Awards for Phase I efforts are expected to be made during the first half of calendar year 2003. Deliverables, milestones, and demonstrations must be included and clearly defined in proposals with links to the Statement of Work. The establishment of detailed lower level milestones, while at the discretion of the proposer, should clearly provide demonstrable results of the research and integration cumulatively achieved by the team at the milestone described. Milestones of specific interest were briefly discussed earlier in this document. It is anticipated that there will be multiple awards for ACIP Phase I.

Proposers should propose a multi-organizational but integrated team comprising a Lead System Integration (LSI) function and a set of Technology Contributors (TC's). The LSI function will have overall project management responsibility, to include chief architect and interface control functions, system integration of concepts from the TC's, and concept validation and evaluation processes. A proposing LSI should be composed of a well balance team of performers that fully cover the topics of interest of this ACIP Phase I BAA. Multi disciplinary teams are highly encouraged. The teams assembled should incorporate the research disciplines, specifically address the cognitive computing approaches, structures, and architectures proposed, and provide the experience and knowledge of processing approaches, structures, and architectures deemed necessary to address ACIP. The LSI, the integration lead and system integrator, is anticipated to provide the DoD application context lead, specifically providing the expertise and in-context knowledge to support cognitive computing development for relevant in-context DoD mission areas, and or provide unique cognitive processing experience and capabilities (such as concurrent work in cognitive processing algorithm or technique definition and development). Technology Contributors themselves may be multi-organizational, and should reflect a broad and deep representation from the technical community with unique and enabling capabilities for major technical sub-areas key to ACIP Phase I success. They should participate in the design and development activities of the Lead System Integrator, recommend technology elements to the Lead System Integrator, and develop technology elements for all iterations of the architecture and technology concepts for all cognitive computing systems envisioned by the proposal. Proposers are encouraged to bid using this team approach. If multiple mission areas are to be bid, separate proposals should be submitted for each mission area. The CIFF area shall be bid separately from the architecture development activity and can be bid as a single entity or as a team depending on the proposer’s determination to provide the best approach.

Collaborative efforts/teaming are strongly encouraged. The program is designed for teams organized around members with ongoing cognitive experience and current cognitive development activities, relevant DoD mission and application area experience

and knowledge, and supporting technology efforts. Additional information is provided in the BAA xx-xx Proposer Information Pamphlet referenced below. Cost sharing is not required and is not an evaluation criterion, but is encouraged where there is a reasonable probability of a potential commercial application related to the proposed research and development effort. Although proposals identified for funding under this effort may result in a contract, grant, cooperative agreement, or other transaction depending upon the nature of the work proposed, the required degree of interaction between parties, and other factors, the Government anticipates awarding only contracts in order to maintain the desired level of control over this research.

This solicitation is for Phase I only. A separate full and open solicitation is currently planned at a later date for a Phase II program. Offerors should not propose a base effort exceeding 36 months. Any such proposal doing so may be disregarded. Options for up to an additional twelve months over the base period will be acceptable. Any offeror may submit a proposal in accordance with the requirements and procedures identified in this BAA. These requirements and procedures include the form and format for proposals. Any classification requirements deemed necessary due to DoD content in any portion of the proposed effort need to be clearly stated and the handling of classified elements of the proposed effort specifically addressed.
PROGRAM OBJECTIVES AND DESCRIPTION. The Defense Advance Research Projects Agency (DARPA) is soliciting proposals for DARPA's Information Processing Technology Office to perform research, development, modeling, design, and testing to support the Self-Regenerative Systems (SRS) program. Network-centric warfare demands robust systems that can respond automatically and dynamically to both accidental and deliberate faults. Adaptation of fault-tolerant computing techniques has made computing and information systems intrusion-tolerant and much more survivable during cyber attacks, but even with these advancements, a system will inevitably exhaust all resources in the face of a sustained attack by a determined cyber adversary. Computing systems and information systems also have a tendency to become more fragile and susceptible to accidental faults and errors over time if manually applied maintenance or refresh routines are not administered regularly. The Self-Regenerative Systems (SRS) program seeks to address these deficiencies by creating a new generation of security and survivability technologies. These "fourth-generation" technologies will bring attributes of human cognition to bear on the problem of reconstituting systems that suffer the accumulated effects of imperfect software, human error, and accidental hardware faults, or the effects of a successful cyber attack. The overarching goals of the SRS program are to implement systems that always provide critical functionality and show a positive trend in reliability, actually exceeding initial operating capability and approaching a theoretical optimal performance level over long time intervals. Desired capabilities include self-optimization, self-diagnosis, and self-healing; it will be important for systems to support self-awareness and reflection in order to achieve these capabilities.

