Public Meeting of the

President's Council of Advisors on Science and Technology (PCAST)

September 7, 2022

Meeting Minutes

MEETING PARTICIPANTS

PCAST MEMBERS

1. Frances Arnold, Co-Chair
2. Francis Collins, Co-Chair
3. Maria T. Zuber, Co-Chair
4. Dan E. Arvizu
5. Dennis Assanis
6. John Banovetz
7. Ash Carter
8. Frances Colón
9. Lisa A. Cooper
10. John O. Dabiri
11. William Dally
12. Sue Desmond-Hellmann
13. Inez Fung
14. Andrea Goldsmith
15. Laura H. Greene
16. Paula Hammond
17. Eric Horvitz
18. Joe Kiani
19. Jon Levin
20. Steve Pacala
21. Saul Perlmutter
22. William Press
23. Penny Pritzker
24. Jennifer Richeson
25. Vicki Sato
26. Lisa Su
27. Kathryn Sullivan
28. Terence Tao
29. Phil Venables
30. Catherine Woteki

PCAST STAFF

1. Lara Campbell, Executive Director
2. Reba Bandyopadhyay, Deputy Executive Director
3. Sarah Domnitz, Principal Deputy Executive Director and PCAST Designated Federal Officer
4. Kevin Johnstun, Research Analyst

START DATE AND TIME: WEDNESDAY, SEPTEMBER 7, 2022, 11:00 A.M. EASTERN TIME

LOCATION: Virtual Meeting via Zoom.gov

WELCOME

PCAST Co-chair Maria Zuber

Maria Zuber called the meeting to order. Zuber noted that the Council voted at its July 28, 2022 meeting to release a letter addressed to President Biden that contained high-level recommendations for implementing the funds from the CHIPS and Science Act that Congress specifically appropriated for semiconductor research and development. She said that the text of the letter is available on the PCAST website, WhiteHouse.gov/PCAST, and that today's meeting would provide more information about the detailed report on revitalizing the U.S. semiconductor industry to which the letter alluded. Zuber then introduced the co-leads of the PCAST semiconductor working group: William Dally and Lisa Su.

PRESENTATION OF THE PCAST REPORT, "*REVITALIZING THE U.S. SEMICONDUCTOR ECOSYSTEM*"

Lisa Su and William Dally, PCAST Members

Lisa Su began her remarks by noting that the working group engaged with a number of different sources of expertise and thanking all who helped the working group frame their ideas. The working group included members from industry, startup companies, and academia. The purpose of the report, explained Su, was to focus on how the implementation of the CHIPS and Science Act can revitalize the nation's semiconductor ecosystem in the face of significant global competition.

Su listed key findings from the report:

- A healthy, U.S.-based semiconductor ecosystem is vital to U.S. economic prosperity and national security.
- The United States leads the world in semiconductor-related revenue. However, the nation's leadership in other aspects of semiconductor production has been declining in recent years as capabilities have been increasing in other countries, particularly in Asia. Further investment in semiconductor research and development will help the nation retain its leadership role over the long term.
- Government investment and startups have been key drivers of the semiconductor ecosystem's success.

- Bold actions are required now to invest in, develop, and implement a comprehensive strategy that rebuilds the domestic semiconductor ecosystem. The CHIPS and Science Act provides the opportunity to take such bold actions.

The PCAST report's 10 recommendations, said Su, focus on the $11 billion that Congress appropriated specifically for semiconductor research and development, including establishing the National Semiconductor and Technology Center (NSTC). Broadly speaking, the report recommends building a strong coalition to implement NSTC, one that brings together the entire U.S. semiconductor ecosystem in a public-private partnership. The report also recommends increasing the semiconductor workforce through the formation of a National Microelectronics Training Network, fostering innovation by reducing the barriers to entry for startups, and setting a national semiconductor research agenda with fundamental research and nationwide grand challenges.

