REQUEST FOR INFORMATION
Qubits for Computing Foundry (QCF) W911NF-20-RFI-QCF

U.S. Army Contracting Command, Aberdeen Proving Ground

Research Triangle Park Division

RTP Contracting Division, P.O. Box 12211, Research Triangle Park, NC 27709-2211

1.0 Description

1.1 The U.S. Army Contracting Command, Aberdeen Proving Ground, Research Triangle Park Division. is issuing this Request for Information (RFI) in support of the U.S. Army Research Office (ARO) and the Laboratory for Physical Sciences (LPS), in seeking information on qubit foundries for US researchers in the field of gate-based quantum computing. This RFI seeks input from both potential end-users and potential foundry partners. Experimental researchers in the field of quantum computing need qubit devices to explore both the foundational physics and new types of qubits that can be realized in these systems. Unfortunately, the barrier to entry can be quite large due to the lack of sufficient high-quality qubit fabrication facilities or expertise. A potential avenue to overcome such limitations could involve standing up and/or making available to a wider community, fabricated qubit devices. The ideal would be sources of qubit devices that offer flexibility in design, materials, and qubit types to meet the needs of a diverse range of research laboratories. To understand the research community requirements, we seek information from both potential users/customers, as well as the capabilities of potential foundry facilities.

1.2 THIS IS NOT A SOLICITATION FOR PROPOSALS. This Request for Information (RFI) is for planning and informational purposes only and shall not be considered as a request for proposals or as an obligation on the part of the Government to acquire any products or services. No entitlement to payment of direct or indirect costs or charges by the Government will arise as a result of contractor submission of responses to this RFI or the Government's use of such information. The Government reserves the right to reject, in whole or in part, any contractor's input resulting from this RFI. No contract will be awarded from this announcement. Data submitted in response to this RFI will not be returned. Information is being requested in order to make potential future requirements better for the quantum information science research community and the Government.

2.0 Statement of Objectives

2.1 PURPOSE

The Laboratory for Physical Sciences (LPS) and the U.S. Army Research Office (ARO) often select their research efforts through the Broad Agency Announcement (BAA) process. This request for information (RFI) is intended to provide information relevant to a possible future BAA, so that feedback from potential participants can be considered prior to the issuance of a BAA.

Respondents are invited to provide comments on the content of this announcement to include suggestions for improving the scope of a possible solicitation to ensure that every effort is made to adequately address the scientific and technical challenges described below. Responses to this request may be used to support development of, and subsequently be incorporated within, a future BAA and therefore must be available for unrestricted public distribution. The following sections of this announcement contain details of the scope of technical efforts of interest, along with instructions for the submission of responses. The responses to the RFI may also be used in planning a workshop prior to the issuance of a BAA.

2.2 BACKGROUND

To make progress in the field of gate-based quantum computing, researchers must spend significant time and resources developing in-house specialized fabrication procedures. In many cases, continuity and maintenance of institutional knowledge from graduate student to graduate student is difficult, and recipes may need constant revision due to multi-user equipment typically accessible by research groups. A potential avenue to overcome these limitations may involve access to high quality and specialized foundry facilities. This would enable the researchers to focus on the science instead of the fabrication. Such foundries would, however, need to be flexible to meet the ever-changing needs of the research community by offering "design-to" capabilities within foundry constraints; by offering well-characterized multi-qubit systems; or, more aggressively, by allowing for the incorporation of novel components and materials.

2.3 SCOPE

LPS and ARO would like to solicit information from both potential end-users and potential qubit foundry facilities. Information is sought on the broad needs of the research community, the end-users, and from foundry facilities that can meet these needs in one or more of the following technology areas: 1) superconducting qubits; 2) gate-defined semiconductor quantum dots; 3) traps for trapped ion qubits. Respondents are encouraged to be as succinct as possible while providing specific information that may address one or both of the following two topic areas; (a) needs of potential users/customers of foundry facilities, and (b) capabilities of potential foundry facilities.

Within these two topic areas, please address the following questions about your topic.

Topic 1: Potential users/customers of foundry facilities
For potential end-users interested in utilizing a quantum computing research foundry facility, we would like to know if you and your team would be interested in using a foundry facility if one was available. In your response, please consider the following topics/questions:
- Which qubit technology(s) is your research team focused on?
- Are you aware of foundries in existence today that are capable of meeting your needs?

- Are there fabrication processes currently unavailable to your team that would add to your scientific goals? Are these processes available in modern fabrication facilities?
- How much time and money does your team currently spend on the fabrication aspects of your research? How much of this could be eliminated by outsourcing to a sufficiently high-quality foundry? What aspects would you be comfortable outsourcing?
- What device parameters do you require? How much spread in device parameters can be tolerated?
- Do you require packaged and characterized devices or simply diced chips? If so,
  - Do you have packaging restrictions?
- Which parameters would you need pre-characterized?
- What kind of qubit design flexibility do you require? e.g.
  - Novel material sets
  - Novel device design/geometries
  - Novel device packaging requirements
- How do you see successfully managing the tension between allowing novel fabrication methods and providing stable processes at a foundry?
- What engagement model and level of interaction would you find most helpful? Would you be open to:
  - Basic device parameter feedback?
  - Collaborative device design?
  - Detailed discussion of experimental performance and suggestions for future developments?
- Do you have limitations/break-points related to cost per chip/device?
  - How many device designs/fabrication runs per year would you require?
  - Do you need short-time design-fab-test cycles in order to make progress?
- Do you desire or require assistance with fabrication process planning or process simulation?
- In addition to access to fabrication capabilities, are there other aspects or expertise you would find valuable as a foundry offering? (e.g. microwave/RF engineering, modeling, design, test, component development, etc.)
- Are there barriers (other than access) or concerns that would prevent you from seeking out a foundry service, and if so, what are they and do you have suggestions to mitigate them?

