Industrial Advisory Committee (IAC)
Meeting Summary
National Institute of Standards and Technology (NIST)
Gaithersburg, Maryland
(Virtual)
February 7, 2023

Advisory Committee Members:

Michael Splinter, Chair	General Partner, MRS Business and Technology Advisors
Susan Feindt, Vice-Chair	Fellow, Analog Devices Inc.
James Ang	Pacific Northwest National Laboratory
Daniel Armbrust	Silicon Catalyst
Susie Armstrong	Engineering Qualcomm
Ahmad Reza Shaikh Bahai	Texas Instruments
William Chappell	Microsoft
Michael Fritze	Potomac Institute for Policy
Charles Gray	Ford Motor Company
Carol Handwerker	Purdue University
Deirdre Hanford	Synopsys
Rajarao Jammy	MITRE Ingenuity
Kenneth Joyce	Brewer Science
Ann Kelleher	Intel Corporation
Mukesh Khare	IBM
Meredith LaBeau	Calumet Electronics
Tsu-Jae King Liu	University of California Berkeley
Omkaram Nalamasu	Applied Materials
Debo Olaosebikan	Kepler Computing Inc.
Alexander Oscilowski	TEL Technology Center America
Willy Chao-Wei Shih	Harvard Business School
Brandon Tucker	Washtenaw Community College
Hon-Sum Philip Wong	Stanford University
Anthony Yen	ASML

NIST Leadership:

Laurie Locascio	Under Secretary of Commerce for Standards and Technology Director, NIST
James Olthoff	Associate Director for Laboratory Programs (ADLP)
Mojdeh Bahar	Associate Director for Innovation & Industry Services (ADIIS)
Delwin Brockett	Associate Director for Management Resources (ADMR)
Jason Boehm	Chief of Staff

NIST Presenters (listed in alphabetical order):

Eric Lin	Interim CHIPS R&D Director

Non-NIST Presenters (listed in alphabetical order):

Dan Armbrust	R&D Working Group Chair, Silicon Catalyst
Deirdre Hanford	Organized and Public & Private Partnerships Working Group Chair, Synopsys
Tsu-Jae King Liu	Workforce Working Group Chair, University of California Berkeley

I. Call to Order and Opening Remarks

Mr. Benjamin Davis and Ms. Tamiko Ford, both serving as the Designated Federal Officer (DFO), called the meeting to order and took roll call of the Committee members. All members were present and accounted for.

Mr. Davis announced a Committee session consensus will be taken for every recommendation. The consensus for each recommendation will be duly considered by NIST and the DOC, but implementing the recommendation is not required. Members can abstain. Comments are limited to two per committee member, to account for time.

Mr. Davis then reviewed the agenda and introduced the IAC Committee Chair, Michael Splinter.

II. IAC Welcome and Opening Remarks

Mr. Splinter welcomed the Committee to the second public meeting for the IAC Committee and welcomed the non-committee work members and all those who attended to observe the recommendations. Mr. Splinter acknowledged all team members for their dedication and time. Each team member has a full-time job but is putting in countless hours. He stated that the Committee will be hearing from the three working groups, Creating Helpful Incentives to Produce Semiconductors (CHIPS) R&D Working Group, Organizational and Public & Private Partnerships (PPP) Working Group, and Workforce Working Group. Mr. Splinter stated each of these teams has been working hard, understanding the work, then formulating recommendations on how to move forward. Today the committee will hear the first recommendations.

Mr. Splinter acknowledged much work is to be done. He stated that NIST and DOC believe the recommendations are foundational to setting up the National Semiconductor Technology Center (NSTC) and to building the workforce for these endeavors. Mr. Splinter stated he wants to encourage open discussion and will ask all committee members to limit the time for questions and answers to two minutes to allow for enrichment of all work. Mr. Splinter then turned to Ms. Susan Feindt. Ms. Feindt welcomed everyone but was cut off by technical difficulties. She shortly returned and stated she was looking forward to having constructive conversation. Ms. Feindt thanked everyone for their time and effort.

Mr. Splinter then turned the meeting over to Director of NIST and Under Secretary of Commerce for Standards and Technology, Dr. Laurie Locascio.

III. DOC Welcome Remarks

Dr. Locascio welcomed all members and attendees. Dr. Locascio recapped that since last fall IAC members have been donating their time to creating recommendations, and the reports represent ingenuity and creativity. Dr. Locascio stated Dr. Eric Lin will provide an update, then recapped that NSTC will serve as the center for all prototyping and manufacturing for the entire sector. Dr. Locascio stated the CHIPS R&D Office will release a white paper outlining the NSTC strategy and will be available at CHIPS.gov. The CHIPS R&D team has also been building a vision for the National Advanced Packaging Manufacturing Program (NAPMP),

which will be closely integrated and aligned with the NSTC. She further stated that the Manufacturing USA Group has finished their analysis of the comments that they received in response to the October 2022 Request for Information, and a summary of those comments will be available in March 2023.

Dr. Locascio added CHIPS is designed to facilitate the continued development of the semiconductor industry and increase security and productiveness within the industry. Funding opportunities are anticipated to begin in spring and fall 2023. The timeline of funding opportunities will allow for fair and transparent opportunities. The funding will be released in phases. Dr. Locascio stated she is delighted with many of the upcoming updates and is looking forward to hearing from the community and the semiconductor industry.

