

U.S. ARMY RESEARCH OFFICE
BROAD AGENCY ANNOUNCEMENT

W911NF-13-R-0010

Research in Quantum Computing

**Issued by the U.S. Army Contracting Command-Aberdeen Proving Ground
Research Triangle Park Division on behalf of the Army Research Office (ARO)**

Issued: June 12, 2013

Proposals Due: September 10, 2013

TABLE OF CONTENTS

- I. OVERVIEW OF THE FUNDING OPPORTUNITY:3
 - A. Required Overview Content 3
 - 1. Federal Agency Name(s): 3
 - 2. Funding Opportunity Title: 3
 - 3. Announcement Type 3
 - 4. Research Opportunity Number: 3
 - 5. Catalog of Federal Domestic Assistance (CFDA) Number: 3
 - 6. Response Dates: 3
 - B. Additional Overview Information..... 3

- II. DETAILED INFORMATION ABOUT THE FUNDING OPPORTUNITY.....4
 - A. Funding Opportunity Description 4
 - B. Award Information..... 7
 - C. Eligibility Information 8
 - 1. Eligible Applicants: 8
 - 2. Cost Sharing or Matching:..... 9
 - 3. Dun and Bradstreet Universal Numbering System (DUNS) Number and Central Contractor Registrations (SAM): 9
 - 4. Other:..... 9
 - D. Application and Submission Information 9
 - 1. Address to View Broad Agency Announcement 9
 - 2. Content and Form of Application Submission 9
 - 3. Submission Dates and Times: 16
 - 4. Intergovernmental Review..... 16
 - 5. Funding Restrictions:..... 17
 - 6. Other Submission Requirements:..... 17
 - E. Application Review Information: 17
 - 1. Criteria:..... 17
 - 2. Review and Selection Process:..... 18
 - 3. Recipient Qualification 18
 - F. Award Administration Information: 18
 - 1. Award Notices: 18
 - 2. Administrative and National Policy Requirements:..... 18
 - 3. Reporting: 22
 - G. Agency Contacts: 22

I. OVERVIEW OF THE FUNDING OPPORTUNITY:

A. Required Overview Content

1. Federal Agency Name(s):

U.S. Army Research Office

Issuing Acquisition Office:

U.S. Army Contracting Command-Aberdeen Proving Ground, Research Triangle Park Division (ACC-APG RTP Division)

2. Funding Opportunity Title:

Research in Quantum Computing

3. Announcement Type

Initial Announcement

4. Research Opportunity Number:

W911NF-13-R-0010

5. Catalog of Federal Domestic Assistance (CFDA) Number:

12.431 – Basic Scientific Research

6. Response Dates:

White Papers: 4:00 PM Eastern Daylight Savings Time on Wednesday, 10 July 2013.

Proposals: 4:00 PM Eastern Daylight Savings Time on Tuesday, 10 September 2013. See Section II, D, 3 for additional information.

B. Additional Overview Information

This Broad Agency Announcement (BAA) which sets forth research areas of interest to the Army Research Laboratory- Army Research Office (ARL-ARO) is issued under paragraph 6.102(d)(2) of the Federal Acquisition Regulation (FAR), and 10 USC 2358 which provides for the competitive selection of basic research proposals. Proposals submitted in response to this BAA and selected for award are considered to be the result of full and open competition and in full compliance with the provision of Public Law 98-369, "The Competition in Contracting Act of 1984" and subsequent amendments.

The Department of Defense agencies involved in this program reserve the right to select for award; all, some, or none of the proposals submitted in response to this announcement. The participating DoD agencies will provide no funding for direct reimbursement of proposal development costs. Technical and cost proposals (or any other material) submitted in response to this BAA will not be returned. It is the policy of participating DoD agencies to treat all proposals as sensitive, competitive information and to disclose their contents only for the purposes of evaluation.

II. DETAILED INFORMATION ABOUT THE FUNDING OPPORTUNITY

A. Funding Opportunity Description

The U.S. Army Research Office (ARO) in collaboration with the National Security Agency (NSA) is soliciting proposals for research in quantum computing.

There are two separate research topics covered in this announcement:

1. Quantum characterization, verification, and validation
2. Advanced quantum computing measurement technology

Topic 1: Quantum Characterization, Verification, and Validation

As the scale and complexity of quantum information processing systems increases, so too does the challenge of accurately and efficiently verifying and validating operations in these systems. The Quantum Characterization, Verification, and Validation (QCVV) research topic seeks proposals addressing the development of theoretical and experimental techniques, procedures, and methods for characterizing few-qubit systems with a focus on metrics relevant to robust fault-tolerant quantum computation (FTQC). FTQC is defined here as the implementation of a quantum algorithm using methods that would be tolerant against faulty components (giving the algorithm some acceptable probability of success). The ultimate goal of the proposed research should be a set of standards and procedures, together with experimental demonstration, that will aid in characterizing increasingly complex quantum information systems.

Our understanding of current QCVV techniques indicates that they will be insufficient or incomplete as quantum systems reach modest sizes. For example, quantum tomography (even the recent enhanced techniques, such as compressed sensing) scales poorly with system size and randomized benchmarking returns an “average fidelity” that may not properly offer a complete characterization of a fault tolerant system.

