Quantum Access

September 2, 2020

Agenda

- 10:00 AM EDT Business Meeting
  - Would participants be interested in becoming an IEEE interest group?
  - This is the developmental website https://fab.quantum.ieee.org.
  - Introduction of Gordon Harling of CMC Microsystems
  - Would this group be interested in responding to U. S. based RFI?
  - There is also a (U. S. based) ARO RFI seeking in a related area http://www.fbodaily.com/archive/2020/08-August/14-Aug-2020/FBO-05754252.htm (due October 6, 2020).
- 10:15 AM EDT Robert Freeman, Synopsys: TCAD & EDA Design Tools for the Quantum Industry (20 mins)
  - How far or adjacent are the needed TCAD & EDA Design Tools to have a similar impact to the Quantum Industry?
- 10:35 AM EDT Brian Tyrrell, MIT-LL: Technologies and engagement models: Opportunities and Challenges for a quantum MOSIS-like service (20 mins)
  - Could a MOSIS-like service create opportunities to tap into the many technologies at Lincoln Laboratory, etc.
- 10:55 AM Tom Ohki, Raytheon: QED-C Activity to Support Quantum Access (20 mins)
  - The Quantum Economic Development Consortium is an industry driven group looking to accelerate the QIS sector's needs for enabling technology, use cases, workforce, standards and national security interests.

Multi-Project Wafer (CMOS)

- Most wafers are entirely one type of chip
  - Microprocessor
  - Memory
- Student projects shouldn’t need a full wafer
  - No time to design a complex chip
  - Only need a few chips to test
  - However, fabs have to make a whole wafer at a time
- Multi-project wafer concept
  - Gather together many simple projects
  - Put them on a wafer where each chip is different
  - Have to pay, but can aggregated funds

- Example
  - A dozen different projects
  - Each project replicated four time

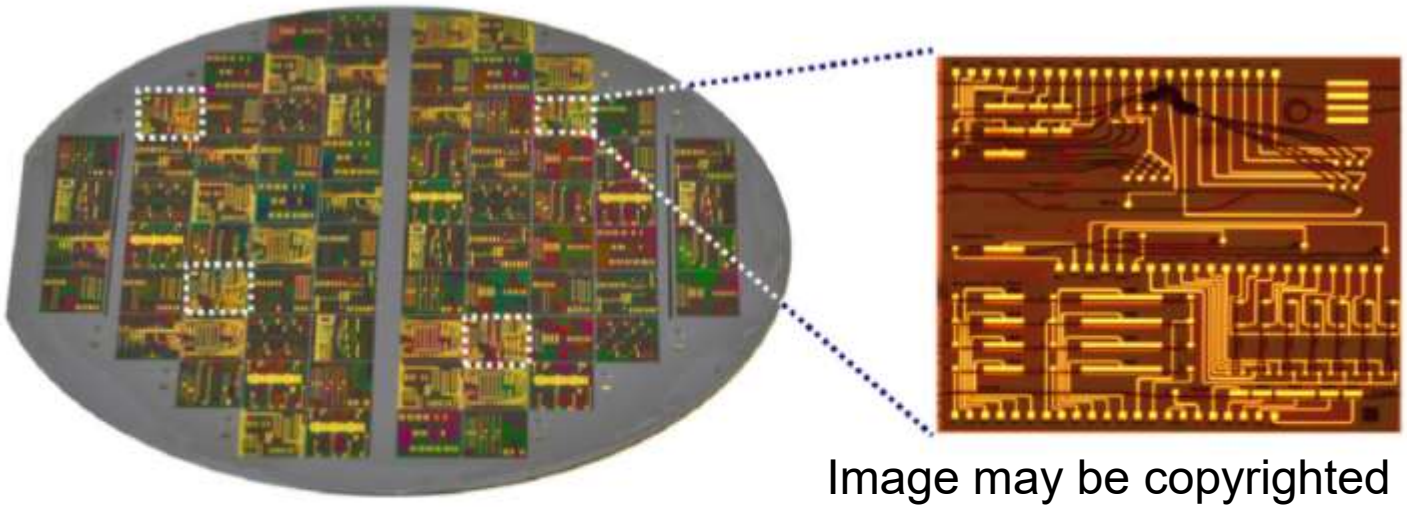


Image may be copyrighted

Example of a multi-project wafer (MPW) realised in the COBRA process. The wafer contains a large number of cells with different ASPICs. The wafer has 52 cells in the usable wafer area. Each ASPIC is copied at four different locations on the wafer, so that we have room for 12 users and one test cell, which is used for wafer validation. The figure shows one cell (a test cell) and its position on the wafer. In this way, each user will receive four copies of his chip per wafer in the MPW batch. COBRA usually runs two wafers in a batch.