IV. CHIPS R&D Update

Mr. Davis turned the meeting over to Dr. Eric Lin. Dr. Lin thanked the Committee, and stated this would be an exciting update. Mr. Lin again thanked all members of the R&D Working Groups and the leads in supporting this very important work. The Committee is deeply grateful for the provided recommendations. First, Dr. Lin went over R&D progress and outlines. He stated the work of the industry and of the committee from December to now was greatly appreciated. Dr. Lin stated the work came in three major parts:

- US technology leadership**:** To ensure NIST helps in making the semiconductor ecosystem more efficient, but also in choosing and collecting problems that will set the pace.
- Accelerating ideas to the market**:** A thriving ecosystem focused on getting the best ideas to commercial scale as quickly and cost effectively as possible.
- Development of talent: To create the next generation of skilled labor.

Dr. Lin then illustrated the primary programs for Research and Development: NSTC, NAPMP, Manufacturing USA Institute(s), and Metrology R&D through NIST. He added that the primary goal was to strengthen and advance U.S. leadership in R&D. In addition, the R&D programs are an integrated ecosystem that drives innovation, and these programs will be in close partnership with industry, academia, the government, and allies. Dr. Lin stated that the R&D Working Group were taking a strategic view of R&D infrastructure, participant value proposition, and technology focus areas. Finally, all of these programs are informed by the IAC and highly value the input the Committee offers.

Dr. Lin then discussed the program development approach:

- Build a national scale: Pursuing and developing an innovation ecosystem, building and connecting programs in stages, investing in interfaces, and investing in people. Dr. Lin acknowledged this is a great challenge and the CHIPS R&D office is working to fill key gaps and avoid duplication of effort and redundancy of ideas. Dr. Lin articulated the value of leveraging existing programs such as the Department of Defense (DoD) Microelectronics Commons, to aid in building an ecosystem.
- Build out the stages of the ecosystem: Enable quick movement and adjustment over

time. This would allow for the strategic creation of programs to tackle challenges. Dr. Lin described a need to invest at the interfaces between programs and create connecting points between programs.

- Develop talent: The CHIPS R&D programs must provide the support to make this happen.

Dr. Lin illustrated a high-level overview of the timeline. The NSTC is the most important part, delivering the white paper that outlines the program and the NSTC in quarter one. Quarters two and three would focus on building out the program while other, parallel programs are being built. This will ensure these other programs are well aligned. The NAPMP outline will be in quarter two. Dr. Lin stated the Manufacturing USA Request for Information (RFI) submissions should be ready by the end of quarter one, then topics will be selected, and the proposals process will begin starting in quarter two. Metrology R&D internal developments and investments will occur in quarter one and programs will begin in earnest in quarter two.

Dr. Lin stated the white paper is a starting point and will guide all actions, enabling parallel work. He then briefly summarized the program for new attendees. Dr. Lin then restated the NSTC goals:

- Vison: The vision will serve as the focal point for research and a public-private consortium. The vision includes an outline with elements focusing on research and engineering for challenging projects with a horizon of five years. The NSTC will serve as a key convening body for the ecosystem.
- National Advanced Packaging Manufacturing Program: Using a wide range of technologies, strengthen semiconductor advanced test, assembly, and packaging capability. Create an R&D environment advancing state-of-the-art developments in advanced packaging, and ecosystem support to bolster domestic growth. Dr. Lin showed some illustrated examples from RFI options.
- Manufacturing USA Institute(s): Up to three new public-private partnership institutes in the Manufacturing USA Network. Opportunity to integrate the Manufacturing USA Network with the CHIPS R&D Network. The Manufacturing USA Institute is looking into what new manufacturing technologies could be deployed.
- RFI: Four webinars closed at the end of the calendar year and are being compiled into a report. Dr. Lin stated that CHIPS R&D is excited to see such great interest and is looking forward to launching more programs in the future.

Dr. Lin also stated the CHIPS Metrology R&D Measurements on Standards report is available for download on CHIPS.gov.

Dr. Lin also announced Dr. Maria L. Dowell, currently Director of the Communication Technology Lab (CTL), has been named director of the NIST Metrology department. Dr. Dowell is a fellow of the Society of Photo-Optical Instrumentation Engineers (SPIE) and SPIE Women in Optics. Her appointment is pending Department of Commerce (DOC) approval.

Dr. Lin also gave an interagency coordination update, including information about the impact of CHIPS R&D, working closely with the DoD, the Nation Science Foundation (NSF), the

Department of Energy (DOE), and others. CHIPS R&D is working on frameworks at different levels. Dr. Lin highlighted the value of departmental agreements with common language, as well as mechanisms to reduce the time different organizations spend working together. CHIPS R&D plans on creating unified messaging on agency roles and responsibilities, program coordination across agencies, intellectual property (IP) and unique capability access across agencies, and exciting and fluid partnerships with other agencies. These efforts will create fluid partnerships with federally funded institutions and are all challenges for driving the ecosystem. Lots of exciting progress is being made across the government.

Dr. Lin stated the next steps NSTC white paper and additional steps will be shared in quarter one. Dr. Lin directed meeting participants to visit CHIPS.gov for more information.