The first recommendation is for the Secretary of Commerce to establish NSTC as an independent legal entity in a public-private partnership by the end of 2023. The NSTC should have a board of directors and that board should oversee both NSTC and the National Advanced Packaging Manufacturing Program (NAPMP) to ensure synergy and alignment in the investments. Board members should include broad representation from government, industry, and academia to address the concerns of the wide range of stakeholders in the U.S. semiconductor ecosystem.

The second recommendation, said Su, calls for the Secretary of Commerce to ensure that NSTC's founding charter includes establishing prototyping capabilities in a geographically distributed model. This model should encompass up to six coalitions of excellence aligned around major technical thrusts such as advanced logic; advanced memory; analog and mixed-signal; life science applications; design and methodologies; and packaging.

The third recommendation would have the Secretary of Commerce, in coordination with the Director of the National Science Foundation (NSF), support establishing a national microelectronics education and training network by the end of 2023. Su noted that NSF has significant efforts underway in this area. For this recommendation, the Secretary of Commerce would also allocate on the order of over $1 billion over the next five years to upgrade educational laboratory facilities, support curriculum development, and facilitate hiring faculty into this field. To support this network, the fourth recommendation calls for the Secretary of Commerce to ensure that NSTC-funded research will support approximately 2,500 scholarships and research assistantships per year across the educational spectrum.

Dally explained that the fifth recommendation aims to supplement efforts to grow the domestic workforce by recruiting the most talented people in the semiconductor field from around the world to the United States. It calls for the Department of Homeland Security to implement existing statutory and regulatory authorities to provide premium processing to newly filed Immigrant Petitions for employment-based, second preference advanced degree immigrants seeking a National Interest Waiver to work in microelectronics endeavors.

The goal of the sixth and seventh recommendations, said Dally, is to lower the barrier to entry for startups. In the semiconductor industry, most established companies began as startups. Currently, many startups face a major barrier to innovation because of the high level of investment needed to create a new semiconductor product. Toward that end, the sixth recommendation is for the Secretary of Commerce to ensure that by the end of 2023, NSTC creates an investment fund of some $500 million to provide financial support and in-kind access to prototyping and tools for semiconductor startups.

To help avoid the need for startups to "reinvent the wheel" for new semiconductor products, said Dally, the seventh recommendation calls for the Secretary of Commerce to ensure that NSTC establishes or funds the creation of a "chiplet" platform with a complete software stack by the end of 2025. This would enable startups and academic institutions to integrate their custom chiplet(s) with the NSTC-supported chiplet platform to demonstrate new innovations with dramatically reduced investment and time. Dally explained that a chiplet platform is an integrated circuit comprising multiple smaller chips where the common, non-innovative parts of a product, such as a memory system and input/output functions, are designed specifically so that innovators can add customizable components—chiplets—to address particular applications, performance, or functionality.

The eighth recommendation, said Dally, seeks to ensure that the innovation pipeline remains filled with new ideas. Toward that end, the recommendation calls for the Secretary of Commerce to ensure that the NSTC founding charter allocates on the order of 30 to 50 percent of its funding to a national research agenda. This research agenda, said Dally, should be broad in nature and address the following areas: materials, process, and manufacturing technologies; packaging and interconnect technologies; energy-efficient computing and domain-specific accelerators; design automation tools and methods; semiconductor and system security; and semiconductors and life sciences.

Dally said that one way to focus this research agenda is to establish a number of grand challenges. Along those lines, the ninth recommendation calls for NSTC to identify a set of nationwide grand challenges.

These grand challenges should span three complementary areas that would benefit from large-scale, nationwide collaboration: advanced computing into the zettascale era; significantly reducing design complexity; and proliferating semiconductors in life sciences applications. The zettascale grand challenge, Dally explained, would require building a computer that would be one thousand times more powerful than the exascale computer at Oak Ridge National Laboratory.

