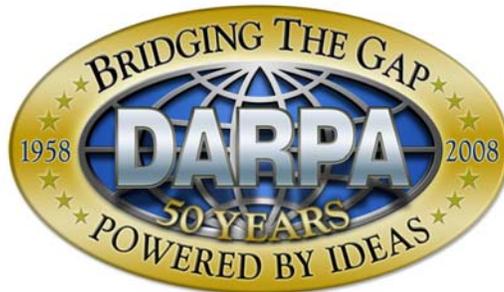


## BAA 07-50

# Carbon Electronics for RF Applications (CERA)



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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 appear first on the FedBizOpps website, <http://www.fedbizopps.gov/> and Grants.gov website at <http://www.grants.gov/>. The following information is for those wishing to respond to the BAA.

DARPA is soliciting innovative research proposals to develop carbon-based electronics for RF applications. The Carbon Electronics for RF Applications (CERA) program will develop wafer-scale graphene synthesis approaches focused on enabling ultra-high-speed, low-power graphene-channel field effect transistors. The CERA program will culminate in a demonstration of high performance W-band (> 90 GHz) low noise amplifiers (NF

<1dB) making use of graphene transistors on wafers with diameters  $\geq 8$  inches. The cross wafer yield is expected to be better than 90% to assure the cost effectiveness of this technology.

The desirable properties of graphene, including high mobility, high saturation velocity, high current carrying capability, excellent thermal conductivity, ultra-thin geometry and the potential to integrate with traditional CMOS processes, suggest that graphene-based transistors are potentially the best technical solution for high-performance, high-integration-density RF system-on-chip applications. Graphene-based RF electronics developed in the CERA program is expected to be a very promising technology for ultra-high-speed, ultra-low power RF circuits, which will have significant impact on communications, electronic warfare, radar, and other key DoD systems.

Proposed research should investigate innovative approaches that enable revolutionary advances in materials science, epitaxial growth, transistor development, and RF circuit design. The research needed to achieve the goals of the CERA program may be carried out through collaborations between different participants. Specifically excluded is research that primarily results in evolutionary improvements to the existing state of practice.

## **BACKGROUND AND DESCRIPTION**

Over the past decade there has been significant progress in understanding the fundamental physical properties of carbon based electronic devices. For example, carbon nanotube (CNT) transistors have been demonstrated with high mobilities ( $> 10X$  silicon), high thermal conductivity and excellent current carrying capabilities. Graphene, the planar form of carbon, has recently received increasing attention from the research community. This system has most of the desirable properties of carbon nanotubes but is much more amenable to conventional CMOS processing flows. The development of graphene-based RF technology is the focus of this solicitation.

The desirable physical properties of graphene are particularly well suited for ultra-high speed, ultra-low power analog device applications. Key properties including excellent electrostatic control for deeply scaled devices, high current carrying capability, excellent thermal conductivity and low voltage operation potential are very desirable from the RF/mm-wave technology point of view. Now is the time for technological exploitation of these scientific discoveries for the benefit of the DoD.

The Carbon Electronics for RF Application (CERA) program will develop graphene-based field effect transistors for RF/mm-wave circuits. Desirable properties of such transistors include high mobility, high cutoff frequencies ( $f_t$  and  $f_{max}$ ), high transconductance ( $g_m$ ), low noise, and low voltage operation. Graphene channel devices also offer low parasitic resistances, excellent electrostatic scaling and high integration potential with silicon CMOS. This program will focus on the study of graphene-based RF electronics including synthesizing high quality graphene films on wafer scales,

developing high performance RF transistors, graphene bandgap engineering, and integrating the transistors to build a low-power high-performance low noise amplifier. Many technical challenges need to be addressed in the CERA Program that include monolayer-control of the graphene synthesis process over large areas, demonstrating high mobility graphene-channel FETs, developing low resistance contacts, nanometer scale patterning of graphene ribbons, and accurate device models for RF circuit design.