Questions and Remarks:
Q. Question on interagency chart: does IP need greater explanation across agencies?
A. Dr. Lin stated this is still a work in progress. One of the challenges is identifying the common libraries to be used and creating an NSTC environment where there is access to shared IP.

Q. How does coordination with DOC work and what would that look like?
A. A steering committee is responsible for answering this question. An interagency collaboration in NIST will be composed between programs with individuals to ensure coordination and to ensure agency level of understanding.

V. [R&D Working Group Update](#)

Mr. Davis turned the meeting over to Dan Armbrust, the R&D Working Group Chair from Silicon Catalyst. Mr. Armbrust stated the R&D Working Group has been productively working after a 90-day sprint. He stated he is excited to provide recommendations and acknowledged the working group members and the valued support from NIST. He stated the team represented a variety of responsibilities, ranging from government agencies, commercial industries, manufacturing, and design. This allowed a great deal of experience to be brought to bear. Mr. Armbrust briefly summarized what the R&D Working Group has been up to and stated there are three recommendations to address today.

Mr. Armbrust first discussed the working group's examination of gaps and priorities for the CHIPS Act, to charter strategic long-term research needs as a whole. Mr. Armbrust stated this 90-day sprint consisted of a series of meetings, which included over 95 percent participation. The group focused on deliberations and outside work to feed working group meetings. Mr. Armbrust asked every member to assemble their point of view regarding challenges. He added that the working group has worked hard to integrate those viewpoints. As part of the process, the working group broke out into several teams to further partition the work. This allowed the team to draft recommendations and a narrative to the IAC. Mr. Armbrust brought recommendations for deliberation, which will benefit work across organizations in the R&D landscape. The teams were able to comment often on the work and various stakeholders from the DoD, DOE, NIST, DOC, the U.S. Trustee Program (USTP), the Federal Aviation Administration (FAA), and the Semiconductor Research Corporation (SRC) were also able to

comment during contemplation. The working group contacted subject matter experts to opine on their field, including grand research challenges and their points of view on recommendations. Mr. Armbrust acknowledged and thanked all individuals for taking this task seriously.

Mr. Armbrust focused on chartered members, compiled four main questions that drove output, synthesized all information, and further explained the three smaller working groups focused on questions that needed to be addressed. Mr. Armbrust briefly summarized:

- 90-day sprint: The working group reviewed 15 R&D topics, created an overarching vision, achieved a consensus, defined an ecosystem, identified measures of success, and prepared recommendations. Mr. Armbrust acknowledged there are some challenges that still need to be resolved and raised the questions of how to prioritize grand challenges and how to execute the overall mission of NSTC/NAPMP.
- Demonstrated R&D gaps working group framework: The framework set an overall vision and Mr. Armbrust stated they needed to narrow its scope. This guided challenge led to the first recommendation about capabilities. The second recommendation relates to applying grand challenges. The third recommendation involves the measures of success. Mr. Armbrust presented a visual to help with recommendations.
- Gaps vision: Mr. Armbrust stated this led to a drive for efficiency and a sustainable planet in the semiconductor industry. Mr. Armbrust stated energy consumption is a significant problem. He added the semiconductor industry should point to efforts that need to be broadened and democratized access would ensure innovation. Mr. Armbrust added numerous barriers need to be addressed and the Committee must supercharge the semiconductor system with innovation through an open chiplet platform.
- Context: Mr. Armbrust stated the semiconductor industry is a vast space. Some of the most difficult parts are the unknown. He stated that the Committee should listen to what is communicated and the concerns from the R&D space, the chosen efforts, and the efforts of the working groups. Mr. Armbrust presented graphs showing the direct effects of the semiconductor industry. He showed on the graph's Z axis that doubling the transistor count was over 11 orders of magnitude, and today, most chips have thousands of connectors. Today the industry is limited by the size of theocraticals. Mr. Armbrust stated that to continue in this industry, billions of transistors will exist on a chip. Half a billion dollars in investments would be needed to achieve this. The Committee needs to learn innovate is necessary to utilize all the transistors through Moore's Law. Mr. Armbrust stated everyone was looking to achieve system performance. He pointed out the industry acts as a single chip working monolithically and stated there is a need to create a chiplet level.
- Finale: Mr. Armbrust stated the vision's goal is monolithic integration, which is needed to achieve success. Mr. Armbrust returned to the chart, discussing the Z axis and looking at utilizing the transistors consistently. He stated artificial intelligence (AI) shows a massive parallelism with the appropriate software stack. The result of these parallels is a decade of improving packaging, which has led to improving text and transforming 2 million parameters. He used ChatGPT as an example of the fastest adoption of technology. ChatGPT gained over a million users over a few months. This can be done to leverage transistor development, drive improvements, and address grand challenges.