Innovative proposals are sought to develop QCVV tools that will aid researchers as experiments begin to incorporate on the order of ten physical qubits. In particular, proposals should be focused on efficient (and near-optimal) methods for extracting metrics from experimental systems. Research areas include, but are not limited to: advances/alternatives to quantum tomography; methods for extracting fidelity of gate or computation success; and methods or procedures for verifying complex quantum computations that cannot be classically simulated in qubit technologies capable of performing quantum gates. The performance of current qubits is below estimated fault-tolerant thresholds and this topic is not focused on reaching such thresholds. However, fault-tolerant architectures impose additional requirements on qubits and these requirements should be considered in the proposals for developing QCVV metrics.

Since each qubit technology provides different capabilities and requirements, QCVV techniques are likely to be tailored to a specific qubit technology and implementation. However, the metrics themselves should be broad-based and allow comparison across the different technologies. Methods and metrics must be articulated in a clear manner in the context of FTQC and

experimentalists must be able to design experiments to unambiguously measure their results against these metrics. For this reason, strong collaboration between experimental and theoretical researcher efforts in the field is encouraged.

Two categories of proposals are sought for this topic. Most proposals selected for funding are likely to be from the first category.

1. The first category of proposals seeks strongly integrated theoretical and experimental efforts focused on a specific qubit that is currently capable of performing quantum gates. More than one qubit technology may be considered if there is sufficient justification to do so. Theory should focus on topics involving QCVV specific to the particular proposed experimental system but tailored to the requirements of FTQC. The team is expected to develop methods and metrics that are then experimentally demonstrated. The experimental research should provide data and feedback to the theory component, throughout the lifetime of the effort, to help inform research directions for theory. Goals for the proposed research should include a set of methods and metrics for the systems studied and experimental demonstrations of the metrics.
2. For the second category of proposals, independent theoretical proposals that address major new advances or novel approaches to QCVV relevant to FTQC are sought. In particular, proposed research should be relevant for quantum systems of intermediate numbers of qubits (e.g., 3-30). Proposals may also address the theory of fault tolerant quantum computing, tailored to the limitations of possible QCVV protocols (e.g., the lack of a fully benchmarked non-Clifford gate).

The generic problem of quantum state reconstruction, e.g., in quantum analog simulation, is not of interest to this topic. Quantum state reconstruction in the specific context of novel or revolutionary techniques for FTQC will be considered.

Performers addressing this topic should deliver a review of QCVV protocols with respect to their chosen technology no later than ten months after the contract start date, with yearly updates every year thereafter while under contract. This review should expand on the proposal and include review and analysis of the relevant protocols in the literature relevant to FTQC, any gaps that might exist to the chosen qubit technology, and any new results or analysis that were not included in the performers' proposal or were made since the contract start date. See Section VII.C for further reporting requirements.

Topic 2: Advance Quantum Computing Measurement Technology

Research areas of interest to this topic are:

1. Technology improvements to existing measurement techniques for existing qubits
2. Demonstrations of novel qubit measurement techniques for existing qubits

Quantum information systems utilize measurement in a variety of ways: for diagnostic purposes while calibrating a quantum information system, to tune up a process for optimal operation, and for final read-out when implementing a quantum information process. For this topic, three performance parameters characterize quantum computing measurement techniques; (a) speed, (b) fidelity, and (c) resources.

Measurement speed: Significant increases to measurement and readout speeds will provide corresponding benefits to the execution of quantum algorithms, where feedback from measurement to subsequent gates requires the speed of measurements to be faster than the rate of catastrophic errors in a qubit system. Additionally, improving measurement speeds will beneficially impact the calibration of quantum systems by reducing the time required for this (often) rate limiting step.

Measurement fidelity: Measurement fidelity increases are an important component of improving the implementation of small quantum algorithms. Additionally, improvements to measurement fidelity can improve the characterization of initialization errors and gate errors. For these reasons, measurement and readout fidelity are important focuses of this solicitation.

Measurement resources: Many resources are required to successfully measure and readout a qubit system. Broadly speaking, these resources could include components that vary tremendously in size and complexity. For example, bulk equipment is required for qubit measurement: rack-mounted electronics components; specialized lasers; high quality oscillators and timing standards. Another example is interconnect resources that are required for qubit measurement: electronic leads into a dilution refrigerator, filters for different frequencies and bandwidths; optical fibers; specialized chip holders and on-chip interconnects to reduce cross-talk and other unwanted noise. A third example of a measurement resource is the physical space within a dilution refrigerator or inside a vacuum chamber. Finally, the monetary cost of setting-up a high-quality qubit measurement system (fast and high-fidelity) can be considerable and represents a measurement resource. Proposers are encouraged to pursue aggressive improvements to the resources required to perform high-quality qubit measurements.

Proposals should address all three aspects of measurement and readout improvements: speed, fidelity, and resource reduction. A successful proposal may include an especially aggressive improvement in one of these three areas with more modest improvements in the other two areas. Each proposal must clearly articulate the qubit technology and measurement process that it seeks to improve. A description of this measurement process should include a quantitative breakdown of the time-steps involved in the measurement process, as well as a breakdown of the error budget of the measurement process. The resources required to perform current measurements should be articulated, and those resources that are being focused on for improvement should be made clear. This topic is focused on experimental efforts to develop and demonstrate improvements to measurement techniques. Demonstration should include testing with an extant qubit system. Teaming with researchers who can provide existing qubit systems for the purposes of testing and demonstration will also be considered. Purely theory efforts are not encouraged. Any theoretical components of these efforts must include clearly articulated theoretical goals in support of the experimental demonstrations. Proposals to demonstrate novel qubit measurement techniques that promise significant improvements to measurement performance parameters are encouraged.