Quantum Equivalent

- Here's what a student might get
  - Qubit (rectangle)
  - Control electronics
  - Mounted

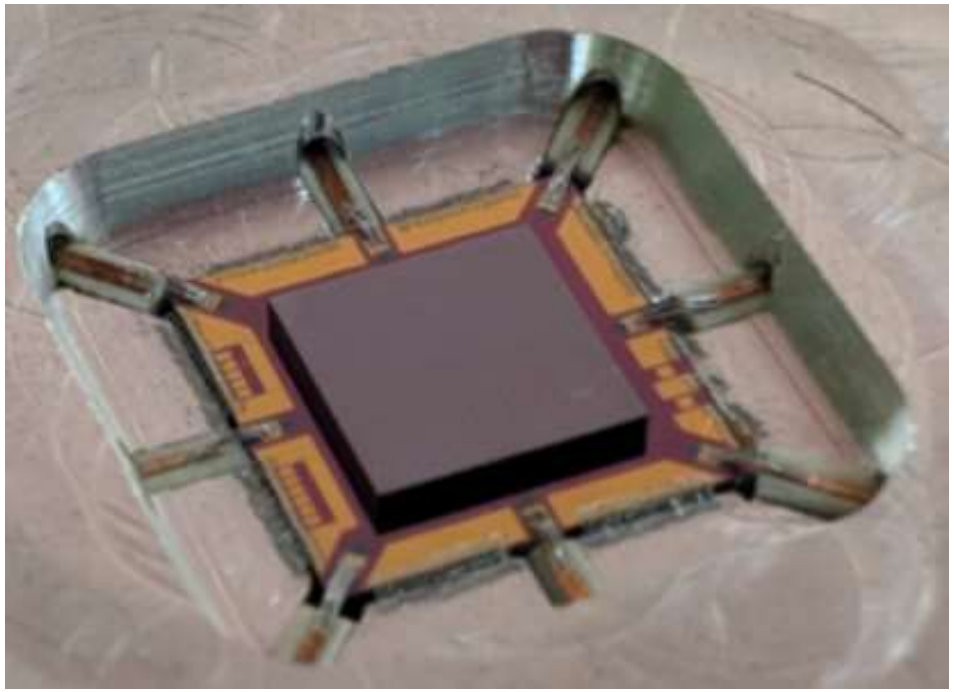


Image may be copyrighted

- What's the research/development paradigm?:
  - Module on the left was a research project by a team
  - Students don't need to do a research project
  - Repeating a research project is a lot easier

- Plan
  - Reproducing the module on the left with limited changes would be important lab training

  - The module has subcomponents
    qubits
    amplifiers
    interconnect, …
    A student project could be to improve one component, leaving the rest as the "test harness"

IEEE Interest Group

COVID, Conferences, and “365”

- IEEE does not have in person conferences due to COVID
  - One alternative is to have virtual conferences at the same time as the physical conferences
- Alternative is to have a “365” event
  - Occurs 2 hrs per month
  - Maintains continuity

To be an interest group for “quantum fab”

- Create a program committee
- Create a “call for content”
- Create a program committee to assess which content is worthy
- Run like a conference, but 2 hrs at a time

Could issue a workshop conclusion document

- Workshop conclusion document could be an RFI response

Request for Information

- Request for information
  - Due 4:00 pm Eastern Time on 6 October 2020

Description

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

U.S. Army Contracting Command, Aberdeen Proving Ground, Research Triangle Park Division
P.O. Box 12211, Research Triangle Park, NC 27709-2211