## **PROGRAM OBJECTIVES & SCOPE**

The objective of the CERA program is to develop ultra-low power ultra-high speed graphene-based electronics. Specific program goals at the end of the program include:

- Graphene active area covering an entire 8-inch wafer
- Carrier mobility of the FET exceeding  $15,000 \text{ cm}^2/\text{V-s}$
- Drain voltage of the FET smaller than 0.25 V
- $f_t$  and  $f_{\text{max}}$  both larger than 500 GHz
- W-band low noise amplifier with  $>15 \text{ dB}$  of gain and  $<1\text{dB}$  of noise figure
- Wafer yield of the low noise amplifiers is more than 90%

The technology development of the CERA program will be conducted in three phases, each having definite and measurable milestones, the most critical of which will be referred to as Go/No-Go (GNG) metrics (see below). The length of each phase will be proposed by the bidders and will be factors considered as part of the source selection process. In general, shorter phases are preferable, but each phase should clearly be adequate in duration to meet its objectives with reasonable risks and costs. Proposals should discuss plans for managing these factors.

The three distinct phases of the program are:

**Phase I: Graphene Synthesis Process Development.** The objectives of this phase are to develop synthesis processes for graphene thin films and to demonstrate the feasibility of high performance graphene-based field effect transistors. The most important goal at the end of Phase I is the development of a synthesis process which can produce a high quality graphene film in an area larger than 50 mm x 50 mm. The graphene films and resulting FETs must satisfy all the GNG metrics listed in Table 1. Graphene films on insulating materials ( $\text{SiO}_2$ , SiC, etc) are clearly preferred for device/circuit applications.

**Phase II: Wafer-size Graphene Film and Ultra-Low-Power High-speed Field Effect Transistor.** The objectives of this phase are to significantly increase the area of the graphene films and to be able to control the thickness of the graphene down to monolayer accuracy. The graphene active area at the end of this phase will have to cover a 4-inch wafer. The specific ultra-high-speed transistor demonstrator has to satisfy the GNG metrics listed in table I.

**Phase III: Transistor Optimization & Circuit Integration.** The objectives of this final phase are to optimize the transistor performance and further increase the active area of graphene to cover an 8-inch wafer. The specific circuit demonstrator to validate the material and transistor progress will be a W-band low noise amplifier satisfying the GNG metrics listed in table I.

## TECHNICAL AREAS OF INTEREST

This BAA will address the following technical areas of interest:

- I. *Graphene Synthesis:* Synthesis of high quality graphene films are the most critical enabler for this program. The synthesis approaches developed under CERA should lead to a reliable and manufacturable process in order to cover an entire wafer. Thin films on insulating materials such as SiO<sub>2</sub> or SiC are desirable for target RF circuit applications. In addition, the proposed process should be able to control the thickness of the graphene down to monolayer accuracy in order to minimize variation of the electrical properties.
- II. *Graphene FET:* An ultra-high speed low-power graphene-channel field effect transistor will be developed in the CERA program. Due to the superior properties of graphene, the graphene FET is expected to be the best building block for high-performance, high-integration-density RF circuits. Many device challenges will be overcome in the program including minimizing the contact resistance, reducing the defect states of the gate dielectric and substrate, maintaining high carrier mobility and saturation velocity in the channel, and patterning graphene ribbons to engineer their energy gaps.
- III. *Device Modeling:* Accurate device models are essential for high-performance RF/mm-wave circuits. The device physics and associated large-signal and small-signal models will be developed under this program. This research activity plans to understand those novel properties of graphene channels and associated electrical and thermal characteristics.
- IV. *Graphene-based RF Circuits:* A simple RF circuit, i.e., low noise amplifier, is a good demonstrator to evaluate graphene technology. In addition to fabricating single FETs, integration processes to fabricate graphene-based electronic circuits will be developed in this program. Several technical areas may be addressed in this section, such as interconnect technology, passive components, high yield process flow, and integration with CMOS.

*The Government strongly prefers an integrated approach which will systematically address the technical areas of interest and program goals in their entirety.* However, highly innovative advanced studies in one or more of these technical areas, such as graphene synthesis or transistor development, by individual investigator or small groups, may also be considered. A bidder who is proposing such an advanced study should

clearly identify it as such, should present its (limited) objectives and metrics (see below), and should explain the relevance of the work to the overall program goals.

