NATIONAL SCIENCE FOUNDATION
2415 EISENHOWER AVENUE
ALEXANDRIA, VIRGINIA 22314

NSF 21-112

Dear Colleague Letter: CISE RFI on Semiconductor Research and Education

August 6, 2021

Dear Colleagues:

Semiconductor-related research, including underlying supply-chain, business, and economic impacts, are increasingly important to the Nation's long-term competitiveness and security. Through this Request for Information (RFI), the National Science Foundation's (NSF) Directorate for Computer and Information Science and Engineering (CISE) seeks input from those who are directly engaged in, or might potentially benefit from, CISE-related research and education in semiconductor and micro- and nano-electronics.

The computing stack has traditionally been viewed as a hierarchy of layers with devices and circuits comprising the lowest layers, and architectures, software, algorithms, and applications constituting progressively higher layers. Lower layers of the stack (e.g., devices, circuits, architectures) more directly involve semiconductor technologies to the extent that researchers may interact with large-scale fabrication facilities, but all levels of the stack are influenced by microelectronic advances to varying degrees. Thus, although in its entirety CISE research may not directly involve research on semiconductors, per se, the entire computing stack, from circuit design to architectures and on to software and applications such as sensor networks including the Internet of Things (IoT), embedded computing, next-generation wireless systems, large-scale data analytics, artificial intelligence (AI), edge and cloud computing, and high-performance computing, heavily depends on advances in this space.

As a result, much of the CISE directorate's portfolio is dependent upon advances in semiconductor technologies. For one example, tomorrow's AI innovations offer transformative societal impacts, but require advanced hardware capabilities that leverage newer semiconductor technologies. Conversely, the hardware design problem is a large, multi-objective, multiscale optimization problem that stands to benefit from the application of modern AI techniques.

On December 14-20, 2020, CISE funded a workshop focusing on the lowest levels of the computing stack. This workshop considered the scientific frontiers for semiconductor and microelectronics technologies as well as the needs for access to semiconductor foundries. The workshop report is available at: https://nsfedaworkshop.nd.edu/assets/429148/nsf20_foundry_meeting_report.pdf.

Building upon that workshop and report, and given the diverse interests of the CISE directorate and community, the intent of this RFI is broader. Specifically, NSF/CISE seeks to:

- Gauge the extent to which the community's research and educational agenda would be enabled by the availability of new or different resources, or the re-introduction of resources that were available in the past. By this, NSF/CISE asks that respondents not restrict their answers to issues related to funding, but rather also consider issues related to infrastructure, facilities, access to tools/intellectual property/data, legal issues, etc., that support their research and educational agenda in the broader area of semiconductors;
- Understand what specific activities the research community would pursue and how that activity would impact societal and national interests, if the impediments mentioned in the first category above are removed. NSF/CISE asks respondents to be specific in making projections about new technologies potentially enabled by advances in semiconductor and microelectronics technologies within the 5-, 10-, or 15-year horizons, or longer. Also, if a respondent's research directly involves use of hardware fabrication, NSF is interested in learning specifics, as outlined in the questions below.

This RFI is issued solely for information-gathering purposes. NSF/CISE's intent is to analyze the responses received from this RFI for internal needs and for potentially formulating future program solicitations. NSF/CISE may make anonymized versions of the responses available to the public. This RFI does not constitute a formal solicitation for proposals.

INSTRUCTIONS TO SUBMITTERS

NSF invites both individuals and groups of individuals to provide their inputs via the online submission form (link below). The submission form requires the following information:

Affiliation information: Please select from the following options:

- University Faculty
- University Staff
- Industry Professional
- National Lab Researcher
- Other (please describe)

If you are associated with an institution of higher education, please let us know what

department you are in:

- Computer Science
- Electrical Engineering
- Electrical and Computer Engineering
- Materials Science
- Physical sciences
- Other (please describe)

If you are associated with industry, please let us know what segment of industry you represent:

- Semiconductor fabrication
- Materials/Devices
- Electronic Design Automation (EDA) tools
- Design services
- Embedded system /IoT design
- Software systems
- Cloud services
- Other (please describe)

While NSF/CISE has formulated the following questions, please feel free to submit inputs as free-form text, limiting responses to the specified number of words. Note that the questions are presented here as information. There is a pointer to the on-line survey at the end of this RFI.