B. Award Information

It is anticipated the awards will be made in the form of contracts, grants, and cooperative agreements and are subject to the availability of appropriations. Multi-year projects must have clear goals for each year. Funding for subsequent years will be contingent upon satisfactory performance and the availability of funds.

The ACC-APG RTP Division has the authority to award a variety of instruments on behalf of ARL-ARO. The ACC-APG RTP Division reserves the right to use the type of instrument most appropriate for the effort proposed. Applicants should familiarize themselves with these instrument types and the applicable regulations before submitting a proposal. Following are brief descriptions of the possible award instruments.

1. Procurement Contract. A legal instrument, which, consistent with 31 U.S.C. 6303, which reflects a relationship between the Federal Government and a State Government, a local government, or other entity/contractor when the principal purpose of the instrument is to acquire property or services for the direct benefit or use of the Federal Government.

Contracts are governed by the following regulations:

- a. Federal Acquisition Regulation (FAR)
 - b. Defense Federal Acquisition Regulation Supplement (DFARS)
 - c. Army Federal Acquisition Regulation Supplement (AFARS)
2. Grant - A legal instrument that, consistent with 31 U.S.C. 6304, is used to enter into a relationship:
 - a. The principal purpose of which is to transfer a thing of value to the recipient to carry out a public purpose of support or stimulation authorized by a law or the United States, rather than to acquire property or services for the DoD's direct benefit or use.
 - b. In which substantial involvement is not expected between the DoD and the recipient when carrying out the activity contemplated by the grant.
 - c. No fee or profit is allowed.
 3. Cooperative Agreement - A legal instrument which, consistent with 31 U.S.C. 6305, is used to enter into the same kind of relationship as a grant (see definition "grant"), except that substantial involvement is expected between the DoD and the recipient when carrying out the activity contemplated by the cooperative agreement. The term does not include "cooperative research and development agreements" as defined in 15 U.S.C. 3710a. No fee or profit is allowed.

Grants and cooperative agreements are governed by the following regulations:

- a. 2 CFR Part 220, "Cost Principles for Educational Institutions" (Formerly OMB Circular A-21)
- b. 2 CFR Part 225, "Cost Principles for State, Local and Indian Tribal Governments" (Formerly OMB Circular A-87)
- c. OMB Circular A-102, "Uniform Administrative Requirements for Grants and Cooperative Agreements with State and Local Governments"
- d. 2 CFR 215, "Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations" (Formerly OMB Circular A-110)
- e. 2 CFR Part 230, "Cost Principles for Non-Profit Organizations" (Formerly OMB Circular A-122)
- f. OMB Circular A-133, "Audits of States, Local Governments, and Non-Profit Organizations"
- g. DoD Grant and Agreement Regulations (DoDGARs), DoD 3210.6-R

Copies of OMB regulations may be obtained from:

Executive Office of the President
Publications Service
New Executive Office Building
725 17th Street, N.W., Room 2200
Washington, DC 20503

Telephone: (202) 395-7332
FAX Requests: (202) 395-9068
<http://www.whitehouse.gov/OMB/grants>

An electronic copy of the DoDGARs may be found at <http://www.ecfr.gov> (Title 22: National Defense, Part 22 —DoD Grants and Agreements – Award and Administration)

C. Eligibility Information

1. Eligible Applicants:

Proposals may be submitted by degree-granting universities (foreign and domestic), nonprofit organizations, or industrial concerns (large and small businesses). Proposals are encouraged from Historically Black Colleges and Universities (as determined by the Secretary of Education to meet requirements of Title III of the Higher Education Act of 1965, as amended (20 U.S.C. §1061) and from Minority Institutions defined as institutions whose enrollment of a single minority or a combination of minorities exceeds 50 percent of the total enrollment. [20 U.S.C. § 1067k(3) and 20 U.S.C. § 2323(a)(1)(C)]. However, no funds are specifically allocated for HBCU/MI participation.

2. Cost Sharing or Matching:

There is no requirement for cost sharing, matching, or cost participation to be eligible for award under this BAA.

3. Dun and Bradstreet Universal Numbering System (DUNS) Number and Central Contractor Registrations (SAM):

Each applicant (unless the applicant has an exception approved by the agency under 2 CFR 25.110(d)) is required to: (a) be registered in the SAM prior to submitting its application; (b) provide a valid DUNS number in its application; and (c) continue to maintain an active SAM registration with current information at all times during which it has an active Federal award or an application or plan under consideration by an agency.

An Agency receiving an application may not make an award to the applicant until the applicant has complied with all applicable DUNS and SAM requirements. If an applicant has not fully complied with the requirements by the time the agency is ready to make an award, the agency may determine that the applicant is not qualified to receive an award and use that determination as a basis for making an award to another applicant.

4. Other:

Federal Laboratories. Pursuant to the policy of FAR 35.017 and supplements, selected Federally Funded Research and Development Centers (FFRDC) may propose under this BAA. FFRDCs may propose as allowed by their sponsoring agency and in accordance with their sponsoring agency policy.

