Industrial Advisory Committee (IAC)
Meeting Summary
Mayflower Hotel
Washington, D.C.
(In-Person/Virtual)
June 6, 2023

Advisory Committee Members:

Michael Splinter, Chair	MRS Business and Technology Advisors
Susan Feindt, Vice-Chair	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 (absent)	Ford Motor Company
Carol Handwerker	Purdue University
Deirdre Hanford	Synopsys
Rajarao Jammy	MITRE Engenuity
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 (absent)	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
Charles Romine	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):

Ben Davis	Designated Federal Officer of the IAC
Eric Lin	Interim and Deputy Director CHIPS R&D
Laurie Locascio	Under Secretary of Commerce for Standards and Technology Director, NIST

Non-NIST Presenters (listed in alphabetical order):

Dan Armbrust	R&D Working Group Chair, Silicon Catalyst
Deirdre Hanford	Organization and Public & Private Partnerships Working Group Chair, Synopsys
Lisa Friedersdorf	Assistant Director for Microelectronics, Materials, and Critical Minerals, Office of Science and Technology Policy
Barry Johnson	Assistant Director for Microelectronics Materials, and Critical Minerals, National Science Foundation (NSF)
Ann Kelleher	Executive Vice President, General Manager, Technology Development, Intel Corporation
Andrew Schwartz	Division Director, Material Sciences and Engineering Division Basic Energy Sciences, Office of Science Department of Energy
Willy Shih	Sequencing Working Group Chair, Harvard Business School
Alison Smith	Microelectronics Commons Technical Director, Office of the Under Secretary of Defense for Research and Engineering
Dr. Tsu-Jae King Liu	Workforce Working Group Chair, University of California Berkeley

I. Call to Order and Opening Remarks

Mr. Benjamin Davis, serving as the Designated Federal Officer (DFO), Ms. Tamiko Ford being absent, called the meeting to order. Mr. Davis stated that the Committee would receive recommendations and vote for consensus after each presentation. A two-thirds majority vote would be considered a consensus, and Mr. Davis advised that neither the DOC or NIST is obligated to implement the recommendations made by the IAC. Mr. Davis then took roll call of the Committee members. After the roll call, Charles Gray and Omkaram Nalamasu were listed as absent from the meeting.

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

II. IAC Welcome and Opening Remarks

Mr. Splinter welcomed the Committee members and colleagues of the working groups. He also welcomed those attending in person and online. He stated that the Committee has come together over the last nine months to create remarkable recommendations for the National Semiconductor Technology Center (NSTC) and the National Advanced Packaging Manufacturing Program (NAPMP). He acknowledged that the Committee is taking in the serious impact of the work for the country, industry, and the world. The Committee members and working groups have spent countless hours honing their ideas to make meaningful recommendations and using their knowledge to tackle challenges faced by the Secretary and the Department of Commerce (DOC). The working groups have had numerous presentations on numerous topics to expand their expertise.

Mr. Splinter further reviewed how the charges were divided into four working groups, three of them continuing since their formation. The groups were R&D Gaps, led by Mr. Dan Armbrust; Organization and Public and Private Partnerships (PPP), led by Ms. Deirdre Hanford; the Workforce R&D Working Group led by Dr. King Liu; and the Sequence Working Group, a new combined group formed with members from the R&D Gaps and Organizational and PPP working groups, led by Dr. Philip Wong and Dr. Willy Shih. The last group had to pull double shifts and stated that all the groups had to get all this work done along with their regular full-time jobs. Mr. Splinter also thanked the Secretary and the members of Congress. Though not all recommendations will be implemented, the hope is to build a stronger future.

Mr. Splinter stated there is less time after every presentation than wanted for additional interchange. Mr. Splinter went over the etiquette for the meeting and said the etiquette would allow the speakers to move smoothly. Mr. Splinter then turned the meeting over to Mrs. Susan Feindt.

Mrs. Feindt thanked and welcomed all Committee members. She reiterated that all members of the IAC, and those outside the Committee, have been working very hard. Mrs. Feindt stated that the summary presentations were compiled from numerous entities and hours of conversations. She also said that despite many waiting on the NSTC and NAPMP to get up and running, it would be better to do this correctly than to do it quickly. She noted that the Committee has been thorough and created impactful recommendations, and everyone is excited to see what today's recommendations are and have thoughtful conversations.

III. DOC Welcome Remarks

Mr. Davis turned the meeting over to Dr. Laurie Locascio. Dr. Locascio welcomed all members, saying a huge thank you to the IAC and their dedication to the needs of the nation and CHIPS R&D. She stated the IAC had been a tremendous help in addressing the mission set by the CHIPS Act, adding that the Committee members have gone above and beyond. Dr. Locascio stated that the Committee exceeded all expectations and needs to get this stage of the program's development right. Everyone wants to see what comes next. Dr. Locascio stated she was excited to see more of what the Committee had planned and knows much more is to come. Dr. Locascio announced that a vision and strategy paper was published; one of many milestones. She thanked the Committee members for all their accomplishments in publishing that paper, along with NIST and the DOC working to get that paper out.