### PROGRAM GO/NO-GO METRICS AND MILESTONES

The performer will be expected to achieve clearly identified milestones, the most critical of which will be referred to as Go/No-Go (GNG) metrics. The proposal should very clearly identify a milestones schedule. **Milestones should be quantifiable and measurable and should not simply reflect the completion of task elements.**

The testing of graphene thin films, transistors, and circuits will be a critical aspect of this program. In particular, demonstrations should be performed by the contractors at the end of each program phase to verify that they have met the GNG requirements. Bidders should describe, in some detail, how they plan to evaluate the demonstration transistors and circuits and how they will demonstrate that they meet GNG requirements.

Table 1 shows the minimal set of key GNG metrics which must be achieved by the conclusion of each phase. Bidders may, at their option, propose a more ambitious and/or detailed set of GNG metrics.

**Table 1: Metrics and Milestones by Phase:**

Metric	Unit	Phase I	Phase II	Phase III
<b>GNG Metrics</b>				
Graphene Active Area	mm <sup>2</sup>	50 x 50	Wafer diam. ≥ 100 mm	Wafer diam. ≥ 200 mm
Uniformity	N	N ± 1 <sup>(1)</sup>	N ± 0 <sup>(1)</sup>	N ± 0 <sup>(1)</sup>
Carrier Hall Mobility	cm <sup>2</sup> /Vs	≥ 10,000	≥ 15,000	≥ 15,000
Carrier FET Mobility	cm <sup>2</sup> /Vs	≥ 5,000	≥ 10,000	≥ 15,000
V <sub>ds</sub> (device bias)	V	≤ 1.0	≤ 0.5	≤ 0.25
I <sub>ON</sub> <sup>(2)</sup>	μA/μm	≥ 250	≥ 1000	≥ 2000
I <sub>ON</sub> /I <sub>OFF</sub> <sup>(2)</sup>		10	100	1000
f <sub>t</sub> <sup>(2), (3)</sup>	GHz		> 300	≥ 500
f <sub>max</sub> <sup>(2), (3)</sup>	GHz		> 300	≥ 500
Demonstration Circuit				W-band LNA Frequency ≥ 90 GHz Gain ≥ 15 dB Noise Figure ≤ 1 dB Cross wafer yield ≥ 90%

(1) Control number of electrically active layers over required area,  $N \geq 1$

- (2) Data measured when the device is biased at  $V_{ds}$
- (3) S-parameter measurement into 50 ohm load

## **DELIVERABLES**

The primary deliverables for the CERA program are the experimental demonstrations described above, and a final technical report. Intermediate reports, at quarterly intervals, will also be required. The Government also expects to test devices in order to validate performance consistent with the GNG metrics. The bidders should describe a deliverable schedule consistent with this requirement. The exact population and details of the deliverable schedule are important aspects of the proposal.

## **TECHNOLOGY TRANSITION**

DARPA is interested in the development of capabilities for producing graphene-based RF circuits that meet the objectives of a broad range of DoD systems and platforms. Evaluation of the technology transition plans, therefore, is an important part of the proposal selection process. A clear and credible plan by which the technology developed will be commercialized and made available to DoD contractors is an important element of the proposal.

## **PERIOD OF SOLICITATION**

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.

Please pay particular attention to the conflict of interest issues described in the section “*PROCUREMENT INTEGRITY, STANDARDS OF CONDUCT, ETHICAL CONSIDERATIONS, AND ORGANIZATIONAL CONFLICTS OF INTEREST (OCIs)*”.

The time and date for submission of abstracts and full proposals are specified in the BAA below. DARPA will acknowledge receipt of the submission and assign a control number that should be used in all further correspondence regarding the proposal abstract.

This BAA will remain open from **29 June 2007** through **29 June 2008**. The due date for proposal **abstracts** submission is **31 July 2007 (1600 EDT)**. The due date for proposal submission is **15 October 2007 (1600 EST)**. Proposals submitted after **15 October 2007** will be accepted, but are not likely to be funded during the first round of program funding.

## **SUBMISSION GUIDELINES**

1. Abstracts

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

**Please note that abstracts should not be submitted via Grants.gov.**

## 2. Proposals

Full proposals should be submitted electronically using one of the following two submission methods. Note that neither dual submissions nor a paper copy are required.