1.0 Description

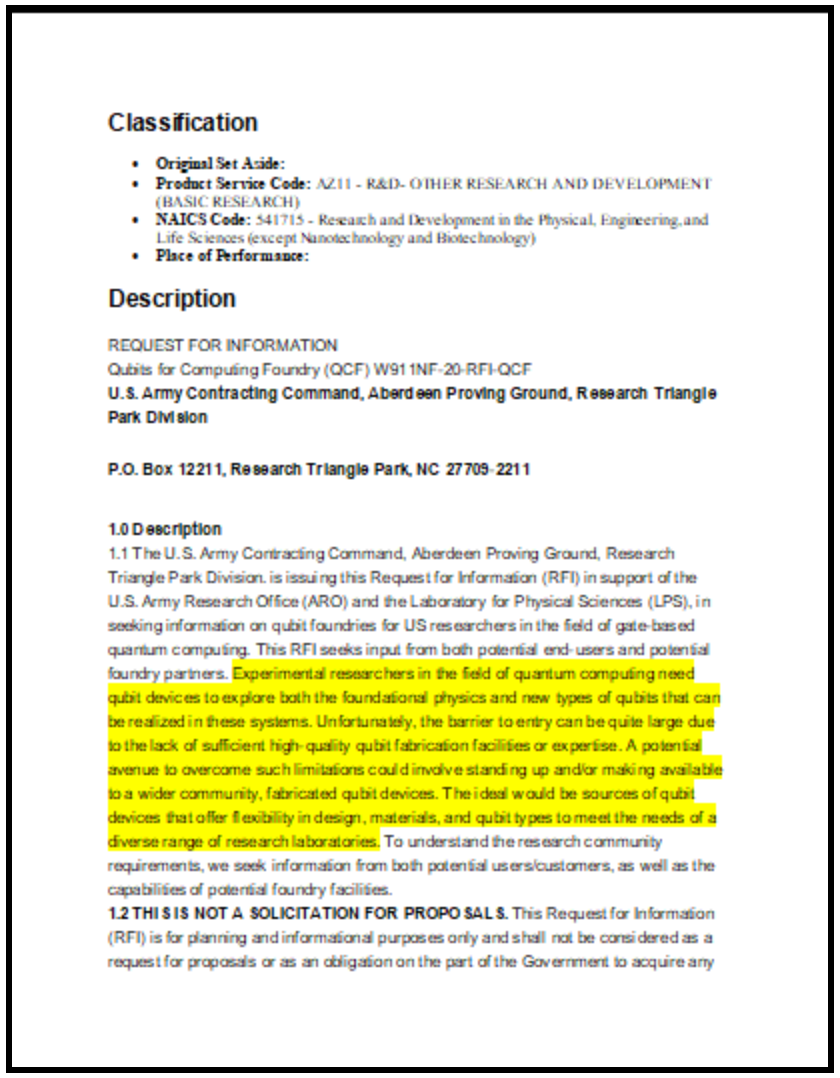
1.1 The U.S. Army Contracting Command, Aberdeen Proving Ground, Research Triangle Park Division. is issuing this Request for Information (RFI) in support of the U.S. Army Research Office (ARO) and the Laboratory for Physical Sciences (LPS), in seeking information on qubit foundries for US researchers 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

- From RFI:
  - This RFI seeks input from both potential end-users and foundry partners.
  - Unfortunately, the barrier to entry can be quite large due to 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.

Quantum Access Summary

- Provide enabling technology services for quantum systems to users in education and industry
  - Fab service for qubits and cryo control electronics
  - Coordinate with design tool vendors
  - Manage non-sensitive and minimally sensitive IP
- Modeled after MOS Implementation Service (MOSIS), a service fabricating CMOS for students and startups since 1981
  - https://mosis.com
  - Some early reduced instruction set computing (RISC) processors such as MIPS (1984) and SPARC (1987) were run through MOSIS during their early design and testing phases. Could the same be true for Quantum Access?
- May lead to standards for connecting quantum hardware
  - Packaging, e. g. cryo connectors that can carry quantum or quantum control signals
  - Electrical and IP, e. g. specs for cryo amplifiers, test equipment
  - Design, e. g. physical layout of qubit/control chips and design file formats

RFI Key Points



Classification

- **Original Set Aside:**
- **Product Service Code:** AZ11 - R&D- OTHER RESEARCH AND DEVELOPMENT (BASIC RESEARCH)
- **NAICS Code:** 541715 - Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology)
- **Place of Performance:**

Description

REQUEST FOR INFORMATION
Qubits for Computing Foundry (QCF) W911NF-20-RFI-QCF
U.S. Army Contracting Command, Aberdeen Proving Ground, Research Triangle Park 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

- 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

Call to Action

- Let me know if you are sensitive about being acknowledged as being on this telecon (re. GDPR)

- Would you be willing to be on a “program committee” for additional workshops?
  - Telecon currently first Wednesday of each month, ~2 hrs

- Would you be willing to help put together a 4-5 page group overview of Quantum Fab
  - Open document to be on the web, but email a version to US govt by October 6
  - You can be visible or invisible (re. endorsement by your employer)
  - Work with other regions (Canada, EU, etc.)
  - Report out on October 7 telecon

- Tom Ohki/QED-C
  - <<his issues were presented in the talk>>