Mr. Armbrust briefly listed three recommendations:

- Recommendation 1: Establish easily accessible prototyping, further look into innovation in AI, and create a bridge out of the research and into the commercial space. Create a semiverse digital twin, including testing and prototyping. To establish a chiplet ecosystem, we need to develop capabilities, including manufacturing capabilities; build an accessible platform for chip design; and treat 3D as an intrinsic assumption. These efforts will create a nurturing ecosystem for promising startups.
- Recommendation 2: Identify a small number of applications driven by grand challenges to inspire innovation across the computing stack, which spans fundamental materials. The working group came to a consensus on three grand challenges.
  - First is improving computing energy efficiency. To achieve this, we need to leverage domain and innovations. There are two broad categories: a data center and Internet of Things (IOT), data constrained. CHIPS platforms need to be zero emissions and sustainable. Recommendations on applying manufacturing must apply to the grand challenges. While recommendations were initially vertically applied, they are now horizontal, allowing for stakeholders to be united around goals.
  - Second, we need to practice using a fly wheel to continually intake feedback and spur innovation.
  - Third point is to prioritize new innovations in wireless, life sciences, and autonomous systems via multi-modal and "intelligent" sensing-to-action with integrated, decision-making AI and 100x lower energy and cost for ubiquitous application. Mr. Armbrust recognized prioritizing new innovations is difficult. In essence, these are startups, which need to get started, gain experience, then scale up. The reason for the great challenge is the stakeholders that need to weigh in are often different from the usual and are often not practiced in helping others. It is crucial to gather details including information about the appropriate pre-competition? We need to build our playbook over time.
- Recommendation 3: The CHIPS Act must be relevant to the contributions of stakeholders and a scorecard must be built periodically, through qualified metrics. This is the job of the DOC, executives, and other agencies. Mr. Armbrust suggested success metrics: capabilities, applications and overall R&D programs. Mr. Armbrust stressed the Committee should want to measure an effective and functional ecosystem, and generating an ecosystem being funded by the licensing of IP developed by the CHIPS Act R&D programs as well as valuations, which are non-cash, and returns from investment capital for the startup portfolio. Applications will drive fundamental breakthroughs. He stated he was not advocating for building electronic systems, which would be unethical and unaffordable. Instead, Mr. Armbrust suggested building test vehicles and minimum viable products (MVPs). There is a subset of work focused on building product-consistent companies. Programs may be canceled, which may indicate a lack of feedback, as well as measuring revenue screens using developed IP and the evaluations of investment capital.

Mr. Armbrust then moved to deliberations. Mr. Davis reserved five minutes for deliberations.

Mr. Davis tuned to Mr. Splinter to mediate and begin.

Questions and Remarks:
Mr. Splinter asked members to clarify what section they wanted to ask about.

Committee comment: A committee member thanked Mr. Armbrust for a great amount of deep thought to process. Mr. Armbrust presented interesting synergies, specifically in recommendation one. They stated many early discussions on technology readiness level (TRL) prototyping are occurring.

Q. Please clarify TRL prototyping levels?
A. In general, there is an element of research. The R&D Working Group were concerned with demonstrating the levels. The prototyping level ends when there is proof there is something here that could be driven into commercial. TRL 3 to TRL 6 or 7. Transitional work must be conducted with stakeholders; even in a competitive space, mutual spaces are considered okay. Mr. Armbrust stated they focused on building confidence and working intimately with the supply chain is essential.

Q. Question about ecosystem; excited for chiplets. How deep was the dive into the ecosystem? Was there thought on how to address the issues within the ecosystem as a whole?
A. It would misrepresent the group to state they focused on that. Guest speakers and teams looked more at the gaps in research.
Committee comment: Agrees with recommendation, with a highlight on how it was done.
Committee comment: NSTC has the authority to bring players together, so that every member of the supply chain can benefit. The thinking is to use that authority to make it open for the ecosystem and to encourage and supercharge partnership.
Committee comment: Agreement with prior comment, and the chip lingo system complexity is part of the challenge. We do not want the lowest common denominator.

Q. Question about recommendation two. Please elaborate on energy efficiency.
A. Mr. Armbrust agrees this is very difficult and traditional metrics of energy efficiency are skewed. We need to make gains on this, plus supplementation. Even on stacked and 3D levels, issues exist.
Committee comment: The approach to domain-specific acceleration is creating great improvements in energy efficiency and co-design opportunities, creating new generations. This improvement is not in a vacuum and would benefit from the 3D and packaging opportunity. Another comment was about interagency cooperation. With respect to our second recommendation, we did not want a long list, but an example. The interagency grand challenges will be application drivers for the ecosystem that NIST is establishing and will bring prototyping to the next level.
Committee comment: Jim's comment was highlighted in presentation, the gaps in the ecosystems and only government agencies have the capability to meet these grand challenges.

Q. When you talk about the semiverse and digital modeling, was apre-competitive approach discussed?

A. We think about the very fact that we will be standing up and building on those tools. We need to balance the proprietary nature of the tools. We can practice and build the semiverse to teach us what matters and what does not. A semiconductor is around 3 millimeters. We need to discover what to collect and what minimum capabilities are possible. We may have lost some of those roots. In a tool, in a fab, a proof of concept is where it matters first. We start in a prone way, use the playbook, and put tools into competitive spaces.

Committee comment: Thinking about the semi-twin. The NSTC provides an important capability by being a government-funded agency. The NSTC can collect data and make it available to stakeholders. One of the keys to moving forward is the lack of data; a physical structure allows for us to collect data and utilize it. This capability is truly unique, as companies cannot use this.