D. Application and Submission Information

1. Address to View Broad Agency Announcement

This BAA may be accessed from the Grants.gov (www.grants.gov), FedBizOpps (www.fbo.gov), and the ARL website <http://www.arl.army.mil/www/default.cfm?Action=6&Page=8>. Amendments to this BAA will be posted to these websites when they occur. Interested parties are encouraged to periodically check these websites for updates and amendments.

The following information is for those wishing to respond to the BAA:

2. Content and Form of Application Submission

a. General Information

The proposals submitted under this BAA must address unclassified fundamental research. Proposal submissions will be protected from unauthorized disclosure in accordance with

applicable laws and DoD regulations. Applicants are expected to appropriately mark each page of their submission that contains proprietary information.

Prospective proposers interested in responding to both research topics described in this BAA must submit separate White Papers and Full Proposals for each topic.

The application process is in two stages as follows in section b (Submission of a White Paper) and section c (Submission of a Full Proposal):

b. Submission of a White Paper:

Stage 1 White Papers – Prospective proposers are strongly encouraged to submit White Papers. The purpose of requesting White Papers is to minimize the labor and cost associated with the production of detailed proposals that have very little chance of being selected for funding. Based on assessment of the White Papers, feedback will be provided to the offerors to encourage or discourage submission of full proposals. Regardless of the Government response to a White Paper, offerors may submit a full proposal.

White Paper Format and Content:

1. White Papers must be submitted electronically to usarmy.rtp.aro.mbx.baa3@mail.mil in the following format:
 - Single PDF file as an email attachment
 - Page Size: 8 ½ x 11 inches
 - Margins – 1 inch
 - Font – No smaller than Times New Roman, 12 point
 - Number of Pages – no more than ten (10) single-sided pages. Any pages exceeding the ten page limit may not be evaluated.
2. White Papers must contain the following:
 - Title page. The title page should be labeled “Topic # White Paper” and should include the BAA number, proposed title, Principal Investigator (PI) with telephone number and email address, and an executive summary. (Not to exceed one page.)
 - Expected expenditures and justifications. (Not to exceed one page.)
 - Curriculum vitae sketches. (Not to exceed one page.)
 - Technical portion including all references and figures. Introduce the problem to be addressed, briefly survey related work, identify key obstacles, outline the proposed solution and well-defined objective, outline the yearly research plan with milestones, and state the impact if successful. (Not to exceed seven pages.)

c. Submission of a Full Proposal:

Stage 2 Full Proposals - After Stage 1 reviews are completed, offerors should submit full proposals in accordance with the requirements set forth in this BAA.

NOTE: All proposals submitted under the terms and conditions cited in this BAA will be reviewed regardless of the feedback provided on a White Paper submission(s). If offerors have

not submitted White Papers under Stage I of the BAA, offerors may still submit Full proposals for consideration for funding. Full proposals must be submitted in order for the offeror to receive consideration for funding.

Registration Requirements for Grants.gov: Proposals must be submitted electronically through Grants.gov. There are several one-time actions your institution must complete in order to submit applications through Grants.gov (e.g., obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number; register with the System for Award Management (SAM); register with the credential provider; register with Grants.gov; and obtain approval for an Authorized Organization Representative (AOR) to submit applications on behalf of the organization). Go to http://www.grants.gov/applicants/get_registered.jsp for further information. Use the Grants.Gov Organization Registration Checklist, which may be accessed at <http://www.grants.gov/assets/OrganizationRegCheck.pdf> to guide you through the process.

Applicants, who are not registered with SAM and Grants.gov, should allow at least 21 days to complete these requirements. It is suggested that the process be started as soon as possible.

Questions: Questions relating to the registration process, system requirements, how an application form works, or the submittal process must be directed to Grants.gov at 1-800-518-4726 or support@grants.gov.

VERY IMPORTANT – In order to view, complete, and submit an application package, you will need to download the appropriate software packages. Go to http://www.grants.gov/applicants/apply_for_grants.jsp for further information.

****Grants.gov intends to deploy a website design change on July 31, 2013. It is not believed this will affect the submission process for this BAA, but some of the web links located in this BAA may change. ****

Submitting the Application

Application forms and instructions are available at Grants.gov. To access these materials, go to <http://www.grants.gov>, select “Apply for Grants,” and then select “Download Application Package.” Enter the CFDA number, 12.431, Basic, Research in Science and Engineering. You can also enter the funding opportunity number for this announcement, W911NF-13-R-0010.

Application Forms – The forms are contained in the Application Package available through the Grants.gov application process. Applicants must complete the mandatory forms and any optional forms that are applicable (e.g., SF-LLL Disclosure of Lobbying Activities) in accordance with the instructions on the forms and the additional instructions below. The required fields should be completed in accordance with the “pop-up” instructions on the forms. To activate the instructions, turn on the “Help Mode” (icon with the pointer and question mark at the top of the form). Files that are attached to the forms must be in Adobe Portable Document Form (PDF) unless otherwise specified in this announcement.

Form: SF 424 (R&R) (Mandatory)

The SF 424 (R&R) form is to be used as the cover page for all proposals. Complete this form first to populate data in other forms. By submitting an application through grants.gov, the Authorized Organization Representative (AOR) identified by username and password is providing an electronic signature. By signing the SF 424 (R&R), applicants are providing the certification required by 32 CFR Part 28 regarding lobbying as contained in this BAA. If you encounter problems, contact customer support at 1-800-518-4726 or support@grants.gov.

