

**BAA 07-36**

**THERMAL GROUND PLANE (TGP)**



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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 solicitation notice will appear first on the FedBizOpps website, <http://www.fedbizopps.gov/> and Grants.gov website at <http://www.grants.gov/>. This BAA document constitutes the entire solicitation.

DARPA is soliciting innovative research and development (R&D) proposals in the area of Thermal Ground Planes (TGP). The overall goal is the creation of a thin, lightweight substrate for electronic systems and multi-chip modules that has thermal conductivity at least 100X higher than common copper alloy substrates used in these applications. These TGPs will enable a new generation of high-performance, integrated systems to operate at high power density without problems from temperature gradients, increased weight, or added complexity. TGP will be particularly important for enhancing existing systems that are highly constrained in size and weight. A key aspect of the TGP will be matching thermal expansion coefficients to the thermal expansion coefficients of common microelectronic substrates, such as Si, GaAs, and SiC.

Proposed TGP approaches should investigate innovative uses of 2-phase cooling, as in common heat pipes, where the benefits include very high thermal conduction, extreme reliability, no moving parts, electrodes, or need for external power. Heat pipes are widely used in DoD applications, as well as in commercial and industrial systems, primarily because of the attributes listed above. The TGP program envisions development of flat, thin heat-pipe structures that will have many of these advantages, but will also be thin enough to be used in common electronic systems, and will be built with materials that have thermal expansion coefficients that match the electronic devices.

Successful TGP approaches will explore modern, nano-structured materials for use as the wick, with the materials properties optimized for this role in the system (high lateral fluid mobility, high vertical thermal conductivity), and are compatible with the fluid and casing materials choices for the TGP. Fluids and casing materials are also an area of potential innovation, leading to the possibility of insulating TGP substrates, or “flex TGP” substrates capable of being bent and twisted to fit novel applications. Specifically excluded are approaches which rely entirely on solid conduction because these approaches cannot deliver the very high thermal conductivity required in this program.

## **BACKGROUND AND DESCRIPTION**

As electronic system technology advances – with continual increases in requirements leading to increasing demand for higher power consumption – there has been increasing pressure on the thermal engineering and heat rejection technologies used. There are many programs and technological approaches that may lead to dramatic reductions in power consumption in specific electronic devices. The need for performance inevitably leads to operation of most electronic systems at the limits of the available thermal management technology. For most systems, solid conductors and heat pipes are allowed, with pumped fluid approaches used only in extreme cases. Or, there are compartmentalized systems where solid conduction and heat pipes are used on the modules, and pumped water cooling is used in the rack and beyond.

For many systems, the electronic devices are mounted on copper alloy substrates using soft or hard die attach (depending on the need for low thermal resistance, the thermal expansion mismatch, and the need for rework of the die attach). The copper alloy substrates represent a compromise between performance and cost, with thermal conductivities that are about half that of copper (~200 W/m·K), which is also only 1/10 that of diamond. These copper alloy structures are inexpensive and reliable, but better thermal conductivity would be a great benefit in all systems.

There has always been the possibility that diamond thermal structures could solve many problems in thermal management, but diamond remains very expensive, and the thermal expansion coefficient of diamond is not a good match to electronic device materials. As a result, diamond components are rarely used in DoD systems, even though the additional thermal conductivity would be important for solving thermal management problems.

Heat pipes are an interesting alternative to consider. A common heat pipe usually has very high thermal conductivity, more than 10X better than would be offered by diamonds of the same size and shape. Heat pipes are inexpensive, reliable, and widely used in many electronic systems.

Desktop and laptop computers have all used heat pipes for transport of heat from microprocessors to heat sinks located tens of centimeters away, such as on the edges of a laptop keyboard. Common heat pipes, however, are based on copper/copper foam technologies which provide good heat transport at the few mm to cm diameter scale, but do not deliver the necessary performance at smaller diameter. Also, the cylindrical shape of existing heat pipes is a poor match to the planar interfaces between devices and packages. Vapor chambers – flat heat pipes – have been developed for positioning as efficient heat spreaders in the base of metal fin heat sinks, and there are advantages to the use of this technology. DARPA, however, is interested in a more generic and higher-performance technology for multi-chip systems.

## PROGRAM REQUIREMENTS

The objective of the TGP program is to develop a practical, high-performance thermal substrate that can improve the thermal performance of almost all DoD systems.

The TGP program will focus on the development of large-area, thin, high-thermal conductivity substrates for multi-chip modules (MCM). The specific program targets are for TGP substrates with:

- **High Thermal Transport:** >100X increase in power density transport over current MCM substrates (CuMo substrates have  $k \sim 200$  W/m·K; program goal is for TGP substrates with  $k \sim 20,000$  W/m·K).
- **Operation Under Acceleration:** TGP substrates should operate at the performance target while being accelerated to 20g.
- **Thin, 2-D Geometry:** Thickness <1 mm, Lateral dimensions >10 cm.
- **Low Density:** <3 g/cc (~1/3 that of copper).
- **Thermal Expansion-Matched:** Match within 1% to Si (2.6 ppm/°C), GaN (3.2ppm/°C), or GaAs (6.9ppm/°C) (note: Cu is 13.5ppm/°C, and Al is 23ppm/°C).
- **Reliable operation:** Ideal TGPs would operate indefinitely with no degradation in performance. In this program, studies to show reliable long-term operation will be required.

TGP structures based on semiconductor materials are desired, as it should be possible to form high-quality bonds between semiconductor TGPs and semiconductor substrates, which would greatly reduce thermal resistances at those interfaces. Other desired features of TGPs include the possibility of tailoring the fabrication process of the substrate so that more than one thermal expansion coefficient can be matched. Also, opportunities for the TGP to be made entirely from insulating materials (which would allow the TGP to serve electronic and thermal roles in a dense system) and possibly include thru-TGP electrical vias for stacked systems are of great interest. In addition, approaches that rely on flexible materials, such as Kapton (used in flex-circuits) are of interest. A flexible TGP could become an important enabler for novel high-density systems, UAVs, fabrics, and even more applications. The TGP program is intended to encourage approaches across this spectrum of materials and methods in order to address thermal management problems throughout the DoD.