Optional: If you feel comfortable saying where you are employed, please enter that here.

Question 1 (*300 words*) – Semiconductor and microelectronic research: Describe current or emerging research enabled by semiconductor or microelectronic technology, providing context in terms of recent research activities and standing questions in the field. NSF/CISE is particularly interested in cross-disciplinary challenges that will drive requirements in a variety of research fields, but that are rooted in, or rely upon, advances in semiconductor and microelectronic technology.

Question 2 (*300 words*) – Educational Issues: Describe your current educational situation relative to semiconductor, micro- and nano-electronics. What classes does your department/organization teach? What are the challenges moving forward in terms of education (such as enrollment or diversity challenges, access to fabrication facilities, detailed simulation data, design kits, intellectual property, EDA tools, or data sets)?

Question 3 (*300 words*) – Infrastructure and capabilities needed for research: Describe any limitations or absence of existing semiconductor and microelectronic facilities, or capabilities

and services and/or specific technical and capacity advances needed in this area (such as access to fabrication facilities, detailed simulation data, design kits, intellectual property, access to advanced technologies, EDA tools, or data sets) that would be required or desired to advance this research.

> **Question 3.1** (*200 words*) – If your answers involve specific semiconductor or microelectronic technologies, please let us know what those are, and be as specific as possible (e.g., semiconductor technology, feature size, die size, processing requirements, packaging, specific foundries, turn-around time, or expected annual cost). If your needs are more for leading-edge semiconductor fabrication facilities, or more for CMOS+X (i.e., integration of Complementary Metal Oxide Semiconductor with beyond-Moore's-Law technologies denoted by "X"), list the specific ("X") technologies in which you may be interested.
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> **Question 3.2** (*200 words*) – If you have experience with international collaborations specifically involving semiconductor or microelectronic technologies, please let us know what those are, and how they are different or unique from domestic partnerships or facilities. What are the challenges and/or benefits of international collaborations in this space?

Question 4 (*300 words*) – New research agenda: Please describe what new research would be enabled if you had access to the leading-edge infrastructure described in Question 3.

Question 5 (*300 words*) – Facility access: How might existing facilities to which you may have access be augmented to address any further needs? Please note tools or processes that could be housed in an open-access facility.

> **Question 5.1** (*200 words*) – If your answers involve specific intellectual property in this area, please let us know what that is, and be specific as possible [e.g., cell libraries, memories, input/output (I/O) systems, field-programmable-gate-array (FPGA) resources, accelerators, simulation data, data sets, or execution traces].
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> **Question 5.2** (*200 words*) – If your answers involve more general connections to semiconductor and microelectronic systems, please describe how these systems are connected to and critical to the research challenges that you described previously.

Question 6 (*300 words*) – Other considerations: Please let us know of other concerns or requirements that you think are important in research that involves semiconductor or microelectronic technologies. For example, describe organizational, process, learning and workforce development, access and sustainability, and diversity issues, along with any other issues more generally relevant that NSF/CISE should consider.

To respond to this RFI, please use the official submission form available at

https://www.surveymonkey.com/r/CISERFIonSemiconductorResearchandEducation.

SUBMISSION DEADLINE

Responses must be received on or before 5:00 PM Eastern time on September 30, 2021.

For questions concerning this RFI and submission of input, please contact Sankar Basu, or Erik Brunvand, at CISE_SemiWG@nsf.gov.

Federal Register Notice: https://www.federalregister.gov/documents/2021/07/02/2021-14159/request-for-information-national-science-foundations-directorate-for-computer-information-science

Sincerely,

Margaret Martonosi
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