

EE482A Spring Quarter 1999-2000 Pseudo-DARPA Proposal Assignment Assigned 4/5/00, Due 4/19/00

You are to write a proposal in response to the following simulated broad-area announcement (BAA). Please visit Prof. Dally or TA, Mattan Erez if you have questions. You may work on this assignment individually or in groups of up to 4 students.

NOTE

This is not an actual DARPA solicitation. It is a simulation of such a solicitation for a class assignment. Portions of this text have been borrowed from actual DARPA solicitations available on the DARPA web page (www.darpa.mil).

BAA 00-482 High-Performance Single-Thread Architecture

Program Vision and Goals

DARPA requests proposals to significantly improve the performance of computer systems running a single thread of computation. There are many tasks for which single-thread processors are required. These include tasks running legacy single-thread codes and tasks that are inherently difficult to parallelize. For tasks that can be parallelized into multiple threads, single-thread performance affects the execution time of the program by determining the time required by the critical path.

Many tasks of interest to DARPA involve computer systems powered by batteries or in environments with limited power availability. Hence there is a need for processors that realize high single-thread performance with minimal power dissipation.

Many of these tasks also involve hard real-time constraints on performance. Hence successful processor architectures should have not only good average performance, but also good performance predictability and good worst-case performance.

Many problems of interest to DARPA involve processing streams of low-precision data, e.g., data returned from a radar or communications antenna. Other problems involve making essentially random accesses to data tables the size of main memory. Such problems are a poor match for conventional memory systems. Architectures are needed that achieve good performance on these classes of problems.

It is anticipated that on-chip wire latency will become more significant in future semiconductor technologies. There is a need for processor architectures that achieve good single-thread performance under the constraint of slow global communication among the elements of the processor.

Latency of memory accesses is also seen as a limiting factor in the performance of future computer systems. New techniques are needed both to reduce this latency and to tolerate memory latency.

Proposals will be accepted on all aspects of high-performance single-thread architecture. In particular, the following areas are of interest:

1. Architectures that reduce the impact of control hazards on single-thread performance.
2. Architectures that reduce the impact of increasing memory access times on single-thread performance.
3. Architectures that realize the highest single-thread performance per unit power.
4. Architectures with good single-thread performance predictability and worst-case performance.
5. Architectures that achieve good single-thread performance on problems with little memory locality
6. Architectures that will achieve good single-thread performance when implemented with future VLSI technologies with high-latency global interconnect.
7. Studies that characterize key applications in terms of their control behavior, memory reference patterns, and instruction-level parallelism.
8. Development of tools to characterize application behavior and performance of proposed architectures.

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. Research should result in prototype hardware and/or software demonstrating integrated concepts and approaches. Specifically excluded is research that primarily results in evolutionary improvement to the existing state of practice or focuses on a specific system or solution. Integrated solution sets embodying significant technological advances are strongly encouraged over narrowly defined research endeavors.

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 of the proposal shall not exceed 45 pages. Maximum page lengths for each section are shown in braces { } below.

Section I. Administrative

{1} Cover Page including: (1) BAA number; (2) Technical topic area; (3) Proposal title; (4) Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (5) Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (6) 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; and (7) Contractor's type of business, selected from among the following categories: "LARGE BUSINESS," "SMALL DISADVANTAGED BUSINESS," "OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," or "OTHER NONPROFIT."

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.

- A. {1} Innovative claims for the proposed research. This page is the centerpiece of the proposal and should succinctly describe the unique proposed contribution.
- B. {1} A "Proposal Roadmap" which shall address the following nine areas that must be addressed in the proposal. For each area, the roadmap will contain a summary statement (or "sound bite") for that area and identify the page number(s) where the issue is addressed in detail. It is important to make these statements as explicit and informative as possible. The areas are:
 1. Main goal of the work (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. Specific basis for 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/novel/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 evaluating progress and capabilities.
 9. Cost of the proposed effort for each contract year.
- C. {7} Technical Description
 1. Technical Innovations. This subsection provides the technical rationale and approach. It must give a clear, technical explanation of the ground-breaking analysis, composition, transformation, or aspect programming ideas and the implementation strategy.

2. Proposed Experiment. This subsection must provide details of the aspects or other technology to be implemented and of the validation approach. This subsection should identify figures of merit and plans for evaluation of improvement in the development of real-time embedded systems. Quantitative measures are preferred, where suitable, but qualitative measures are allowed. Evaluation should address improvements in both effort and dependability.
 3. Technology Adoption. This subsection must provide technical details of how the resulting technology will be incorporated into tools or languages, and provide a transition plan for moving the innovations into practice.
 4. Research Plan. This subsection gives the constructive plan for accomplishment of technical goals in support of innovative claims and deliverables.
- D. {1} Deliverables associated with the proposed research. 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.)
- E. {2} Statement of Work (SOW) written in plain English, outlining the objectives and scope of the effort and citing specific tasks to be performed and specific contractor requirements.
- F. {1} Comparison with other ongoing research indicating advantages and disadvantages of the proposed effort.
- G. {1} 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.
- H. {1} 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.
- I. {2} Cost by task, with breakdown into accounting categories and equipment for the entire contract and for each contract year. 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. Details of any cost sharing should also be included.