An important feature of some embodiments of the intended TGP technology is complete compatibility with many existing DoD systems without redesign of those systems. Insertion of TGPs into these systems can provide new engineering margins that can be taken up by increasing the power use of the system, reducing the operating temperature of the electronic devices, or reducing the size of the other components of the thermal management system. In addition, the availability of TGPs will allow future DoD system designs to be more aggressive in increases of density, power consumption, and performance than is presently allowed.

Heat pipes are widely used in DoD systems because of their simplicity, practicality, and low cost. The use of fluidic heat transfer within heat pipes is not readily apparent to users. In many cases, heat pipes have been included in systems without end users becoming aware of them, and certainly without users being concerned about them. This is in strong contrast with other pumped fluid-cooling approaches, which are generally regarded as risky, unreliable, and expensive. Our intent is for TGPs to offer the same features to the users as heat pipes, but in new sizes and shapes, with new materials and with better performance. Ideal TGP approaches will consist of sealed chambers with no moving parts, no electrodes, and no externally-noticeable complexity.

## TGP PROGRAM MILESTONES

Proposers must define their TGP approach and describe in detail how the performance metrics of their TGP designs will satisfy the requirements of the program. Though the performance parameters will depend on the particular architecture proposed, DARPA envisions some common performance metrics and some metrics specific to the proposed architecture. Common performance metrics to be used for go/no-go evaluations between phases will be drawn from this list:

<i>Metric</i>	<i>Unit</i>	<i>SOA</i>	<i>Phase I</i>	<i>Phase II</i>	<i>Phase III</i>
Hermeticity	% fluid loss/yr @ 100°C	0	10	1	0.1
Wicking <sup>(1)</sup>	g (inertial force)	3	2	10	20
Thermal Expansion Mismatch <sup>(2)</sup>	%	10	10	5	3
Wick Thermal Conductivity <sup>(3)</sup>	W/m·K	23 (Cu foam)	100	-	-
TGP Thermal Conductivity	W/m·K	200 (CuMo)	--	500	20,000
TGP Thickness	mm	2	2 <sup>(4)</sup>	3	<1
Area	cm x cm	15 x 30	--	3 x 3	10 x 20
Weight	gm	270	--	20	50
Duration <sup>(5)</sup>	hours	infinite	--	100	1,000

- (1) Wick must remain saturated at up to 2g of lateral acceleration in Phase 1. In Phases 2 and 3, requirement is for maintenance of thermal conductivity of a complete TGP above the required performance.
- (2) Percentage difference in relation to semiconductor material (Si, GaN/SiC, GaAs, etc.). Material selected by contractor. Preference given to solutions which can be tailored to match more than one semiconductor TEC.
- (3) Thermal conduction measurement method to be defined by proposer.
- (4) For wicking and thermal conductivity tests in Phase 1, the sum of the substrate and wick thicknesses should be below 2 mm.
- (5) Operation of TGP for extended period with thermal conduction above 500 W/m·K in Phase 2 and 20,000 W/m·K in Phase 3. Temperatures and Heat Flux TBD.

## **EXPLANATIONS AND RATIONALE FOR METRICS**

**Hermeticity** Existing heat pipes are regarded as perfectly hermetic. This program will explore the use of new materials for the casing of the TGP, and it is necessary to show that these new materials can also prevent fluid loss during use. Selection of case materials, dimensions, assembly methods, and fluids will be important factors in meeting this requirement.

**Wicking** To operate the TGP, fluids must be returned from the condensation location to the evaporation location by capillary forces. In the first phase, it is important that the selected wick materials be tested to show that they provide useful amounts of capillary force. A test to show that an entire wick remains saturated up to 2g of in-plane acceleration is offered as the first measure of wicking performance. Later phases will include tests of complete TGP structures under acceleration.

**Thermal Expansion Mismatch** An important feature of the intended TGP is that it is matched to the thermal expansion of semiconducting materials, enabling use of hard die attachment strategies with lower interface thermal resistance. Case materials must be selected so that they can be tailored to match the TEC of at least one of the following: Si, GaAs, or SiC.

**Wick Thermal Conductivity** In the TGP, it is necessary for the wick to carry heat from the case to the interior surface of the TGP. Its thermal conductivity must be high enough to allow performance scaling to program goals. In Phase 1 a measurement of the thermal conductivity of the wick is intended to determine if the selected wick material can meet the program performance goals.

**TGP Thermal Conductivity** In Phases 2 and 3, teams will build complete TGP structures, and one of the most important performance metrics will be measurements of the thermal conductivity of the TGP structure. In Phase 2, the targeted conductivity is chosen at a level that will require fluid/vapor 2-phase processes to be operating in the TGP (beyond the conductivity available in any solid materials other than diamond). In Phase 3, the performance target is set by a 100X improvement over common copper alloy substrates.

**Thickness, Area, Weight** These parameters are intended to constrain the dimensions and materials so that the resulting TGP structures are thin enough to be inserted into all existing

systems, and that there is no associated increase in weight. The increases in lateral dimensions are intended to drive the program towards capability for manufacturing of large-area substrates. The eventual requirement for 10 cm x 20 cm structures is serious, and should be consistent with work carried out in the early phases.

**Duration** TGP structures are intended to have the same excellent long-term reliability commonly expected from heat pipes. In Phase 2, we test this by asking for TGPs to operate for more than 100 hours under conditions consistent with use at high heat flux. In Phase 3, we expect proposers to define a suitable set of long-term tests that will satisfy real customers, based on their experiences in meeting specifications for existing DoD systems. Obviously, a 10-year test is not possible within a year, but approaches that yield statistically-meaningful statements about long-term reliability are expected.

## **DELIVERABLES**

The primary data deliverables will include quarterly reports throughout the program and participation in semi-annual progress reviews (either on site or at DARPA PI meetings). Additional deliverables include 10, 3 cm x 3 cm TGP samples at end of Phase 2, and 50, 10 cm x 20 cm TGP samples at the end of Phase 3.