NOTE: Lead Reviewer to Receive the Proposal – Input the ARO Program Manager data in the field right of Block #2 “Application Identifier” as follows: “Dr. TR Govindan”

Form: Research & Related Other Project Information

Complete questions 1 through 6 and attach files for items 7 through 12 as applicable. The files must comply with the following instructions:

Project Summary/Abstract (Field 7 on the form)

The project summary must be a single page that identifies the research problem, proposed methods, and anticipated outcome of the research, if successful. It should identify the Principal Investigator, the institution (and other institutions involved in the team, if applicable), the proposal title, the topic number, and the total funds requested for the effort. The project summary must not exceed one page when printed using standard 8.5” by 11” paper with 1” margins (top, bottom, left and right) with a font no smaller than Times New Roman, 12 point. To attach a Project Summary/Abstract, click “Add Attachment.” The project summary/abstract should be a concise description of the proposed research (200 words or less).

Project Narrative (Field 8 on the form)

The following formatting rules apply for Field 8

- Paper size when printed - 8.5 x 11 inch paper
- Margins - 1 inch
- Spacing - single
- Font – No smaller than Times New Roman, 12 point
- Number of pages – **not to exceed twenty-five (25)** single-sided pages.
The cover, table of contents, list of references, letters of support, and curriculum vitae are excluded from the page limitations.
- Pages exceeding the limit will not be evaluated.

Include the following in Field 8

The narrative’s first page must include the following information:

- Principal Investigator name

- Phone number, fax number, and e-mail address
- Institution, Department, Division
- Institution address
- Other institutions involved in the Research in Quantum Computing team, if applicable
- Past or current DoD Contractor or Grantee? If yes, provide Agency, point of contact; number
- Proposal title
- Institution proposal number
- Topic number and topic title
- Table of Contents: List project narrative sections and corresponding page numbers.
- Technical Approach: Introduce the problem to be addressed, survey related work, identify key obstacles, and outline the proposed solution and well-defined objective. Proposals should describe an approach to all technical areas with unambiguous and quantitative milestones. Proposers must justify the utility of the proposed work and highlight its benefits over the current state-of-the-art. Proposals should clearly address the expected key challenges and proposed methods to overcome these difficulties taking into consideration the current state of field. Proposers should set aggressive yearly quantitative milestones that define a path toward the end-of-the-program goals and analyze the impact if successful.
- Project Schedule, Milestones, and Deliverables: A summary of the schedule of events, milestones, and a detailed description of the results and products to be delivered.
- Management Approach: A discussion of the overall approach to the management of this effort, including brief discussions of: required facilities; relationships with any subawardees and with other organizations; availability of personnel; and planning, scheduling, and control procedures.

All applications should be in a single PDF file.

To attach a Project Narrative in Field 8, click “Add Attachment.”

Bibliography and References Cited (Field 9 on the form)

Attach a listing of applicable publications cited in above sections. The bibliography and references are not included in the page count.

Facilities and Other Resources (Field 10 on the form)

Describe facilities available for performing the proposed research and any additional facilities or equipment that the organization proposes to acquire at its own expense. To attach facilities information, click “Add Attachment.”

Equipment (Field 11 on the form)

Provide a rationale for each item of equipment requested in the budget and how this equipment will contribute to the goals of the proposal. To attach equipment information, click “Add Attachment.”

Other Attachments (Field 12 on the form)

Attach ARO Form 52 or Form 52A (as appropriate), Protection of Proprietary Information During Evaluation, and After Award/Statement of Disclosure Preference. This form may be

accessed at <http://www.arl.army.mil/www/default.cfm?page=218> under “Forms-Broad Agency /Announcements (BAA),” completed and saved as an Adobe PDF. To attach ARO Form, click “Add Attachments.”

Attach budget proposal at Field 12. The budget must be attached as a PDF file. You must provide a detailed cost breakdown of all costs, by cost category, by the funding periods described below, corresponding to the proposed Technical Approach that was provided in Field 8 of the Research and Related Other Project Information Form. Each year must be separately priced. The Research and Related Budget form is not required.

Annual budgets should be driven by program requirements. Elements of the budget should include:

- Direct Labor – Individual labor category or person, with associated labor hours and unburdened direct labor rates. Provide escalation rates for out years. Provide the basis for the salary proposed.

Administrative and clerical labors – Salaries of administrative and clerical staff are normally indirect costs (and included in an indirect cost rate). Direct charging of these costs may be appropriate when a major project requires an extensive amount of administrative or clerical support significantly greater than normal and routine levels of support. Budgets proposing direct charging of administrative or clerical salaries must be supported with a budget justification that adequately describes the major project and the administrative and/or clerical work to be performed.