- a. University (prime) grant submissions may be made via the Grants.gov web site, <http://www.grants.gov/>, by using the "Apply" function.
- b. Proposals should be submitted to this BAA via the T-FIMS Proposal Submission System. Electronic proposals should be in Microsoft Word format or PDF and submitted via a web site interface: Web Site: <https://www.tfims.darpa.mil/baa>

## **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 for this BAA, or the Security POC cited below, for guidance on submitting the classified annex.

## **SUBMISSION PROCESS**

This Broad Agency Announcement BAA07-50 found on FedBizOpps and Grants.gov, constitutes the total BAA. No additional information is available, nor will a formal RFP or other solicitation 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 07-50. Proposals may not be submitted by fax or e-mail; any so sent will be disregarded. DARPA encourages use of the World Wide Web for retrieving the Broad Agency Announcement and any other related information that may subsequently be provided.

The administrative addresses for this BAA are:  
Fax: (703) 696-2206 (Addressed to: DARPA/MTO, BAA 07-50),  
Electronic Mail: [BAA07-50@darpa.mil](mailto:BAA07-50@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.

Evaluation of proposals will be accomplished through a technical review of each proposal using the following criteria, which are listed in descending order of relative importance: (1) Overall scientific and technical merit; (2) Potential contribution and relevance to the DARPA mission; (3) Relevance of intermediate milestones and GNG metrics; (4) Realism of the proposed schedule; (5) Plans and capability to accomplish technology transition; (6) Offeror's capabilities and related experience; and (7) Cost reasonableness and realism.

### **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 that are clearly defined and feasible.

### **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.

### **RELEVANCE OF INTERMEDIATE MILESTONES AND GNG METRICS**

The relevance and aggressiveness of the intermediate milestones and Go/No Go metrics proposed in the development schedule in an efficient time frame will be evaluated.

### **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.

### **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 intellectual property rights limitations, if any, create a barrier to technology transition.

### **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.

## **COST REALISM**

The objective of this criterion is to establish that the proposed costs are 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.

After selection and before award the Contracting Officer will negotiate cost/price reasonableness.

*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 arrangements should be explained clearly in the proposals. Teams composed of partners from industry, academia, and, where appropriate, national laboratories are encouraged. Preference will be given to integrated teams capable of addressing different technological and scientific aspects of the CERA program. Innovative proposals from small groups will be considered and a website (<http://www.davincinetbook.com/teams>) 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 07-50 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: BAA07-50@darpa.mil.

## POINT OF CONTACT

Dr. Michael Fritze, DARPA Program Manager, MTO, Phone (571) 218-4810, Fax (703) 696-2206, Email [michael.fritze@darpa.mil](mailto:michael.fritze@darpa.mil)

## PROPOSAL ABSTRACT FORMAT

Proposal abstracts are encouraged in advance of full proposals in order to provide potential offerors with a rapid response and to minimize unnecessary effort. 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. Proposal 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 H~~. The proposal abstract should provide schedule and cost information. **The cover sheet should be clearly marked "PROPOSAL ABSTRACT" and the total length should not exceed ten (10) pages.** 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.

## PROPOSAL FORMAT

All full proposals must be in the format given below. 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 three (3) relevant papers can be included with the submission. The bibliography and attached papers are not included in the page counts given below. Inclusion of a single Power Point slide illustrating the proposed concept is required. The submission of other supporting materials along with the proposal is strongly discouraged and will not be considered for review. Except for the attached bibliography, Volume I shall not exceed **fifty five (55)** pages, not including Section IV. Maximum page lengths for each section are shown in braces { } below.

### **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, and the amount of cost-share (if any); (10) date proposal was prepared; and (11) proposal expiration date.

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

#### Section II. Summary of Proposal

A. {3} **Executive Summary.** This should clearly and concisely summarize the following:

- The quantitative end-of-program performance goals and the milestones associated with each Phase of the development effort. The milestones and

performance goals should be listed in a single table (see below for an example table).

- An explanation of how the above goals and milestones compare to what has already been demonstrated.
- A description of the unique approaches and technical solutions proposed.
- An explanation of how and to what extent (being as quantitative as possible) the proposed work will benefit the Department of Defense.