## **PROGRAM SCOPE**

The TGP program will consist of three phases. The length of each phase shall be determined by the bidder and will be considered under the evaluation criteria. Generally, phases of shorter duration are preferred. Each phase shall have measurable go/no-go metrics, based on the table presented above. The focus of each phase is described below:

Phase 1 *Materials Selection and Preliminary Testing.* In this phase performers are expected to investigate candidate materials for casing, wick and fluid. Design, fabrication and testing of devices based on these materials choices are to be used to verify the utility of chosen materials. Attention should be given to issues with final integration of casing, wick and fluid, as well as to fabrication of large-area TGP structures. Comprehensive full-physics models of the operation and performance of the TGP designs and materials should be constructed to prove that scaling to performance goals of the program is possible.

Phase 2 *Integrated TGP Construction and Testing.* In this phase, complete TGP structures will be built and tested. 3 cm x 3 cm samples should be constructed, and testing to show that TGP operation is successful at 500 W/m<sup>2</sup>·K will be completed. These experiments are intended to prove that the fluid and wick are operational in a sealed system, and also to provide evidence that scaling to higher performance and larger sizes is possible. Preliminary reliability tests will be carried out, and some 3 cm x 3 cm samples will be delivered for testing in DoD labs.

Phase 3 *Performance Optimization and Scale-up.* In this phase, adjustments to design and fabrication of components of the system will be carried out to improve performance and reliability and to allow construction of 10 cm x 20 cm TGP samples for final testing. 10 cm x 20 cm samples will be delivered for testing in DoD labs.

## PERIOD OF SOLICITATION

This BAA will remain open from 16 April 2007 through 16 April 2008. The due date for abstract and/or proposal submissions are as stipulated in the following section. Proposals submitted after the first round due date will be accepted for evaluation by the Government, but are not likely to be funded during the first round.

## SUBMISSION GUIDELINES

Proposers are **strongly encouraged** to submit a proposal abstract in advance of a full proposal. This procedure is intended to minimize unnecessary effort in proposal preparation and review.

**\*\*Proposal abstracts must be submitted to DARPA/MTO by Friday, June 1, 2007.**

**\*\*Full proposals must be submitted to DARPA/MTO by Monday, July 23, 2007.**

Abstracts and proposals should be submitted electronically using one of the following two submission methods. Note that neither dual submissions nor a paper copy are required. Please note that proposers will receive a confirmation e-mail generated from the T-FIMS electronic system (described below) as receipt that their proposal has been received.

1. DARPA/MTO will employ an electronic upload process, the Technical Financial Information Management System (T-FIMS) Proposal Submission System, for proposal submissions to this BAA. Abstracts and proposals should be in Microsoft Word format or PDF and submitted via a web site interface: Web Site: <https://www.tfims.darpa.mil/baa>.

2. Proposals may also be submitted to this BAA via the Grants.gov web site, <http://www.grants.gov/>, by using the "Apply" function.

DARPA will respond to proposal abstracts with a recommendation to propose or not propose and the time and date for submission of a full proposal. DARPA will attempt to review proposal abstracts within thirty (30) calendar days after receipt and will allow proposers at least thirty (30) calendar days after review of their proposal abstracts in order to complete and submit their full proposals. Upon review, DARPA will provide written feedback on the likelihood of a full proposal being selected and the time and date for submission of a full proposal. Early submissions of proposal abstracts and full proposals are strongly encouraged because selections may be made at any time during the evaluation process. Regardless of the recommendation, the decision to propose is the responsibility of the proposer.

All submitted proposals will be fully reviewed regardless of the disposition of the proposal abstract. Proposers not submitting proposal abstracts are required to submit full proposals by **Monday, July 23, 2007**; proposals received after this deadline, however, may be received and evaluated up to one year from date of posting on FedBizOpps.gov and Grants.gov. Full proposals submitted after the due date stated above or due date otherwise specified by DARPA after review of proposal abstracts may be selected contingent on the availability of funds.

The typical proposal should express a consolidated effort in support of one or more related technical concepts or ideas. Disjoint efforts should not be incorporated into a single proposal.

## **PROPOSER REGISTRATION**

Organizations planning to submit proposals via T-FIMS must register at: <http://www.tfims.darpa.mil/baa>. Only the lead or prime organization should register. One registration per proposal should be submitted. This means that an organization wishing to submit to multiple technical topic areas should complete a single registration for each proposal. The proposer makes no commitment to submit by registering. Please note that it is recommended that proposers register on T-FIMS at least a week prior to the submission deadline to allow sufficient time for completing the registration process and uploading the submission. Please also note that proposers will receive a confirmation e-mail generated from the T-FIMS electronic system as receipt that their proposal has been received.

The T-FIMS Proposal Submission System supports the following file formats: Portable Document Format (PDF), Word Document (doc), Plain Text (txt), Comma-separated I-7 Values (CSV), PowerPoint Presentation (ppt), Excel Worksheet (xls), and Excel Workspace (xlw). Proposal submissions made through the T-FIMS Proposal Submission System must be no larger than 50 megabytes per file.

All material submitted electronically must be UNCLASSIFIED. Please DO NOT attempt to submit a CLASSIFIED material proposal through an electronic upload process as this is PROHIBITED. Offerors that intend to include classified, or potentially classified, information or data as part of their proposals shall submit an UNCLASSIFIED PROPOSAL referring to a classified annex. The offeror should contact the Technical POC, or the Security POC listed below, for this BAA for guidance on submitting the classified annex.

## **SUBMISSION PROCESS**

This BAA constitutes the entire solicitation for TGP. No additional information is available, nor will a formal RFP or other solicitation document regarding this announcement be issued. Requests for the same will be disregarded. The Government reserves the right to select for award all, some, or none of the proposals received and to award without discussions. All responsible sources capable of satisfying the Government's needs may submit a proposal which shall be considered by DARPA. Input on technical aspects of the proposals may be solicited by DARPA from non-Government consultants /experts who are bound by appropriate non-disclosure requirements. Non-Government technical consultants/experts will not have access to proposals that are labeled by their offerors as "Government Only". Historically Black Colleges and Universities (HBCUs), Minority Institutions (MIs), and Small and Small Disadvantaged Businesses are encouraged to submit proposals and join others in submitting proposals; however, no portion of this BAA will be set aside for these organizations' participation due to the impracticality of reserving discrete or severable areas of research in the subject technology area(s).