The tenth and final recommendation, said Dally, includes three actions that would improve visibility into and coordinate federal semiconductor investment efforts, measure the progress across the industry at the federal level, and maximize the leverage of such investments. The three parts of this recommendation include:

- Starting in 2023, and annually thereafter, the Networking and Information Technology Research and Development program should collate and publish annual investment figures for semiconductors across all federal agencies.
- NSTC should encourage all agencies with semiconductor research and development investments to leverage and use NSTC facilities and capabilities. NSTC should also expand and co-fund programs with other agencies and in public-private partnership where the research agendas are synergistic including, for example, the Defense Advanced Research Projects Agency's (DARPA) Electronics Resurgence Initiative, Research on the Future of Semiconductors sponsored by the Computer and Information Science and Engineering Directorate at NSF, and the Semiconductor Research Corporation's broad, multi-sector collaborations.
- The Secretary of Commerce should develop and regularly evaluate performance measures to assess progress, effectiveness, outcomes, and impact of the CHIPS and Science Act initiatives and report them annually to the President.

ZUBER MODERATED THE Q&A AND DISCUSSION WITH PCAST MEMBERS.

Zuber opened the discussion by asking Su and Dally to highlight what was new in the report that the letter to the President did not mention. Su replied that the report contains a more detailed set of recommendations compared to the high-level points in the letter. In particular, the working group is excited about the broad coalition that will be involved in the NSTC. The opportunity there, she

said, is to have a geographically diverse and experienced coalition that encompasses the entire semiconductor ecosystem. The details on workforce development, which previous PCAST discussions have identified as a high priority, create the opportunity to make a difference for the next generation of researchers. Dally added that the report also provides more details on the co-investment fund and chiplet ecosystem that should help startups, as well as on the grand challenges and research areas that the nation should pursue.

William Press (PCAST member) remarked that the broad coalition approach highlighted in the recommendations seems to anticipate that NSTC funded research will be done across a broad set of venues, including universities, industry, and perhaps the national laboratories. However, some in the semiconductor ecosystem have expressed the view that in order for research to advance manufacturing and the nation's competitiveness with China, it should be concentrated in the big players in industry and not across broad and diverse venues. Dally responded by noting that there was consensus among the working group members that a broad coalition will give the nation the best chance of having a robust research portfolio with many different ideas flourishing, rather than having research consolidated among a few large companies. The working group felt that consolidation would result in too much emphasis on fine-tuning processes and not enough emphasis on innovation. Su said she agreed and added that the working group's conversations concluded that innovation requires a continuum of research. Given the diversity of research topics, the working group strongly supported the broad coalition approach.

Andrea Goldsmith (PCAST member), a member of the semiconductor working group, added that the working group hoped that the broad collation will facilitate farther-reaching research, given that big companies tend to focus on the near term. Having a broad coalition, with people in academia working with their counterparts in industry, can facilitate far-reaching, groundbreaking research for a decade into the future.

Joe Kiani (PCAST member) commented that the report was excellent and thoughtful, with actionable recommendations. His hope is that the report will facilitate a successful future for the U.S. semiconductor ecosystem.

Jon Levin (PCAST member), who also expressed his support for the report, noted that it mentions SEMATECH, which the nation set up in the 1980s as a response to earlier threats to U.S. leadership in semiconductors. He asked Su and Dally if there were any lessons from the SEMATECH experience

from which the NSTC could learn. Su replied that NSTC is a broader effort with a much larger investment that includes a wide range of disciplines. One significant difference is that the PCAST report recommends that NSTC have a number of geographical locations and be comprised of a broad coalition. That said, Su added it will be important to ensure that there is strong leadership on the NSTC board. Dally agreed.