The approach of this program to constructing self-regenerative systems that meet the above needs is to create fourth generation survivability and security mechanisms to complement received first-generation security mechanisms (trusted computing bases,

encryption, authentication and access control), second-generation security mechanisms (boundary controllers, intrusion detection systems, public key infrastructure, biometrics) and third-generation security and survivability mechanisms (real-time execution monitors, error detection and damage prevention, error compensation and repair). Among other things, new fourth generation technologies will draw on biological metaphors such as natural diversity and immune systems to achieve robustness and adaptability, the structure of organisms and ecosystems to achieve scalability, and human cognitive attributes (reasoning, learning and introspection) to achieve the capacity to predict, diagnose, heal and improve the ability to provide service.

The vulnerabilities of computing and information systems addressed by this program include mobile/malicious code, denial-of-service attacks, and misuse and malicious insider threats, as well as accidental faults introduced by human error and the problems associated with software aging. The program will build on the advances made in earlier programs addressing the DoD's operational needs for information systems, such as the ability to operate through attacks, maintenance of critical functionality, graceful degradation of non-critical functions in the face of intrusions and attacks when full functionality cannot be maintained, and the ability to dynamically trade off security, performance and functionality as a function of threat.

Fault-tolerant systems deal with accidental faults and errors while intrusion-tolerant systems cope with malicious, intentional faults caused by an intelligent adversary. Combining fault- and intrusion-tolerance technologies produces very robust and survivable systems, but these techniques depend upon resources that may eventually be depleted beyond the point required to maintain critical system functionality. The fourth generation technologies we seek will reconstitute and reconfigure these resources in such a manner that the systems are better protected in the process, reliability is continually improved as vulnerabilities and software bugs are discovered and fixed autonomously, and the ability to provide critical services is never lost.

Assessment and validation of self-regenerative approaches will be carried out to determine their efficacy. The challenge here is that security and survivability requirements have heretofore defied quantification and analytical approaches. Progress made in creating a practical framework for validating intrusion-tolerance techniques will be built upon and extended to validate SRS technologies.

The first phase of this effort is planned to be 18 months long. This is a solicitation for Phase I only. If results are promising, a Phase II follow-on program is a possibility.

Phase I program goals are to create the core technologies needed

- to design and develop systems that provide 100% critical functionality at all times in spite of attacks;
- for a system to learn its own vulnerabilities over time,
- to ameliorate those vulnerabilities,
- to regenerate service after attack, and

ultimately, to improve its survivability over time.

The ultimate goal at the end of a Phase II program would be to achieve sufficient system robustness and regenerative capacity to provide 100 per cent availability of critical functionality and system integrity in the face of sustained malicious attacks and accidental faults.

There will be four major research thrusts in the Phase I technology development of the program. These areas, along with their success criteria, are as follows:

Biologically-inspired diversity. This research thrust area will create a genetically diverse computing fabric in which diversity limits the impact of any given vulnerability. Coarse-grained diversity (e.g., using several different operating systems or server software packages in an architecture) has been used to achieve intrusion tolerance, but that approach was limited by the relatively small number of manually-created interchangeable operating systems, server packages, and similar software components. The technical approach of the SRS program is to achieve fine-grained diversity at the module level to remove common vulnerabilities and to automatically generate numerous diverse software versions. The success criterion for this thrust is the automatic production of 100 functionally-equivalent versions of a software component with no more than 33 having the same deficiency.

"Cognitive immunity" and self-healing. This research thrust area will show automated cyber immune response and system regeneration. The technical approach will include biologically-inspired response strategies, machine learning, and cognitively-inspired proactive automatic contingency planning. The success criterion for this thrust is the accurate diagnosis of at least 10% of the root causes of system problems and automatic effective corrective action for at least half of those diagnoses.

Granular, scalable redundancy. This research thrust area will increase the practicality of redundancy techniques by dramatically reducing the time required to achieve consistency among replicas after an update. This thrust area will attack the consistency problem in two distinct sub-areas—a centralized server setting, and a distributed publish/subscribe setting. Performers who propose to the scalable redundancy thrust area may address either or both sub-areas. Success criteria here include the following: in the centralized server setting, attain a three-fold reduction in latency for achieving consistency of replicated data while tolerating up to five Byzantine failures; in the distributed publish/subscribe setting, attain a fifteen-fold reduction in latency for achieving consistent values of data shared among one hundred to ten thousand participants while using robust epidemic algorithms, where all participants can send and receive events.

Reasoning about the insider threat to preempt insider attacks and detect system overrun. The technical approach will include inferring user goals, enabling anomaly detection, and combining and correlating information from system layers, direct user challenges, etc. The success criterion for this thrust is the thwarting or delaying of at least 10% of insider attacks.

These research areas will explore techniques that span the spectrum from autonomic/reflexive response through and including introspection and learning. These

research areas will explore techniques that span the spectrum of human mental function, from autonomic/reflexive response through and including introspection and learning. Proposals should address only one research thrust area. A proposer may submit multiple proposals. The success criteria for the four thrust areas constitute the program's gating evaluation criteria for the possibility of a Phase II follow-on program. They are minimum requirements to gain confidence that self-regenerative systems are feasible. A Phase II program would seek much higher levels of performance. Phase I offerors are strongly encouraged to aim for performance that exceeds these criteria where possible.