All administrative correspondence and questions on this solicitation, including requests for

information on how to submit a proposal to this BAA, should be directed to the administrative addresses below; e-mail or fax is preferred. DARPA intends to use electronic mail and fax for correspondence regarding BAA 07-36. Proposals may not be submitted by fax or e-mail; any so sent will be disregarded. DARPA encourages use of the WWW for retrieving the BAA document and any other related information that may subsequently be provided.

The administrative addresses for this BAA are:

Fax: (703) 741-0079 (Addressed to: DARPA/MTO, BAA 07-36),

Electronic Mail: [BAA07-36@darpa.mil](mailto:BAA07-36@darpa.mil) or [Mary.Jacobs.ctr@darpa.mil](mailto:Mary.Jacobs.ctr@darpa.mil)

Restrictive notices notwithstanding, proposals may be handled, for administrative purposes only, by a support contractor. This support contractor is prohibited from competition in DARPA technical research and is bound by appropriate nondisclosure requirements. Proposals and proposal abstracts may not be submitted by fax or e-mail; any so sent will be disregarded.

## **EVALUATION CRITERIA/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 two-volume document described in PROPOSAL FORMAT (see below). Other supporting or background materials submitted with the proposal will be considered for the reviewer's convenience only and not considered part of the proposal.

The criteria to be used to evaluate and select proposals for this project are described in the following paragraphs. The criteria to be used to evaluate and select offers under this BAA are, in order of descending importance: (1) Overall Scientific and Technical Merit; (2) Proposer's Capabilities and/or Related Experience; (3) Realism of Proposed Schedule. (4) Potential Contribution and Relevance to the DARPA Mission; (5) Plans and Capability to Accomplish Technology Transition; and (6) Cost Reasonableness and Realism; each proposal will be evaluated on its own merit and relevance rather than against other proposals in the same general area, since no common work statement exists. Proposals may be evaluated as they are received, or they may be collected and periodically reviewed. The following are descriptions of the above listed criteria:

### **1. OVERALL SCIENTIFIC AND TECHNICAL MERIT**

The proposed technical approach is feasible, achievable, complete and supported by a proposed technical team that has the expertise and experience to accomplish the proposed tasks. Task descriptions and associated technical elements provided are complete and in a logical sequence with all proposed deliverables clearly defined such that a final product that achieves the goal can be expected as a result of award. The proposal identifies major technical risks and planned mitigation efforts are clearly defined and feasible.

### **2. PROPOSER'S CAPABILITIES AND/OR RELATED EXPERIENCE**

The proposer's prior experience in similar efforts must clearly demonstrate an ability to deliver products that meet the proposed technical performance within the proposed budget and schedule. The proposed team has the expertise to manage the cost and schedule. Similar efforts completed/ongoing by the proposer in this area are fully described including identification of other Government sponsors.

### **3. REALISM OF PROPOSED SCHEDULE**

The proposer's abilities to aggressively pursue performance metrics in the shortest timeframe and to accurately account for that timeframe will be evaluated.

### **4. POTENTIAL CONTRIBUTION AND RELEVANCE TO THE DARPA MISSION**

The potential contributions of the proposed effort with relevance to the national technology base will be evaluated. Specifically, DARPA's mission is to maintain the technological superiority of the U.S. military and prevent technological surprise from harming our national security by sponsoring revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their military use.

### **5. PLANS AND CAPABILITY TO ACCOMPLISH TECHNOLOGY TRANSITION**

The capability to transition the technology to research, industrial, and operational military communities in such a way as to enhance U.S. defense, to include the extent to which IP being delivered with less than unlimited rights, if any, creates a barrier to technology transition.

### **6. COST REASONABLENESS AND REALISM**

The objective of this criterion is to establish that the proposed costs are reasonable and realistic for the technical and management approach offered, as well as to determine the proposer's practical understanding of the effort. This will be principally measured by cost per labor-hour and number of labor-hours proposed. The evaluation criterion recognize that undue emphasis on cost may motivate proposers to offer low-risk ideas with minimum uncertainty and to staff the effort with junior personnel in order to be in a more competitive posture. DARPA discourages such cost strategies. Cost reduction approaches that will be received favorably include innovative management concepts that maximize direct funding for technology and limit diversion of funds into overhead.

Award(s) will be made to proposers whose proposals are determined to be the most advantageous to the Government, all factors considered, including the potential contributions of the proposed work to the overall research program and the availability of funding for the effort. Award(s) may be made to any proposer(s) whose proposal(s) is determined selectable regardless of its overall rating. The Government reserves the right to select for award all, some, or none of the proposals received and to make awards without discussions. In the event that DARPA desires to award only portions of a proposal, negotiations will be opened with that proposer. All responsible sources capable of satisfying the Government's needs may submit a proposal which shall be considered by DARPA.

*NOTE: PROPOSERS ARE CAUTIONED THAT EVALUATION SCORES MAY BE LOWERED AND/OR PROPOSALS REJECTED IF SUBMITTAL INSTRUCTIONS ARE NOT FOLLOWED.*

As soon as the proposal evaluation is completed, the proposer will be notified of selectability or non-selectability. Selectable proposals will be considered for funding; non-selectable proposals will be destroyed. (One copy of non-selectable proposals may be retained for file purposes.)

Proposals identified for funding may result in a procurement 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. If warranted, portions of resulting awards may be segregated into pre-priced options.

The cost of preparing proposals in response to this announcement is not considered an allowable direct charge to any resulting contract or any other contract. Proposers are warned that only Contracting Officers are legally authorized to commit the Government.

## **TEAMING ARRANGEMENTS**

Teaming is strongly encouraged and teaming arrangements should be explained clearly in the proposal abstracts and full proposals. Integrated teams capable of addressing different technological and scientific aspects of the TGP program will be highly valued. Teams composed of partners from academia, industry, and national laboratories are encouraged. While innovative proposals from small groups will be considered, a website (<http://teaming.sysplan.com/TGP>) will be established to facilitate teaming between interested parties. Specific information content, communications, networking, and team formation are the sole responsibilities of the participants. Neither DARPA nor the Department of Defense (DoD) endorses the destination website or the information and organizations contained therein, nor does DARPA or the DoD exercise any responsibility at the destination. This website is provided consistent with the stated purpose of this BAA.