Dan Arvizu (PCAST member) added his support for the report. He asked how the working group approached the issue of encouraging public-private partnerships that include institutions in underserved regions of the country and that would meet the President's priorities around equity and social mobility. Dally said the report specifically called out that this effort should reach a broad range of academic institutions, including those that serve underrepresented groups, and this initiative will have to reach out and encourage those institutions to participate. Su added that workforce development should extend beyond universities and include all academic institutions, including community colleges and vocational training. In addition to upgrading facilities, which she said is clearly required and should occur across a range of academic institutions, curriculum development will be an important aspect of this initiative. The goal is to develop curricula that can be disseminated to an even broader group of institutions. Those actions, along with scholarships, fellowships, and public-private partnerships, should broaden the impact of this program and enable it to reach all of the nation's population. Zuber remarked that the microelectronics of the future will be different from the microelectronics that university programs address today. Moreover, many universities that will want to participate in this program have never had those facilities. In that regard, she asked whether the working group discussed the tradeoffs of creating centers of excellence at some universities versus building full-scale, and expensive, fabrication facilities at every institution that wanted to participate. Dally replied that the report refers to hub universities with the vision of establishing geographically distributed facilities that would be a reasonable distance from and open to anyone who wanted to conduct experiments.

Zuber then asked about potential partnerships between community colleges and companies. Su said the working group envisioned that the National Microelectronics Training Network would establish a significant curriculum for community colleges and vocational schools. Companies will contribute to the curricula and benefit from the skills that graduates of those programs would develop. It will be important to design a program that a number of academic institutions can replicate easily. Goldsmith added that community colleges are one of the nation's gems. These institutions educate the technicians and other

professionals who do not require a 4-year degree to participate in the semiconductor ecosystem. Additional strengths of community colleges are that they are geographically distributed, affordable, and can help diversify the workforce. The challenge, said Goldsmith, is that some community colleges may not have the faculty with the deep expertise to teach the needed semiconductor courses. That, she added, is something that the report's recommendations hope to remedy.

Zuber said she appreciated that the report took a broad view of what it was going to take for this effort to succeed, going beyond microelectronics fabrication in electrical engineering departments to include disciplines such as thermal physics; thermal, mechanical, and chemical engineering; and materials. She asked how the working group envisioned getting the word out to students in those other areas to both attract talent into the semiconductor field and invigorate these other fields. Dally replied that the challenge is to make the field exciting to students, something he believes this program can do. The result, he predicted, will be to build a vibrant and diverse workforce.

Terence Tao (PCAST member) asked how working group envisioned dissemination and use of the research supported by the centers of excellence, in terms of whether researchers can publish their results in open academic journals, whether companies can use the research for proprietary purposes, and whether any of the research will be restricted because of national security implications. Dally replied that there will be a spectrum of research, from very short-term to very long-term. Long-term research should be completely open, said Dally, and as the time frame gets shorter, there may be some proprietary interests. However, the report recommends that the intellectual property generated by the NSTC should be shared through a reasonable licensing agreement to prevent creating barriers to progress. The working group did not focus on whether any of the research would be aimed specifically at national security needs, but if so, then it would follow the bounds associated with that area. Su added that other government agencies should be able to use NSTC facilities, so, for example, Department of Defense or DARPA programs could use these facilities. Zuber then commented that the objective is that in the academic ecosystem, anything done as part of a student's research project would be open for publication. However, if this effort is successful, there may be discoveries that have national security implications, in which case there are well-established pathways to classify those discoveries. Nonetheless, it is in the best interests of the nation for students to be able to publish openly in journals and present their work at conferences.

Zuber then asked for a motion to approve the report. A PCAST member made that motion, and two PCAST members seconded the motion. By voice vote, PCAST approved the report.

PUBLIC COMMENT

Andrew Reamer, George Washington University, provided two minutes of public comments.

CLOSING COMMENTS

Zuber thanked Reamer for his comments and PCAST members for their deliberations on the report. She noted that the report would now be formatted and copyedited before it is released in the coming weeks. When released, the report would be available on the PCAST website, along with a recording of this meeting and the slides that Su and Dally presented. She added that PCAST's next public meeting would be on Wednesday, September 21, 2022. More information would be available in the coming days on the PCAST website.

MEETING ADJOURNED: 11:40 A.M. Eastern Time

I hereby certify that, to the best of my knowledge, the foregoing minutes are accurate and complete.

Frances Arnold, Ph.D.
Co-Chair
President's Council of Advisors on Science and Technology

Maria Zuber, Ph.D.
Co-Chair
President's Council of Advisors on Science and Technology