It is envisioned that a Phase II program would integrate the more promising techniques into an exemplar system prototype to demonstrate the advantages of implementing these technologies in high value critical applications. The system demonstrated would exhibit the fourth generation capabilities of self-optimization, self-awareness, self-diagnosis, self-healing and reflection.

Offerors must state in their proposals a plan for providing deliverables for installation, training, manuals, etc. required for evaluation by the testing facility, as well as travel costs. Offerors should support the technical feasibility of their concept or idea and discuss the future development of their ideas, validation and transition.

TEST AND EVALUATION. Performers will test and evaluate their technologies using their own facilities and report results at PI meetings. In addition, performers will provide software distributions and will document all test and evaluation choices and procedures (hardware, software environment, scenario, etc.) with enough clarity for a third party to repeat the evaluations. Regarding test and evaluation, an Independent Evaluation Team (IET) will collaborate with performers to foster out-of-the-box thinking and sharing of results among performers and the larger research community. Because progress in the scalable, granular redundancy research thrust area is relative to a baseline that is very sensitive to the testing environment, performers in that area will construct a testbed environment, establish a test procedure, test the best available techniques to determine baseline performance in that testbed, and report their baseline results at the first PI meeting. Testing and evaluation for granular, scalable redundancy techniques developed in Phase I will be conducted on an identical testbed.

PROGRAM SCOPE. Proposed research should investigate innovative approaches and techniques that lead to or enable revolutionary advances in the state-of-the-art. Proposals are not limited to the specific strategies listed above, and alternative visions will be considered. However, proposals should be for research that substantially contributes towards the goals stated. Specifically excluded is research that primarily results in minor evolutionary improvement to the existing state of practice or focuses on special-purpose systems or narrow applications.

This solicitation is for Phase I only. A separate full and open solicitation is possible at a later date for a Phase II program. Offerors should not propose a base effort exceeding 18 months. Any such proposal doing so may be disregarded. Options for up to an additional twelve months over the base period will be acceptable. Any offeror may

submit a proposal in accordance with the requirements and procedures identified in this BAA. These requirements and procedures include the form and format for proposals. Phase I is planned to be unclassified, but Phase II is likely to be a classified program. Offerors who desire to be able to participate in a possible Phase II program are encouraged to be willing and able to obtain appropriate security clearances. Offerors for the technology development of self-regenerative systems may be foreign firms or may team with foreign firms as long as the firm meets the criteria in this solicitation and the Government is permitted to conduct business with the firm. Offerors for the technology development of self-regenerative systems may also include foreign personnel as part of their proposed resources as long as these personnel qualify technically. It is strongly recommended that researchers in Phase I be willing and able to obtain security clearances in order to be able to continue their work in Phase II.

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Security classification guidance on a DD Form 254 (DoD Contract Security Classification Specification) will not be provided at this time since DARPA is soliciting ideas only. After reviewing incoming proposals, if a determination is made that contract award may result in access to classified information, a DD Form 254 will be issued upon contract award. **If you choose to submit a classified proposal you must first receive the permission of the Original Classification Authority to use their information in replying to this BAA.**

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Overall Scientific and Technical Merit: The overall scientific and technical merit must be clearly identifiable and compelling. The technical concept should be clearly defined, developed and defensibly innovative. Emphasis should be placed on the technical excellence of the development and experimentation approach.

(2) Innovative Technical Solution to the Problem: Proposed efforts should apply new or existing technology in an innovative way such as is advantageous to the objectives. The plan on how offeror intends to get developed technology artifacts and information to the user community should be considered. The offeror shall specify quantitative experimental methods and metrics by which the proposed technical effort's progress shall be measured.

Potential Contribution and Relevance to DARPA/IPTO Mission: The offeror must clearly address how the proposed effort will meet the goals of the undertaking and how the proposed effort contributes to significant advances to the DARPA/IPTO mission of preventing strategic surprise.

Offeror's Capabilities and Related Experience: The qualifications, capabilities, and demonstrated achievements of the proposed principals and other key personnel for the primary and subcontractor organizations must be clearly shown.

(5) Plans and Capability to Accomplish Technology Transition: The offeror should provide a clear explanation of how the technologies to be developed will be

transitioned to capabilities for military forces. Technology transition should be a major consideration in the design of experiments, particularly considering the potential for involving potential transition organizations in the experimentation process.

(6) Cost Realism: The overall estimated cost to accomplish the effort should be clearly shown as well as the substantiation of the costs for the technical complexity described. Evaluation will consider the value to Government of the research and the extent to which the proposed management plan will effectively allocate resources to achieve the capabilities proposed. Cost is considered a substantial evaluation criterion but is secondary to technical excellence.