## **PROPOSER'S QUESTIONS**

A "Proposer's Questions," website will be posted for BAA 07-36 on the DARPA, Microsystems Technology Office solicitations page ([www.darpa.mil/baa/#eto](http://www.darpa.mil/baa/#eto)). If you would like to have a question answered and posted on this site, please send your question to the following address: [BAA07-36@darpa.mil](mailto:BAA07-36@darpa.mil) or [Mary.Jacobs.ctr@darpa.mil](mailto:Mary.Jacobs.ctr@darpa.mil).

## **FORMAT AND SUBMITTAL**

The form and format for abstracts and proposals follows below. Abstracts and proposals that do not satisfy these form and format requirements may be rejected without further review or evaluation. All submissions should be in the English language.

## **PROPOSAL ABSTRACT FORMAT**

The submission of an abstract is optional, but strongly recommended. An abstract should be a brief summary. It introduces the idea, solicits interaction with MTO, and avoids the expense of generating proposals that have little likelihood of selection within this BAA. Abstracts should summarize the planned proposal and clearly articulate the innovative concept or technology development being proposed.

Abstracts should follow the same general structure described for Volume I under PROPOSAL FORMAT (see below), but are expected to provide a concise summary rather than extensive detail, of ONLY section I and II. The proposal abstract should provide schedule and cost information. The maximum page lengths for each section shown in braces { } below can be neglected; however, the total length excluding the cover sheet shall not exceed ten (10) pages. **The cover sheet should be clearly marked “PROPOSAL ABSTRACT.”** All pages shall be printable on 8-1/2 by 11 inch paper with type not smaller than 12 point. The page limitation for proposal abstracts includes all figures, tables, and charts. No formal transmittal letter is required. Receipt will be confirmed. Abstracts should avoid proprietary or classified information or data not critical to the idea being presented. The proposal abstract should be submitted to DARPA/MTO on June 1, 2007.

## **FULL PROPOSAL FORMAT**

All full proposals must be in the following format. Nonconforming proposals may be rejected without review. Proposals shall consist of two volumes. All pages shall be printable on 8-1/2 by 11 inch paper with type not smaller than 12 point. The page limitation for full proposals includes all figures, tables, and charts. Volume I, Technical and Management Proposal, may include an attached bibliography of relevant technical papers or research notes (published and unpublished) which document the technical ideas and approach upon which the proposal is based. Copies of not more than six (6) relevant papers can be included with the submission. The bibliography and attached papers are not included in the page counts given below. The submission of other supporting materials along with the proposal is strongly discouraged and will not be considered for review. Maximum page lengths for each section are shown in braces { } below.

Full proposals should also be submitted to DARPA/MTO on July 23, 2007 in order to be considered during the initial round of selections; proposals received after this deadline, however, may be received and evaluated up to one year from date of posting on FedBizOpps. The full proposals should be accompanied by a transmittal letter signed by an official who is authorized to commit the offeror.

### **Volume I, Technical and Management Proposal**

#### **Section I. Administrative**

- A. {1} **Cover sheet.** This should include: (1) BAA number; (2) Technical area; (3) Lead Organization Submitting proposal; (4) Type of business, selected among the following

categories: "LARGE BUSINESS", "SMALL DISADVANTAGED BUSINESS", "OTHER SMALL BUSINESS", "HBCU", "MI", "OTHER EDUCATIONAL", or "OTHER NONPROFIT"; (5) Contractor's reference number (if any); (6) Other team members (if applicable) and type of business for each; (7) Proposal title; (8) Technical point of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), electronic mail (if available); (9) Administrative point of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), electronic mail (if available), total funds requested from DARPA, broken down by phase, and the amount of cost-share (if any); (10) Date proposal was prepared; and (11) Date of proposal expiration.

**B. {1} Official transmittal letter.**

**Table of Contents:**

Section II. Executive Summary

{4} This should clearly and concisely summarize the following:

- Innovative claims for the proposed programs that include a description of the unique technical solutions and approaches being proposed.
- The quantitative end-of-program performance goals and the key milestones associated with the development effort.
- An explanation of how the goals compare to what has already been demonstrated.

Section III. Detailed Proposal Information

- A. {15} **Technical Rationale & Approach.** A concise section outlining the scientific and technical challenges, unique approaches, and potential anticipated technical solutions to the challenges that will be addressed. This statement should demonstrate that the proposer has a clear understanding of the state-of-the-art; and should provide sufficient technical details so as to permit complete evaluation of the feasibility of the idea.
- B. {7 + 1 for table} **Program Plan & Risk Assessment.** A narrative explaining the explicit timelines, milestone achievements, and quantitative metrics by which progress toward the goals can be evaluated. This plan should include a specific test plan detailing how performance of milestones will be measured. The proposed period of performance of the overall program should be clearly stated. Milestones must be associated with demonstrable, quantitative measures of performance, and should be summarized in a single table. This section should also identify major technical risk elements specific to the proposed approach. Proposers shall clearly define all deliverables associated with the proposed research; all proprietary assertions to intellectual property of all types, including any background inventions, shall be set forth in detail. (See Intellectual Property.)
- C. {3} **Teaming & Management Plan.** A management plan that describes how the different members of the team will collaborate to demonstrate viable solutions to the program challenges. Overall program costs should be presented by year and by team member.

- D. {5} **Capabilities.** A section describing relevant prior work, the background, qualifications and relevant experience of key individuals to be assigned to the program and the facilities and equipment to be utilized. Please do not attach supporting material (CDs, movies, etc.) to the proposal, except as noted in Section IV below.
- E. {3} **Technology Transition & Business Plan.** A discussion outlining how the technology to be developed in this program will be commercialized and made available to DoD and its contractors. **This section should also include a preliminary draft business plan** that identifies possible military system areas, estimate cost and performance requirements for such application(s), and describes possible plans/capabilities to produce TGP systems in sufficient quantities.
- F. {5} **Slide Summary.** PowerPoint-type slides (i.e., landscape formatted for presentation) that succinctly highlight the major aspects of the proposal in a manner suitable for presentation to DARPA management.
- G. {5} **Statement of Work (SOW).** The SOW should be written in plain English, outlining the scope of the effort (by Phase) and citing specific tasks to be performed, contractor requirements, and data and/or material deliverables.”