- Indirect Costs – Fringe benefits, overhead, G&A, etc. (must show base amount and rate). Provide the most recent rates, dates of negotiations, the period to which the rates apply, and a statement identifying whether the proposed rates are provisional or fixed. If the rates have been negotiated by a Government agency, state when and by which agency. Include a copy of the current indirect rate agreement.
- Travel – Identify any travel requirements associated with the proposed research and define its relationship to the project. List proposed destinations, cost estimate, and basis of cost estimate.
- Subawards – Provide a description of the work to be performed by the subrecipients. For each subaward, a detailed cost proposal is required to be included in the principal investigator’s cost proposal. Fee/profit is unallowable if the instrument is a grant or cooperative agreement.
- Consultant – Provide consultant agreement or other document that verifies the proposed loaded daily/hourly rate. Include a description of the nature of and the need for any consultant’s participation. Strong justification must be provided, and consultants are to be used only under exceptional circumstances where no equivalent expertise can be found at a participating organization. Provide budget justification.
- Materials/Equipment – Specifically itemized with costs or estimated costs. An explanation of any estimating factors, including their derivation and application,

shall be provided. Include a brief description of the applicant's procurement method to be used (competition, engineering estimate, market survey, etc.). Provide budget justification.

- Other Direct Costs – Provide an itemized list of all other proposed other direct costs such as Graduate Assistant tuition, laboratory fees, report and publication costs and the basis for the estimate (e.g., quotes, prior purchases, catalog price lists).
- Cost Sharing or Matching Plan (if applicable) - Construct a table showing the cost sharing or matching share committed to your proposal in the following categories: State, institutional, and private sector. In each category, show the amount and nature of the planned expenditure share (e.g., State appropriation, equipment, faculty release time for research, etc.). A signed statement of commitment regarding the cost sharing or matching funds described above should be obtained from the appropriate State, institutional, and/or private sector officials. The cost sharing or matching plan should be included in the budget justification at Section K.

NOTE: To attach the budget justification at Section K, click “Add Attachment.”

Failure to provide the requested information or exceeding page limits may render the proposal non-responsive, and the proposal may not be evaluated.

Separate attachments, such as institutional brochures or reprints, cannot be considered.

Funding breakdown corresponding to the proposed Technical Approach that was provided in Field 8 of the Research and Related Other Project Information Form must also be attached.

Research and Related – Senior/Key Person Profile Form

Personnel Portion (Not to exceed five (5) pages, excluding letters of agreement from subcontractors.):

Describe the qualifications of the principal investigator and other key researchers involved in the project, along with the amount of effort to be expended by each person during each year, and include brief biographies for each. For all proposals, one individual should be the designated principal investigator for purposes of technical responsibility and contact.

Include letters of agreement from all subcontractors indicating their commitment and ability to perform the requested work. These letters should be signed on the offerors’s letterhead. Letters should be no more than a single page each, and should contain no critical technical information related to the proposal.

State of Current and Pending Support Portion:

A statement of current and pending support must be included for senior/ key investigator listed in the proposal. Use the ARO Current and Pending Support form located at:

<http://www.arl.army.mil/www/default.cfm?Action=29&Page=218#> to submit this information.

This statement requires that each investigator specify all grants and contracts through which he or she is currently receiving or may potentially receive financial support.

3. Submission Dates and Times:

White Papers:

White Papers must be submitted electronically via e-mail to usarmy.rtp.aro.mbx.baa3@mail.mil and received at the Army Research Office by 4:00 PM Eastern Daylight Savings Time on Wednesday, 10 July 2013. The email subject line should contain the following: W911NF-13-R-0010 White Paper Topic #. White Papers received after the deadline will not be reviewed. Feedback on the White Papers will be e-mailed directly to the proposed principal investigators by Friday, 2 August 2013.

Proposals:

Proposals transmitted to be considered for award must be received by Grants.gov **no later than 4:00 PM Eastern Daylight Savings Time on Tuesday, 10 September 2013.**

Applicants are responsible for submitting electronic proposals in sufficient time to insure Grants.gov receives it by the time specified in this BAA. If the electronic proposal is received by Grants.gov after the exact time and date specified for receipt of offers, it will be considered “late” and will not be considered for award. Acceptable evidence to establish the time of receipt by Grants.gov includes documentary evidence of receipt maintained by Grants.gov.

Because of potential problems involving the applicants’ own equipment, to avoid the possibility of late receipt and resulting in ineligibility for award consideration, it is strongly recommended that proposals be uploaded at least two days before the deadline established in the BAA.

If an emergency or unanticipated event interrupts normal Government processes so that proposals cannot be received at grants.gov by the exact time specified in the solicitation, and urgent Government requirements preclude amendment of the solicitation closing date, the time specified for receipt of proposals will be deemed to be extended to the same time of day specified in the solicitation on the first work day on which normal Government processes resume.

Proposal Receipt Notices – After a proposal is submitted to Grants.gov, the AOR will receive a series of three emails from Grants.gov. The first two emails will be received within 24 to 48 hours after submission. The first email will confirm receipt of the application by the Grants.gov system and the second will indicate that the application has either been successfully validated by the system prior to transmission to the grantor agency or has been rejected due to errors. A third email should be received once the agency has confirmed receipt of the proposal. The document, Tracking Your Application Package, located at <http://www.grants.gov/assets/TrackingYourApplicationPackage.pdf> explains this process. The proposal is not considered received until the AOR receives email #3.

4. Intergovernmental Review

Not Applicable

5. Funding Restrictions:

Topic 1: Multiple one to five year awards are anticipated. The maximum total of any award is five (5) years. Most proposals that combine experimental and theoretical efforts in teams are expected to request less than \$1.5M per year. Small theory efforts are expected to request less than \$300K per year. Larger proposals that combine the efforts of multiple investigators from multiple institutions will be considered if a strong and compelling case is made for such a combined effort, rather than multiple smaller efforts.