### Section III. Detailed Proposal Information

- A. {20} **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 and detailed test plan detailing how performance of milestones, particularly the GNG metrics, will be measured. The proposed period of performance of the overall program and specifically of each program phase and demonstration should be clearly stated. Milestones must be associated with demonstrable, quantitative measures of performance, and should be summarized in a single table. **Measurable milestones should occur every six months after start of effort.** This section should also identify major technical risk elements specific to the proposed approach, estimate the risk magnitude for each such element, and describe specific plans to mitigate risk.
- C. {2} **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.
- 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. {5} **Slide Summary.** PowerPoint-type slides (i.e., landscape formatted for presentation) that succinctly highlight the major aspects of the proposal, including proposer-defined measurable metrics, in a manner suitable for presentation to DARPA management.
- F. {5} **Technology Transition & Business Plan.** A discussion outlining how the technology to be developed in this program will be commercialized and made available to DoD contractors. See also “Intellectual Property.”
- G. {5} **Statement of Work (SOW).** A document 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 three (3) 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 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; and (16) Proposal expiration date.
- B. Detailed cost breakdown to include: (1) total program cost broken down by major cost items (direct labor, subcontracts, materials, other direct costs, overhead charges, etc.) and further broken down by year; (2) major program tasks by year; (3) an itemization of major subcontracts<sup>1</sup> and equipment purchases; (4) an itemization of any information technology (IT)<sup>2</sup> purchases; (5) a summary of projected funding requirements by month;

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<sup>1</sup> To include similar cost breakdown as required by 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

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 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 (e.g., Rate Memo’s, etc.), 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**

The government will assess limitations on intellectual property rights in proposed project deliverables as part of the “plans and capability to accomplish technology transition” evaluation criteria.

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 the proposer 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

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not information technology.”

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 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: BAA07-50, DARPA/MTO, Dr. Michael Fritze  
3701 North Fairfax Drive, Suite 521  
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/pdf/321602p.pdf>). 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 <https://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 written approval for open publication as described in subparagraph (a) above, the Contractor must submit a request for public release request to the DARPA TIO and include the following information: 1) Document Information: document title, document author, short plain-language description of technology discussed in the material (approx 30 words), number of pages (or minutes of video) and document type (briefing, report, abstract, article, or paper); 2) Event Information: event type (conference, principle investigator meeting, article or paper), event date, desired date for DARPA's approval; 3) DARPA Sponsor: DARPA Program Manager, DARPA office, and contract number; and 4) Contractor's Information: POC name, e-mail and phone. Allow four weeks for processing; due dates under four weeks require a justification. Unusual electronic file formats may require additional processing time. Requests can be sent either via e-mail to [tio@darpa.mil](mailto:tio@darpa.mil) or via 3701 North Fairfax Drive, Arlington VA 22203-1714, telephone (571) 218-4235. Refer to [www.darpa.mil/tio](http://www.darpa.mil/tio) for information about DARPA's public release process.

## **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 (including deemed exports) of hardware, technical data, and software, and 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 or other controlled technologies.

(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 the Massachusetts Institute of Technology/Lincoln Laboratory and as such is highly likely to have a conflict of interest with the University and with Lincoln Laboratory. This conflict of interest issue applies to both a prime or subcontractor bidder. The Program Manager is required to review and evaluate all proposals received under this BAA and 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, and the government must determine that such plan constitutes effective mitigation. Affected proposers should raise this issue with the DARPA Contracting Officer before time and effort are expended in preparing a proposal. Should the Government Determine that a potential OCI exists for which offeror did not provide a mitigation plan,*

such plan may be requested by the Government during proposal evaluation(s). If the situation cannot be mitigated by the contractor, or if the Government determines some other ethical conflict exists for the Program Manager that cannot be effectively resolved, the proposal may be returned without technical evaluation and withdrawn from consideration for award under this BAA.

All proposers and proposed sub-contractors must 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. If, in the sole opinion of the government Contracting Officer, the situation cannot be effectively mitigated by the contractor, the proposal may be returned without technical evaluation and withdrawn from consideration for award under this BAA.