Section IV. Additional Information {Optional}

- A. A brief bibliography of relevant technical papers and research notes (published and unpublished) which document the technical ideas upon which the proposal is based may be provided. Copies of not more than six (6) relevant papers can be included in the submission. This section does not count towards the overall page limit for Volume I.

**Volume II, Cost Proposal** – {No page limit}

- A. Cover sheet to include: (1) BAA number; (2) Technical area; (3) Lead Organization Submitting proposal; (4) Type of business, selected among the following categories: "LARGE BUSINESS", "SMALL DISADVANTAGED BUSINESS", "OTHER SMALL BUSINESS", "HBCU", "MI", "OTHER EDUCATIONAL", or "OTHER NONPROFIT"; (5) Contractor's reference number (if any); (6) Other team members (if applicable) and type of business for each; (7) Proposal title; (8) Technical point of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), electronic mail (if available); (9) Administrative point of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), and electronic mail (if available); (10) Award instrument requested: cost-plus-fixed-fee (CPFF), cost-contract--no fee, cost sharing contract--no fee, or other type of procurement contract (specify), grant, cooperative agreement, or other transaction; (11) Place(s) and period(s) of performance; (12) Total proposed cost separated by phase, basic award, and option(s) (if any); (13) Name, address, and telephone number of the offeror's cognizant Defense Contract Management Agency (DCMA) administration office (if known); (14) Name, address, and telephone number of the offeror's cognizant Defense Contract Audit Agency (DCAA) audit office (if known); (15) Date proposal was prepared; (16) the offeror's Contractor and Government Entity (CAGE) Code, Dun and Bradstreet (DUN) Number, North

American Industrial Classification System (NAICS) Number, and Tax Identification Number (TIN); and (17) Proposal expiration date.

- B. Detailed cost breakdown to include: (1) total program cost broken down by major cost items (direct labor, indirect rates/factors, subcontracts and/or consultants, materials and/or equipment, travel/other direct costs, etc.) and further broken down by year; (2) major program tasks by year; (3) an itemization of major subcontracts<sup>1</sup> and material and/or equipment purchases; (4) an itemization of any information technology (IT)<sup>2</sup> purchases; (5) a summary of projected funding requirements by month; and (6) the source, nature, and amount of any industry cost-sharing. Where the effort consists of multiple portions which could reasonably be partitioned for purposes of funding, these should be identified as options with separate cost estimates for each.
- C. Supporting cost and pricing information, to include subcontractor proposals and associated backup documentation, in sufficient detail to substantiate the summary cost estimates in B above. Include a description of the method used to estimate costs and supporting documentation. Note: “cost or pricing data” as defined in FAR Subpart 15.4 shall be required if the offeror is seeking a procurement contract award of \$650,000 or greater unless the offeror requests an exception from the requirement to submit cost or pricing data. “Cost or pricing data” are not required if the offeror proposes an award instrument other than a procurement contract (e.g., a grant, cooperative agreement, or other transaction). Please also provide any Forward Pricing Rate Agreement, other such Approved Rate Information, or such other documentation that may assist in expediting negotiations (if not available, state so). All proprietary subcontractor proposal documentation of which cannot be uploaded to TFIMS shall be made immediately available to the Government, upon request, under separate cover (i.e., mail, electronic/email, etc.), either by the Proposer or by the subcontractor organization.

## **INTELLECTUAL PROPERTY**

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<sup>1</sup> To include similar cost breakdown as required for the offeror (prime).

<sup>2</sup> IT is defined as “any equipment, or interconnected system(s) or subsystem(s) of equipment, that is used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information by the agency. (a) For purposes of this definition, equipment is used by an agency if the equipment is used by the agency directly or is used by a contractor under a contract with the agency which – (1) Requires the use of such equipment; or (2) Requires the use, to a significant extent, of such equipment in the performance of a service or the furnishing of a product. (b) The term “information technology” includes computers, ancillary, software, firmware and similar procedures, services (including support services), and related resources. (c) The term “information technology” does not include – (1) Any equipment that is acquired by a contractor incidental to a contract; or (2) Any equipment that contains imbedded information technology that is used as an integral part of the product, but the principal function of which is not the acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information. For example, HVAC (heating, ventilation, and air conditioning) equipment such as thermostats or temperature control devices, and medical equipment where information technology is integral to its operation, are not information technology.”

The government will assess items of intellectual property that are proposed to be delivered with less than Unlimited Rights as part of the “Overall scientific and technical merit” evaluation criterion.

1. Procurement Contract Proposers

a. Noncommercial Items (Technical Data and Computer Software)

Proposers responding to this BAA requesting a procurement contract to be issued under the FAR/DFARS, shall identify all noncommercial technical data, and noncommercial computer software that it plans to generate, develop, and/or deliver under any proposed award instrument in which the Government will acquire less than unlimited rights, and to assert specific restrictions on those deliverables. Proposers shall follow the format under DFARS 252.227-7017 for this stated purpose. In the event that proposers do not submit the list, the Government will assume that it automatically has “unlimited rights” to all noncommercial technical data and noncommercial computer software generated, developed, and/or delivered under any award instrument, unless it is substantiated that development of the noncommercial technical data and noncommercial computer software occurred with mixed funding. If mixed funding is anticipated in the development of noncommercial technical data, and noncommercial computer software generated, developed, and/or delivered under any award instrument, then proposers should identify the data and software in question, as subject to Government Purpose Rights (GPR). In accordance with DFARS 252.227-7013 Rights in Technical Data - Noncommercial Items, and DFARS 252.227-7014 Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation, the Government will automatically assume that any such GPR restriction is limited to a period of five (5) years in accordance with the applicable DFARS clauses, at which time the Government will acquire “unlimited rights” unless the parties agree otherwise. Proposers are admonished that the Government may use the list during the source selection evaluation process to evaluate the impact of any identified restrictions, and may request additional information from the proposer, as may be necessary, to evaluate the proposer’s assertions. If no restrictions are intended, then the proposer should state “NONE.”