Q. What do the facilities look like? It seems that still needs to be thought about.

A. All NSTC facilities will be available to the public.

Committee comment: Each part of the stack, and sectors, needs to be utilized in tandem with all other factors to bring a bigger picture. This cooperation is not easy, but as more technology develops, it will be more expensive to prototype.

Q. Thanked Mr. Armbrust and his team. The recommendations do not include AI. Why wasn't there an AI callout in the recommendations?

A. AI is becoming ubiquitous. Deep neural networks are just a dot on the map. AI is extremely relevant and the recommendations do not call it out because specific AI will be pulled in. AI has to be called out because of the huge economic cost. An individual train model is hardware limited. It falls on the ecosystem to create hard work and dedication to sustain these advances. The recommendations are looking at a fundamental level.

Committee comment: AI is in application and is enabling technology for improved computing.

Q. NSTC needs to be engaged beyond the pre-competitive. Where will NSTC operate in this?

A. Mr. Armbrust sees the great value of all companies having access. Understanding distinctions will help in dealing with IP.

Q. You did not put a similar metric on speed. What were the Committee's thoughts on speed?

A. Looking at the cycle of time as well as the progression of the projects, we are looking at the ability to determine results and the extraction level. We very much think it is the speed of getting results. This results in further funding needs, and the speed of response is becoming important.

Q. Question regarding recommendation one: What are the prototyping facilities? Will the facility be one of the grand challenges, and what is needed?

A. Mr. Armbrust handed this question over to the team because there is no way to discuss

systems without discussing facilities. The team talked about the necessity of sources, electronics, and chiplets. Chiplets allow for a combination of these elements, but in the early days, the Committee needed to acknowledge limitations.

A. Additionally, the capabilities we come up with here will benefit an application space and benefit the entire industry. Perhaps some capabilities were missed, but those are the ones that have been developed for now.

Mr. Splinter thanked the presenters and moved the meeting toward voting on recommendations. Mr. Davis discussed the process of voting on recommendations. If a member is opposed or in favor, they may vote through the chat and or through raising a hand. Anyone not opposed or abstaining, will be counted as a vote in favor.

Consensus Vote:
Recommendation 1: 0 Opposed
Recommendation 2: 0 Opposed
Recommendation 3: 0 Opposed

There was a full consensus and the recommendations have been passed by the IAC.

The meeting broke for lunch and reconvened at 12:35 pm ET.

VI. Organizational and PPP Working Group Update

Mr. Davis turned the meeting over to Ms. Deirdre Hanford, the chair of the Organized and PPP Working Group from Synopsys. Ms. Hanford thanked the IAC members and the members of the public for joining. She stated the PPP Working Group is proud to join in these working matters. The working group's composition has not changed since the last meeting, covering multiple industries. Ms. Hanford stated they were well supported by the NIST team, as it has been a sprint. In November, DOC updated the allegiance of tasks and the PPP has been focused on subjects two and four, regarding governance structure. The first charge of the working group was to deal with funding methods and PPP structures being built. They focused on subject two for the most impacted. Ms. Hanford confirmed they met all briefing meetings and ended with Dr. Gargini's lessons learned, which helped the group get organized.

The working group focused on NSTC governance. Ms. Hanford stated it was important to focus on early wins, not the importance of academia or the composition of governance. She stated another team needs to look at IP rights as the working group did not get into charges one or three. Ms. Hanford acknowledged a lot had been done, but more remained to do.

Ms. Hanford went through the NSTC type of governance, NSTC CEO profile, NSTC capabilities and value proposition, and NSTC interface with CHIPS. She stated the question is what should the NSTC be? She stated it needs to be a nimble, independent agency. She added they don't want to lock out smaller companies and are democratized. She noted requirements for NSTC must be established, including lead administration, the value of collaboration, strategies for out years, and ideas for RFI responses. Ms. Hanford acknowledged organizations

are leveraging that good work and these organizations informed the recommendations.

- NSTC entity structure recommendation 1-1: Ms. Hanford recommended the structure of a new and independent nonprofit organization. She stated the Committee should not want to encumber NSTC with existing structures. NSTC could be structured as a division or a government business, but a nonprofit structure would allow for a bold vision. The working group wants to leverage the best ideas in the company and take the opportunity to start fresh. This is up to the colleges at DOC and NIST.
- NSTC board structure recommendation 1-2: Ms. Hanford recommended a fiduciary board as an oversight. Representative boards are pulled from membership, while fiduciary boards are more for oversight and the financial and economic health of the organization. The working group wants the country to hire the best CEO out there so the board doesn't have to worry about the day-to-day. The working group feels the fiduciary board should not have member companies on board. The working group wants to empower the CEO with streamlined processes and accountability. The CEO needs to drive the agenda. The working group researched various structures, but when they looked at the challenges, they found that member boards cause too many challenges. Interuniversity Microelectronics Centre (IMEC) is a good example because it's run by a fiduciary board. A technical advisory board will help advise the CEO. The working group believes this board structure will most benefit the NSTC.
- NSTC CEO profile recommendation 2-1: Ms. Hanford recommended a highly respected executive with deep technical knowledge and a strong track record of transition and leadership experience. NSTC needs a super dynamic CEO who is passionate and willing to drive for the country. The working group doesn't want to rule out academics. Asking for a commercial individual may not be a significant issue, as there are so many icons in the industry to take on. We need to find someone who has a career runway, and the working group looks forward to someone putting more of their time into the organization. Go bold and go big! The CEO will be a global citizen. Ms. Hanford then illustrated the NSTC capabilities and value proposition. Ms. Hanford stated the NSTC vision is aligned with embracing standards. This creates resonance and the key components need to know where work is required and what the value proposition is.
- NSTC PPP organization recommendation 4-1: Ms. Hanford recommended that NSTC convert to public-private partnerships, led by an independent CEO reporting to a fiduciary board with advice from a Technical Advisory Board (TAB). This structure would utilize the CEO's applied experience and know-how. Ms. Hanford believes the NSTC CEO will have direct connections to the DOC but does not answer to them. The CEO needs to have access to be successful. Leading and convening Coalitions of Excellence (COE). DOC is developing a slate of candidates. The working group believes the CEO needs to have strong authority.
- NSTC sustainable business model recommendation 4-2: Ms. Hanford recommended that NSTC develop as a sustainable business model, with increased funding. Funding from industry is growing and large industry should want to participate. Government funding must be available. Ms. Hanford sees this mix as vital.
- From prototypes to domestic volume manufacturing recommendation 4-3: One key component is a prototyping line. The working group recommends that NSTC offer prototyping enablement. NSTC needs to take investments and needs to be able to invest