Topic 2: Multiple one to three year awards are anticipated. The maximum total of any award is three (3) years. Most proposals are expected to request less than \$750K per year. Larger proposals that combine the efforts of multiple investigators from multiple institutions will be considered if a strong and compelling case is made for such a combined effort, rather than multiple smaller efforts.

The actual amount of each award will be contingent on availability of funds, the specific topic, and the scope of the proposed work. Depending on the results of the proposal evaluation, there is no guarantee that any of the proposals submitted in response to a particular topic will be recommended for funding. On the other hand, more than one proposal may be recommended for funding for a particular topic.

6. Other Submission Requirements:

An applicant may withdraw a proposal at any time before award by written notice or by email. Notice of withdrawal shall be sent to the Contracting/Grants Officer identified in Section G, of this BAA. Withdrawals are effective upon receipt of notice by the Contracting/Grants Officer.

E. Application Review Information:

1. Criteria:

- A. Proposals submitted in response to this BAA will be evaluated primarily on the following criteria, both of equal weight:
 - 1. Scientific and technical merits of the proposed research; and
 - 2. Potential contribution of the research, if successful, to significantly enhance the feasibility of quantum computing.
- B. Other evaluation criteria, of lesser importance, but weighted equal to each other include:
 - 1. Experience and qualifications of the principal investigator, other key research personnel, and the institution sponsoring the proposal; and

2. The realism and reasonableness of cost.

NOTE: Cost sharing will not be considered in the evaluation.

2. Review and Selection Process:

The proposal selection process will be conducted based upon a technical review by a panel of government scientists according to the evaluation criteria specified in Section E.1 (Criteria). Each proposal will be evaluated based on the merit and relevance of the specific proposal as it relates to the research topic rather than against other proposals for research in the same general area.

3. Recipient Qualification

The Federal Awardee Performance and Integrity Information System (FAPIS) only applies to contracts and will be checked prior to making an award. The web address is: <http://www.fapiis.gov/fapiis/index.jsp>. This does not apply to assistance awards. The applicant representing the entity may comment in this system on any information about itself that a Federal Government Official entered. The information in FAPIS will be used in making a judgment about the entity's integrity, business ethics, and record of performance under Federal awards that may affect the official's determination that the applicant is qualified to receive an award.

F. Award Administration Information:

1. Award Notices:

Notification of selection of proposals will be e-mailed by ARO to successful offerors on or about Monday, 14 October 2013. Unsuccessful offerors will be notified shortly thereafter.

The notification e-mail must not be regarded as an authorization to commit or expend funds. The Government is not obligated to provide any funding until a Government Contracting/ Grants Officer signs the grant, cooperative agreement or contract award document.

Applicants whose proposals are recommended for negotiation of award will be contacted by a Contract/Grant Specialist to discuss additional information required for award. This may include representations and certifications, revised budgets or budget explanations, certificate of current cost or pricing data, subcontracting plan for small businesses, and other information as applicable to the proposed award.

2. Administrative and National Policy Requirements:

SAM - Successful applicants not already registered in the System for Award Management (SAM) will be required to register in SAM prior to any award resulting from this BAA. Information on SAM registration is available at www.SAM.gov.

Certifications – Grant awards greater than \$100,000 require a certification of compliance with a national policy mandate concerning lobbying. Grant applications shall provide this certification by electronic submission of SF424(R&R) as a part of the electronic proposal submitted via Grants.gov (complete Block 17). The following certification applies to each applicant seeking federal assistance funds exceeding \$100,000.

Certification Regarding Lobbying Activities

- (1) No Federal appropriated funds have been paid or will be paid by or on behalf of the applicant, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the Federal contract, grant, loan, or cooperative agreement, the applicant shall complete and submit Standard Form-LLL, “Disclosure Form to Report Lobbying,” in accordance with its instructions.
- (3) The applicant shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, title 31, U.S.C. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

Use and Protection of Human Subjects in Research

All research involving human subjects must be conducted in accordance with 32 CFR 219, 10 U.S.C. 980, and DoDI 3216.02, as well as other applicable federal and state regulations. Contractors/grantees must be cognizant of and abide by the additional restrictions and limitations imposed on the DoD regarding research involving human subjects, specifically as regards vulnerable populations (32 CFR 219 modifications to subparts B-D of 45 CFR 46), recruitment of military research subjects (32 CFR 219), and surrogate consent (10 U.S.C. 980). The regulations mandate that all DoD activities, components, and agencies protect the rights and welfare of human subjects of study in DoD-supported research, development, test and

evaluation, and related activities hereafter referred to as “research”. The requirement to comply with the regulations applies to new starts and to continuing research.

Military Recruiting

For Assistance Instruments Only. This is to notify potential applicants that each grant or cooperative agreement awarded under this announcement to an institution of higher education must include the following term and condition:

"As a condition for receipt of funds made available by the Department of Defense (DoD) under this award, the recipient agrees that it is not an institution of higher education (as defined in 32 CFR part 216) that has a policy of denying, and that it is not an institution of higher education that effectively prevents, the Secretary of Defense from obtaining for military recruiting purposes: (A) entry to campuses or access to students on campuses or (B) access to directory information pertaining to students. If the recipient is determined, using the procedures in 32 CFR part 216, to be such an institution of higher education during the period of performance of this agreement, and therefore to be in breach of this clause, the Government will cease all payments of DoD funds under this agreement and all other DoD grants and cooperative agreements to the recipient, and it may suspend or terminate such grants and agreements unilaterally for material failure to comply with the terms and conditions of award."