A sample list for complying with this request is as follows:

NONCOMMERCIAL			
Technical Data Computer Software To be Furnished With Restrictions	Basis for Assertion	Asserted Rights Category	Name of Person Asserting Restrictions
(LIST)	(LIST)	(LIST)	(LIST)

b. Commercial Items (Technical Data and Computer Software)

Proposers responding to this BAA requesting a procurement contract to be issued under the FAR/DFARS, shall identify all commercial technical data, and commercial computer

software that may be embedded in any noncommercial deliverables contemplated under the research effort, along with any applicable restrictions on the Government’s use of such commercial technical data and/or commercial computer software. In the event that proposers do not submit the list, the Government will assume that there are no restrictions on the Government’s use of such commercial items. The Government may use the list during the source selection evaluation process to evaluate the impact of any identified restrictions, and may request additional information from the proposer, as may be necessary, to evaluate the proposer’s assertions. If no restrictions are intended, then the proposer should state “NONE.”

A sample list for complying with this request is as follows:

COMMERCIAL			
Technical Data Computer Software To be Furnished With Restrictions	Basis for Assertion	Asserted Rights Category	Name of Person Asserting Restrictions
(LIST)	(LIST)	(LIST)	(LIST)

2. NonProcurement Contract Proposers - Noncommercial and Commercial Items  
(Technical Data and Computer Software)

Proposers responding to this BAA requesting a Grant, Cooperative Agreement, Technology Investment Agreement, or Other Transaction for Prototype shall follow the applicable rules and regulations governing these various award instruments, but in all cases should appropriately identify any potential restrictions on the Governments use of any Intellectual Property contemplated under those award instruments in question. This includes both Noncommercial Items and Commercial Items. Although not required, proposers may use a format similar to that described in Paragraphs 1.a and 1.b above. The Government may use the list during the source selection evaluation process to evaluate the impact of any identified restrictions, and may request additional information from the proposer, as may be necessary, to evaluate the proposer’s assertions. If no restrictions are intended, then the proposer should state “NONE.”

3. All Proposers – Patents

Please include documentation proving your ownership of or possession of appropriate licensing rights to all patented inventions (or inventions for which a patent application has been filed) that will be utilized under your proposal for the DARPA program. If a patent application has been filed for an invention that your proposal utilizes, but the application has not yet been made publicly available and contains proprietary information, you may provide only the patent number, inventor name(s), assignee names (if any), filing date, filing date of any related provisional application, and a summary of the patent title, together with either: 1) a representation that you own the invention, or 2) proof of possession of appropriate licensing rights in the invention.

#### 4. All Proposers-Intellectual Property Representations

Please provide a good faith representation that you either own or possess appropriate licensing rights to all other intellectual property that will be utilized under your proposal for the DARPA program.

### **GUIDANCE FOR CLASSIFIED INFORMATION AND DATA**

The Government anticipates that proposals submitted under a 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 DD Form 254 will not be provided at this time since DARPA is soliciting ideas only. After reviewing the 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 applying to this BAA. An applicable classification guide should be submitted to ensure that the proposal is protected appropriately.

Classified submissions shall be in accordance with the following guidance:

Collateral Classified Data: Use classification and marking guidance provided by previously issued security classification guides, the Information Security Regulation (DoD 5200.1-R), and the National Industrial Security Program Operating Manual (DoD 5220.22-M) when marking and transmitting information previously classified by another original classification authority. Classified information at the Confidential and Secret level may only be mailed via U.S. Postal Service (USPS) Registered Mail or U.S. Postal Service Express Mail (USPS only; not DHL, UPS or FedEx). All classified information will be enclosed in opaque inner and outer covers and double wrapped. The inner envelope shall be sealed and plainly marked with the assigned classification and addresses of both sender and addressee. The inner envelope shall be addressed to:

Defense Advanced Research Projects Agency (DARPA)  
ATTN: BAA 07-36, DARPA/MTO, Dr. Thomas Kenny  
3701 North Fairfax Drive, Suite 536  
Arlington, VA 22203-1714

The outer envelope shall be sealed with no identification as to the classification of its contents and addressed to:

Defense Advanced Research Projects Agency (DARPA)  
Security & Intelligence Directorate, Attn: CDR  
3701 North Fairfax Drive, Suite 832  
Arlington, VA 22203-1714

All Top Secret materials should be hand carried via an authorized, two-person courier team to the DARPA Classified Document Registry (CDR).

Special Access Program (SAP) Information: Contact the DARPA Program Security Support Center (PSSC) at 703-812-1962/1970 for further guidance and instructions prior to transmitting to DARPA. All Top Secret SAP, must be transmitted via approved methods for such material. Consult the DoD Overprint to the National Industrial Security Program Operating Manual for further guidance. It is strongly recommended that you coordinate the transmission of SAP material and information with the DARPA PSSC prior to transmission.

Sensitive Compartmented Information (SCI) Data: Contact the DARPA Special Security Contact Office (SSCO) at 703-812-1993/1994 for the correct SCI courier address and instructions. All SCI should be transmitted through your servicing Special Security Officer (SSO) / Special Security Contact Officer (SSCO). All SCI data must be transmitted through your servicing Special Security Officer (SSO) / Special Security Contact Officer (SSCO). All SCI data must be transmitted through SCI channels only (i.e., approved SCI Facility to SCI facility via secure fax).

Proprietary Data: All proposals containing proprietary data should have the cover page and each page containing proprietary data clearly marked as containing proprietary data. It is the proposer's responsibility to clearly define to the Government what is considered proprietary in nature.

Proposers must have existing and in-place prior to execution of an award, approved capabilities (personnel and facilities) to perform research and development at the classification level they propose.