Topic 2: Potential providers of foundry facilities
For foundries interested in participating in a quantum computing research foundry effort, we would like a response describing the following topic areas:

1. Foundry program structure: Please describe the types of foundries and types of government and user interactions you see as necessary for implementing a successful quantum foundry service. In your answer please consider the following topic areas:
   - Foundry type:
       i. What model or level of interaction would you find most helpful?
       ii. Which types of foundries are required to meet the needs of quantum researchers?
       iii. Should foundries focus on one technology type or be open to general requests across multiple technologies?
       iv. Should foundries have quantum dedicated fabrication lines or would multi-purpose tools be sufficient?
       v. The immaturity of the underlying fabrication processes is a key challenge for developing a foundry for quantum devices, since there may not be a converged and stable process. How can this be addressed? Does the foundry need to include subject matter experts in the use of quantum devices?
   - User engagement:
       i. What procedure is preferred to select users? (e.g. sole contract with the government, separate contract with each user, etc.)
       ii. Are you aware of potential end-users? What observations do you have of the user community? Is there a minimum number of end-users required for a foundry to be viable?
       iii. What is the desired feedback-loop with future potential end-users?
       iv. Would you be willing to host graduate students or post-docs, and/or grant them access to the facility and tools?
       v. Are there barriers (other than funding) or concerns that you feel will prevent users from seeking out a foundry service, and if so, what suggestions do you have to mitigate those?
2. Foundry status: For your foundry, please describe its ability to participate in a quantum foundry program. In your answer please consider the following topic areas:
   - Foundry type: Which quantum computing qubit technologies could the foundry support? What types of materials and components could be available to end-users?
   - What is the current status and capabilities of the foundry? i.e. is the facility ready to receive users now, or are upgrades required?
   - Are future upgrades likely to be required to meet the evolving quantum research landscape?

- Are there tools or materials that are hard to find, yet would be useful for fabricating novel or next generation qubits?

3.0 Responses

3.1 PREPARATION INSTRUCTIONS

Interested parties are invited to submit ideas related to this topic for use by the Government in formulating a potential program. Submittals must briefly address each survey question above appropriate for the role you are most interested in (user or foundry), identify issues/questions not addressed and outline critical technical issues/obstacles. If appropriate, respondents may also choose to provide a non-proprietary rough order of magnitude (ROM) regarding what such approaches might require in terms of funding and other resources for one or more years. This announcement contains all of the information required to submit a response. No additional forms, kits, or other materials are needed. Responses from all capable and qualified sources from within the US are sought.

Responses have the following formatting requirements:

a. **Cover Sheet** • 1 page

- title, organization
- respondent's technical and administrative points of contact, including for each co-author: name, address, phone and fax numbers, email address
- clear indication of association with W911NF-20-RFI-QCF

b. **Executive Summary**: substantive, focused, one-half page

c. **Responses** to the User or Foundry questions listed in section 2.3
- 4 pages maximum
- font: Times New Roman, 12 point minimum
- single-sided, single-spaced 8.5 by 11 inch paper, 1-inch margins

d. **Citations**: any significant claims or reports of success must be accompanied by citations, and reference material MUST be attached

e. **Overview** (optional): a single overview briefing chart graphically depicting the key ideas

3.2 SUBMISSION INSTRUCTIONS TO RESPONDENTS

Responses to this RFI are due no later than 4:00 pm Eastern Time on 6 October 2020. All submissions must be electronically submitted to
usarmy.rtp.rdecom-aro.mesg.qcbox@mail.mil
as a PDF document. Inquiries to this RFI must be submitted to
usarmy.rtp.rdecom-aro.mesg.qcbox@mail.mil

Do not send questions with proprietary content. No telephone inquiries will be accepted.

4.0 Summary

This is an RFI issued solely for information and planning purposes and does not constitute a solicitation. Respondents are advised that the Government is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI.

The responses to this RFI may be used to help in the identification of promising areas for investment through vehicles such as programs or small studies, as well as in the planning of an agenda and participant list for a potential workshop on quantum computing foundries. If appropriate, a separate workshop announcement may be posted at a later date with additional details.

Responses to this notice are not offers and cannot be accepted by the Government to form a binding contract. Respondents are solely responsible for all expenses associated with responding to this RFI. It is the respondent's responsibility to ensure that the submitted material has been approved for public release by the information owner.

The Government does not intend to award a contract on the basis of this RFI or to otherwise pay for the information solicited, nor is the Government obligated to issue a solicitation based on responses received. Neither proprietary nor classified concepts or information should be included in the submittal. Input on technical aspects of the responses may be solicited by from non-Government consultants/experts who are bound by appropriate non-disclosure requirements.