in infrastructure. Baselines and pipeline tools are needed. Prototyping must be a critical component of NSTC's activities and will create a collection of excellence.

- COE's vital role recommendation 4-4: COE will provide critical functions. Ms. Hanford recommended that NSTC be a funding mechanism for COEs. COEs must hustle and always be working. NSTC should be supporting COEs and coordinating with them.
- Partner with complementary existing centers, rather than building from scratch recommendation 4-5: Ms. Hanford recommended that NSTC partner with democracy access and business entities to emphasize building out the ecosystem and enabling infrastructure. Ms. Hanford stated this is not fully conclusive but will be if PPP has an empowered CEO and COEs. She added government funding must continue over time, allowing small enterprises to continue. NSTC will be a mechanism for COEs.
- NSTC Interface with CHIPS R&D recommendation 5b-1: Questions dictated the pace of the working group. The working group wants competition, as it builds a diversity of approaches. The working group wanted folks to be beholden to NSTC and wanted goals and successful missions. NSTC should dissuade group think and encourage out-of-the-box thinking. The CEO owns the process and is the person to get the job done. NSTC needs the best in class for this position. Oversight is expected. DOC will represent national interests and the working group hopes NSTC and DOC will communicate with each other.
- Recommendation 5b-2: The foundational structure of NSTC must foster healthy competition. Competition must apply to entities who are eligible for funding and who meet publicly stated criteria.
- Recommendation 5b-3: Ms. Hanford stated that this was a grab bag, and they weren't able to get to everything. There were some areas that the working group thought deserved focus, such as the CEO should be able to own the products and operations (P&O), hire and manage executive directors, and work and coordinate with other organizations. A deeply empowered CEO would drive capabilities. The CEO should be empowered with autonomy.

Ms. Hanford stated the Committee had clear objectives and wanted to ensure the NSTC structure was nimble, lean, and could run fast, with a fully capable academic in the lead. The Committee should be able to run quickly and provide key functions so the industry contributes revenue over the years and creates an opportunity to leverage facilities across the country. Ms. Hanford then reviewed what the working group discussed and who the CEO reports to, including close connections with government agencies. She further stated competition would be critical to successful execution and output of these programs. Though the Committee is hoping for large stakeholders, we need to ensure what is best for the country.

Ms. Hanford hoped her presentation clearly demonstrated the work had been done, and thanked all the members of the team. She stated the working group would take a week off to pause and consider the next round of challenges to address. Ms. Hanford requested questions and deliberations from the Committee.

{Presentation link here}

Mr. Splinter thanked the presenter and opened the meeting to questions.

Questions and Comments:

Q. You showed the model of the COEs, and some were shown in a different color, indicating they were coming from the NSTC and other affiliates. How do you distinguish between these two types of COE, with the understanding that industry involvement would be necessary?

A. The working group didn't want to rule out existing capability. As an example, if we had a center where we were doing great work, but I wanted to make that center public, I have to build up walls and safety mechanisms for the public to participate. If I carve out this piece, does it answer to NSTC? What's their relationship to the mothership and entity I am paying rent on? There needs to be fine tuning, but, even so, there will be a part designated for NSTC, and I would like some information from other Committee members about whether that is a good operating model. If we wanted to design a COE, there isn't an entity created for this, but this should be looked into.

Committee comment: We don't have the time and the funds to make new facilities. We are focusing more on leveraging what's there.

Committee comment: In certain aspects, this is good, as we can't afford pure carveouts. There needs to be a work through with the NSTC directors and mapping or something equivalent within the industry for the institutions who will be bringing a large capacity to the NSTC. No one in the industry wants to cleave off a part of their fab.

Committee comment: We have thought about a hub, like DoD Microelectronics Commons, that the CEO isn't executing. A possible affiliate hub.

Q. DoD Microelectronics Commons has severe foreign and national restrictions. Has the group thought of the restrictions being applied to the academics?