## **HUMAN SUBJECT TESTING**

Proposals selected for funding are required to comply with provisions of the Common Rule (32 CFR 219) on the protection of human subjects in research (<http://www.dtic.mil/biosys/downloads/32cfr219.pdf>) and the Department of Defense Directive 3216.2 (<http://www.dtic.mil/whs/directives/corres/html2/d32162x.htm>). All proposals that involve the use of human subjects are required to include documentation of their ability to follow Federal guidelines for the protection of human subjects. This includes, but is not limited to, protocol approval mechanisms, approved Institutional Review Boards (IRBs), and Federal Wide Assurances. These requirements are based on expected human use issues sometime during the entire length of the proposed effort. For proposals involving “greater than minimal risk” to human subjects within the first year of the project, performers must provide evidence of protocol submission to a federally approved IRB *at the time of final proposal submission to DARPA*. For proposals that are forecasted to involve “greater than minimal risk” after the first year, a

discussion on how and when the proposer will comply with submission to a federally approved IRB needs to be provided in the submission. More information on applicable federal regulations can be found at the Department of Health and Human Services – Office of Human Research Protections website (<http://www.dhhs.gov/ohrp/>).

## **AWARD ADMINISTRATION INFORMATION**

(1) Central Contractor Registration. Selected proposers not already registered in the Central Contractor Registry (CCR) will be required to register in CCR prior to any award under this BAA. Information on CCR registration is available at <http://www.ccr.gov>.

(2) Representations and Certifications. In accordance with Federal Acquisition Regulation 4.1201, prospective proposers shall complete electronic annual representations and certifications at <http://orca.bpn.gov>.

(3) Wide Area WorkFlow (WAWF). Unless using another approved electronic invoicing system, performers will be required to submit invoices for payment directly via the Internet/WAWAF at <http://wawf.eb.mil>. Registration to WAWF will be required prior to any award under this BAA.

## **PUBLIC RELEASE OR DISSEMINATION OF INFORMATION**

The following provision will be incorporated into any resultant contract:

(a) There shall be no dissemination or publication, except within and between the Contractor and any subcontractors, of information developed under this contract or contained in the reports to be furnished pursuant to this contract without prior written approval of the Contracting Officer Representative (COR). All technical reports will be given proper review by appropriate authority to determine which Distribution Statement is to be applied prior to the initial distribution of these reports by the Contractor. Papers resulting from unclassified contracted fundamental research are exempt from prepublication controls and this review requirement, pursuant to DoD Instruction 5230.27 dated October 6, 1987.

(b) When submitting material for clearance for open publication, the Contractor must furnish DARPA Technical Information Officer, 3701 North Fairfax Drive, Arlington VA 22203-1714, telephone (703) 526-4163 with five copies and allow four weeks for processing. Viewgraph presentations must be accompanied with a written text. Whenever a paper is to be presented at a meeting, the Contractor must indicate the exact dates of the meeting or the Contractor's date deadline for submitting the material.

## **EXPORT LICENSES**

The following provision will be incorporated into any resultant contract:

Should this project develop beyond fundamental research (basic and applied research ordinarily published and shared broadly within the scientific community) with military or dual-use applications the following apply:

(1) The contractor shall comply with all U. S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, in the performance of this contract. In the absence of available license exemptions/exceptions, the Contractor shall be responsible for obtaining the appropriate licenses or other approvals, for obtaining the appropriate licenses or other approvals, if required, for exports of (including deemed exports) hardware, technical data, and software, or for the provision of technical assistance.

(2) The Contractor shall be responsible for obtaining export licenses, if required, before utilizing foreign persons in the performance of this contract, including instances where the work is to be performed on-site at any Government installation (whether in or outside the United States), where the foreign person will have access to export-controlled technical data or software.

(3) The Contractor shall be responsible for all regulatory record keeping requirements associated with the use of licenses and license exemptions/exceptions.

(4) The Contractor shall be responsible for ensuring that the provisions of this clause apply to its subcontractors.

## **SUBCONTRACTING**

Pursuant to Section 8(d) of the Small Business Act (15 U.S.C. 637(d)), it is the policy of the Government to enable small business and small disadvantaged business concerns to be considered fairly as subcontractors to contractors performing work or rendering services as prime contractors or subcontractors under Government contracts, and to assure that prime contractors and subcontractors carry out this policy. Each proposer who submits a contract proposal and includes subcontractors is required to submit a subcontracting plan IAW FAR 19.702(a) (1) and (2) should do so with their proposal. The plan format is outlined in FAR 19.704.

## **CONFIDENTIALITY**

It is the policy of DARPA to treat all proposals as competitive information and to disclose their contents only for the purpose of evaluation. No proposals will be returned. The original of each proposal received will be retained at DARPA and all other copies of non-selected proposals destroyed. Documentation related to the source selection process will be marked SOURCE SELECTION INFORMATION – SEE FAR 2.101 AND 3.104.

## **PROCUREMENT INTEGRITY, STANDARDS OF CONDUCT, ETHICAL CONSIDERATIONS, AND ORGANIZATIONAL CONFLICTS OF INTEREST (OCIs)**

Certain post-employment restrictions on former federal officers and employees may exist, including special Government employees (including but not limited to Sections 207 and 208 of Title 18, United States Code, the Procurement Integrity Act, 41 U.S.C. 423, and FAR 3.104). Proposers should be aware the Program Manager responsible for this BAA is assigned under the IPA program from Stanford University and as such is highly likely to have a formal conflict of interest with the University. The Program Manager is required to review and evaluate all

proposals received under this BAA and be able to manage all selected efforts. If a conflict of interest exists with a proposer, the proposer must show a plan to mitigate the conflict in the proposal. In fact, it should be raised to the DARPA Contracting Officer before time and effort are expended in preparing a proposal. All proposers and proposed sub-contractors must therefore affirm whether they are providing scientific, engineering, and technical assistance (SETA) or similar support to any DARPA technical office(s) through an active contract or subcontract. All affirmations must state which office(s) the proposer supports and identify the prime contract numbers. Affirmations shall be furnished at the time of proposal submission. All facts relevant to the existence or potential existence of organizational conflicts of interest (FAR 9.5.) must be disclosed. The disclosure shall include a description of the action the proposer has taken or proposes to take to avoid, neutralize, or mitigate such conflict (e.g., Mitigation Plan). If the situation cannot be mitigated by the contractor, the proposal may be returned without technical evaluation and withdrawn from consideration for award under this BAA.