If your institution has been identified under the procedures established by the Secretary of Defense to implement Section 558, then: (1) no funds available to DoD may be provided to your institution through any grant, including any existing grant, (2) as a matter of policy, this restriction also applies to any cooperative agreement, and (3) your institution is not eligible to receive a grant or cooperative agreement in response to this solicitation.

For Contracts Only. This is to notify potential applicants that each contract awarded under this announcement to an institution of higher education shall include the following clause: Defense Federal Acquisition Regulation Supplement (DFARS) clause 252.209-7005, Military Recruiting on Campus.

Appropriations Provisions on Tax Delinquency and Felony Convictions

For Contracts

""252.209-7998 Representation Regarding Conviction of a Felony Criminal Violation under any Federal or State Law.

See Class Deviation 2012-O0007, Prohibition Against Contracting with Corporations that Have a Felony Conviction, dated March 9, 2012. Contracting officers shall include the provision at 252.209-7998 in all solicitations that will use funds made available by Division H of the Consolidated Appropriations Act, 2012, including solicitations for acquisition of commercial items under FAR part 12, and shall apply the restrictions included in the deviation. This deviation is effective beginning March 9, 2012, and remains in effect until incorporated in the FAR or DFARS or otherwise rescinded.

252.209-7999 Representation by Corporations Regarding an Unpaid Delinquent Tax Liability or a Felony Conviction under any Federal Law.

See Class Deviation 2012-O0004, Prohibition Against Contracting With Corporations That Have an Unpaid Delinquent Tax Liability or a Felony Conviction under Federal Law, dated January 23, 2012. Contracting officers shall include this provision in all solicitations that will use funds made available by Division A of the Consolidated Appropriations Act, 2012, including solicitations for acquisition of commercial items under FAR part 12, and shall apply the restrictions included in the deviation. This deviation is effective beginning January 23, 2012, and remains in effect until incorporated in the FAR or DFARS or otherwise rescinded. (Revised February 28, 2013)

For Assistance awards, recipients will be required to submit the following representation prior to award.

Representations under DoD Assistance Agreements: Appropriations Provisions on Tax Delinquency and Felony Convictions

The applicant is () is not () a "Corporation" meaning any entity, including any institution of higher education, other nonprofit organization, or for-profit entity that has filed articles of incorporation.

If the applicant is a "Corporation", please complete the following representations:

(1) The applicant represents that it is () is not () a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

(2) The applicant represents that it is () is not () is not a corporation that was convicted of a criminal violation under any Federal law within the preceding 24 months.

NOTE: If an applicant responds in the affirmative to either of the above representations, the applicant is ineligible to receive an award unless the agency suspension and debarment official (SDO) has considered suspension or debarment and determined that further action is not required to protect the Government's interests. The applicant therefore should provide information about its tax liability or conviction to the agency's SDO as soon as it can do so, to facilitate completion of the required considerations before award decisions are made.

Subcontracting

For Contracts Only. This section is applicable to contracts where the dollar threshold is expected to exceed to \$650,000.00. 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 concerns to be considered fairly as subcontractors under all research agreements awarded to prime contractors.

The required elements of the Subcontracting Plan are set forth by FAR 52.219-9 and DFARS 252.219-7003. The applicant's plan shall depict the percentage values of the option requirements separately. The information in the SB Subcontracting Plan must properly correlate with that of the applicant's SB Participation Plan. The Government's subcontracting goals for Fiscal Year 2013 (FY13) are listed below, future year goals can be found at: <http://www.acq.osd.mil/osbp/gov/sbProgramGoals.shtml>.

Subcontracting Plan Goals. The applicant is requested to consider, when appropriate, the Government's subcontracting goals. The goals for FY13 are as follows:

Small Business 36.7%

Small Disadvantaged Business 5%

Women-Owned Small Business 5%

HUBZone Small Business: 3%

Service-Disabled Veteran-Owned Small Business 3%

3. Reporting:

Topic 1: Experimental data collected for awards made under Topic 1 shall be made accessible to the research community participating in Government quantum computing programs in a standard format. The purpose of this requirement is to provide valuable data to the community that can be further analyzed to understand the performance of different metrics and accelerate all approaches to developing QCVV. Reports and briefing material will also be required as appropriate to document progress in accomplishing program metrics.

Both topics: Additional reports including number and types will be specified in the award document, but will include as a minimum monthly financial status reports. The reports shall be prepared and submitted in accordance with the procedures contained in the award document and mutually agreed upon before award. A final report that summarizes the project and tasks will be required at the conclusion of the performance period for the award.

G. Agency Contacts:

Questions of a technical nature or a programmatic nature shall be directed as specified below:

Quantum Computing Program Point of Contact:

Dr. T.R. Govindan

Army Research Office

Email Address: t.r.govindan.civ@mail.mil

Questions of a business nature shall be directed to the cognizant Grants/Contracting Officer, as specified below:

Mr. Kevin Bassler

Contracting/Grants Officer

Email address: kevin.j.bassler.civ@mail.mil

Comments or questions submitted should be concise and to the point, eliminating any unnecessary verbiage. In addition, the relevant part and paragraph of the Broad Agency Announcement (BAA) should be referenced.