A. The working group didn't focus on the academics; this is something to examine further.

Committee Comment: We did look into open research and anything in the pre-competitive bend. Looking at the structure of governance as it transitions to that private mode, it allows for making things more relaxed.

Committee Comment: NSTC is supposed to cover the entire spectrum of ideas generation. Universities are vital for this and NSTC needs to allow all universities to participate fully. DoD Microelectronics Commons doesn't cover the entire space; universities are entirely blocked from usage.

Committee comment: Agreed, we need academics to be able to contribute to the industry and take information back to the university.

Committee comment: For activities in NSTC for teachers, we need to ensure these academics have longer than two years to support NSTC away from university.

Q. What is your vision with respect to NSTC or NAPMP working with other COEs?

A. We haven't gone deep into the functions. We're going to have to leverage these other labs. The specifics need to be worked out.

Q. Any overlap in roles?

A. If done well, the boards should have light overlap. The CEO needs to be looking at where money is coming from.

Q. What if the NSTC had a member board rather than a fiduciary board?

A. This could be seen as a challenge between taking the business hat off and on the board.
Committee comment: We researched IMEC and are trying to balance risk-taking versus accountability.
Committee comment: We need to leverage what we are doing, absolutely have to leverage lessons learned from IMEC.

Q. Who selects the fiduciary board? What is the process? Who is it accountable to? Independence is important, but we need to know who, how, and what would be part of the board's composition.
A. A normal board has a portfolio of individuals that understand the work being done, using a steady state. This would entail leveraging a nominating and governance process. How the board is initially set up is up to DOC. The board is accountable to the mission, determining how stakeholders are being supported, and oversight.
Committee comment: We examined many board structures, and this was the style that allowed for the best representation of all stakeholders.
Committee comment: The board will include members of academia.
Committee comment: The board will comprise citizens of the U.S. since they are footing the bill.
Committee comment: May want to take on a skills matrix to help DOC, and DOC has the responsibility to build the initial board. What you're recommending suggests we want the fiduciary board and a great deal of things to be finalized.
Committee comment: We have high risk and high payoffs; the CEO needs to be ready for high risk and reward. Fiduciary boards are more cautious and need to be more risk tolerant.
Committee comment: Need the board to enable an aggressive CEO.
Committee comment: The Technical Advisory Board (TAB) should advise the CEO, while the advisory board dictates what the CEO does.

Q. Have you had the opportunity to discuss how the industry funding is going to work over time?
A. NSTC would not be raising dues but will be contracting out services. This is part of the COE hustle. We need to think how we're maximizing this investment.
Committee comment: One of the really powerful things is research funded from proprietary interest. Once something becomes interesting, I want it for my company; I want the IP and exclusive access. Dues will be modest; there might be more proprietary interest, and companies would be willing to pay more.
Committee comment: We need to make sure NSTC does not become an R&D arm of a few large companies.
Committee comment: NSTC may impose cost sharing to create skin in the game.
Committee comment: If NSTC is so unattractive that companies don't want to be here, we failed. We must create that value here.

A. How much would the NSTC build its own capabilities? For example, for chiplet systems, it could develop an IP to license to others, which could build capital.
Q. We need to discuss further. There has to be tremendous leverage for the nation.

Consensus Vote:

Recommendations 1-1 and 1-2: 0 Opposed.
Recommendation 2-1: 0 Opposed.
Recommendations 4-1 through 4-5: 0 Opposed.
Recommendations 5b-1 through 5b-3: 0 Opposed.

A full consensus was reached, and the recommendations have been passed by the IAC.

VII. R&D Workforce Working Group: Report Out and Discussion

Mr. Davis turned the meeting to Dr. Tsu-Jae King Liu, Chair of the Workforce Working Group. Dr. King Liu acknowledged the team had been hard at work and acknowledged the various teams and members who joined and answered questions at numerous meetings. Dr. King Liu announced Carol Handwerker has joined the group and acknowledged all other new members directly.

Dr. King Liu advised that the charge for the working group has been updated, and the R&D Working Group should examine and make recommendations on manufacturing. Dr. King Liu thanked the speakers for taking the time to speak with the working group. Dr. King Liu stated educating the workforce has been difficult. Engineering degrees have dropped over the course of the last few years. The working group looked into strategies for attracting, educating, and addressing the growing talent shortage. She then went over the working group's key takeaways, findings, and recommendations.

- National Institute for Innovation and Technology (NIIT): Currently outlines competencies and skills needed for semiconductor manufacturing roles. The U.S. Census showed less than half of science, technology, engineering, and mathematics (STEM) graduates work in STEM fields. The National Academies of Sciences, Engineering, and Medicine (NASEM) recommended incorporating more experiential learning opportunities. Numerous problems are attached to lack of early interventions. Learn and earn programs work better, and the most helpful interventions are faculty mentorships.
- The working group interviewed leaders of workforce development (WFD) programs. Lorain and Purdue utilize learn and earn programs to promote students in STEM. The working group looked at numerous higher learning environments for the more successful programs to find out what attracted students and retained them more effectively. Elements that attract and retain students include online videos and in person and package technologies.

Dr. King Liu stated the American Semiconductor Academy proposed a scale of broad access to NSTC, including stakeholders in schools, to increase awareness and promote a sustainable culture of diversity, equity, and inclusion. Dr. King Liu suggested the National Nanotechnology Coordinated Infrastructure (NNCI) is a possible location to leverage for facilities. NNCI is an excellent framework.

Dr. King Liu summarized that microelectronics education is locked in small silos, with little sharing of information and courses. Dr. King Liu also stated companies have been lightly involved and the depth and breadth of careers within the industry needs to be emphasized at the

K-12 levels. She also discussed centralized mapping of existing WFD programs and capabilities to the workforce. The effectiveness of WFD programs is ensured by the guiding principles of strategic investments by DOC. Both new and existing programs should coordinate efforts.

- Recommendation 1: The CHIPS R&D programs should foster a strong, coordinated, inclusive workforce development and training program to address the WFD needs across the microelectronics ecosystem.
- Recommendation 2: The CHIPS R&D Program Office (PO) should work in conjunction with its component R&D programs to define metrics by which the success of semiconductor microelectronics WFD programs are measured and to support the mapping of existing programs and the assessment of their effectiveness to guide new investments in existing and new WFD programs and infrastructure.
- Recommendation 3: All post-secondary educational institutions which receive funding through CHIPS R&D programs should be incentivized. The National Network for Microelectronics Education should transcend winners and losers and should be all-inclusive and non-competitive. The American Semiconductor Academy (ASA) initiative published a vision paper that addresses these requirements. The National Network for Microelectronics Education will be expected to facilitate access. Participants should also develop, implement, and assess new pedagogical approaches.
- Recommendation 4: DOC should support coordinated efforts to increase awareness and excitement in K-12 and should utilize comprehensive engineering training and experimental microelectronics education for a whole-of-state approach. Mentorship programs are very effective for women and underrepresented communities in STEM.

{Presentation link here}

Further work will include weekly meetings. Topics of future discussion include programs to motivate and support a greater diversity of students to pursue STEM.

Questions and Comments:
Dr. King Liu moved things over to Mr. Davis, who moved to Mr. Splinter to moderate.

Q. How do we think of recommendations for the three parallel efforts of the CHIPS Act?
A. The CHIPS Act helps build the network; we are recommending that DOC leverage that network in close collaboration. We are committed to preventing a duplication of efforts. Committee comment: Taking a holistic view may be very useful and DOC and DoD should help with this.

Q. STEM topics are intimidating, and this is very true at different levels. How do we train the trainers? Is there a way to establish a national database?
A. It is difficult to track the various gaps. The jobs fall into multiple categories and are hard to track. Where can we invest our resources? It is good to assess effective programs. In terms of mentorship, if we want to increase diversity, we need to build a base for these mentors, empowering them and creating self-efficacy. We not only pair students with mentors but also develop students to become mentors. We teach the teachers that these programs help teachers.

Q. Question about recommendations: Should the COE be required to award internships and allow students to continue research in their COEs?
A. It is included already but will be made more available.
Committee comment: Experimental learning should take over internships and apprenticeships.

Q. How do you address a trade shortage?
A. That's the next level of research, which will explore how to pull in the trades more.
Committee comment: We have heard from companies, which need people who can do all the duties from day one. Who is going to take over that technology gap? Some companies have six-month training programs. There are a lot of different components we need to sort through. We need to make sure the companies know.
Committee comment: The U.S. has always been a magnet for global talent. If 50 percent of students graduating are foreign born, maybe there is an element of an immigration policy.

Q. Will this workforce development be part of the CEO's mission, or independent?
A. More work will be done to connect the two. The answer should be yes.

Q. How are we looking at the AI impact, and are we looking away from automation?
A. Looking at rescaling and upscaling if we have a pathway for folks to move into automation of the microelectronics industries. We want to leverage those AI tools.
Committee comment: Computer science shows it is cheap to build things. Access to computer science and NSTC allows K-12 young people to build on their own. Many people get into computer science because they can start a startup. This is not the same for semiconductors.
Committee comment: Thank you for your input. The working group will look into this topic.

Consensus Vote:
Recommendation 1: 0 Opposed
Recommendation 2: 0 Opposed
Recommendation 3: 0 Opposed
Recommendation 4: 0 Opposed

A full consensus was reached, and the recommendations have been passed by the IAC.

VIII. Public Comment Period

Mr. Davis discussed the public comment period. He stated the questions and responses document will be posted on NIST.gov and noted this is still open to the public.

IX.   Summary Remarks and Next Steps

Dr. Locascio thanked everyone and encouraged them to think big and push. Everyone provided excellent recommendations, empowerments, and recommendations on developing independent systems. Dr. Locascio mentioned how much time and thought has been put into this. Dr. Locascio stated this work is being done for the best of the best of the country and that this group will be doing work for years to come. She added these recommendations are key for implementing the CHIPS Act in 2023. This program is one of the most ambitious. This is an incredible moment in time and an extraordinary opportunity. Dr. Locascio thanked the

participants once more for their attendance and their hard work.

X. Adjournment

Mr. Davis stated all presentations will be on CHIPS.gov, and a poll will be released to discuss the next meeting, likely to occur in May or June 2023.

Mr. Benjamin Davis adjourned the meeting at 2:47 pm ET.