Dr. Locascio also announced CHIPS recently released two additional papers that fit the goal of a continuous vision between manufacturing and R&D. The DOC wants to build an environment to feed the academic and scientific communities with new discoveries, and then funnel those discoveries back into fabs and supply chains. The first paper was published on June 1st was a summary of responses to the request for information (RFI) from the public to inform the design of, and requirements for, potential Manufacturing USA institute(s) understand the sector's needs. Dr. Locascio thanked everyone for their responses, and though there was no clear finding about the Institute's scope, there were a lot of great responses. She stated most responses agreed that the Institute's scope and activities should be carefully coordinated with all other parts of the CHIPS program and that they are all strategically aligned. Dr. Locascio added that the Committee needs to build a vibrant, holistic approach. The second paper, released on June 5th, has ten strategic priorities for the Metrology R&D Program.. Dr. Locascio further pointed out metrology's vital role and standards' importance. She stated these are key to the advances in the entire manufacturing sector. She illustrated that microprocessors are the world's most advanced technology, and standards are needed to build comparability and consistency.

Dr. Locascio then congratulated Neil Alderoty on becoming the new Executive Director of CHIPS R&D Program. Dr. Locascio also welcomed Richard-Duane Chambers as Associate Director for Integration and Policy. Furthermore, Dr. Locascio welcomed Dr. Marla Dowell, the new head of the CHIPS Metrology Program, and Dr. Eric Lin as the new Deputy Director of CHIPS R&D. Finally, Dr. Locascio introduced the incoming head of the CHIPS R&D Office, Dr. Lora Weiss. Dr. Locascio thanked the IAC members for their continued contributions.

IV. CHIPS R&D Update

Mr. Davis turned the meeting over to Dr. Eric Lin. Dr. Lin gave an update, including a summary. He stated he would allow more time for Dr. Dowell to speak more on the metrology aspect of CHIPS R&D. He stated that the presentations' content should be unique. Dr. Lin thanked the working groups for their inspirational work. The pace has been intense, and the groups are in a very good place. Dr. Lin said it is difficult to articulate all the appreciation, words, and discussions and gain more critical thinking for progress. He assured attendees that the working groups' input is considered. Dr. Lin also thanked the Committee, noted that they

paid attention to every discussion and presentation, and ensured nothing offered in terms of expertise and recommendations was missed along the way. Dr. Lin also asked for further patience with the process of setting up NSTC and NAPMP. The process requires patience because there is no single answer to these very complex challenges that require real-time adjustments.

Dr. Lin began reviewing the purposes of CHIPS. He discussed the key concepts, such as:

- U.S. Technology Leadership: Ensure that U.S. technological leadership is the priority. The end goal, the foundational technologies for semiconductor manufacturing in the future, is developed here.
- Accelerate Ideas to Market: To get ideas to commercial scale as quickly and cost-effectively as possible.
- Talent: Developing the workforce for the future.
- CHIPS for America: Four integrated programs, mindful that this is an integrated ecosystem. In partnership with industry, academia, government, and allies. Informed by the Industrial Advisory Committee.

Dr. Lin reiterated that the vision and strategy paper that was recently published was not the end but the start. He addressed that a milestone had been passed, as the (RFI) for Manufacturing in the USA was published and received many responses. Dr. Lin also stated that the NSTC Selection Committee to identify the Board of Trustees would be announced, and the hope is to establish the board for the NSTC before the end of the calendar year. Dr. Lin further stated that a vision and strategy paper for NAPMP is to be published, in conjunction with a metrology paper in the fall. Dr. Lin reviewed the timeline for the NSTC and stated the plan is for the NSTC, by the decade's end, to be seen as an essential resource for state-of-the-art facilities, semiconductor ecosystems, and effective programs. Furthermore, the NSTC should be a hub for accelerating resources, collaborations, grants, and new ideas. Dr. Lin addressed that there are three large categories to facilitate this environment. These are:

- Technical Leadership and Research: The vision is to have the NSTC provide research directly on grand challenges and roadmaps. This includes standards and protocols, technical exchanges, and a focus on the security of semiconductor technology.
- Community Assets: The NSTC is to be the place for shared, state-of-the-art technology, such as chiplets, design enablement gateways, data sets, and technical centers for prototyping.
- Workforce Programs: Outreach to groups traditionally underrepresented. This is also to support the scaling up of existing quality programs.

Dr. Lin stated that the NSTC is meant to be a public-private consortium with membership participation; it is not meant to be a buy-in as a business model. It is a community exercise with business considerations. The idea is that the NSTC is to be the type of place where semiconductor innovators want to be.

Dr. Lin went on to discuss NAPMP. He stated NAPMP is meant to strengthen semiconductor advanced testing, assembly, and packaging in a domestic ecosystem. The program will fund

activities and leverage public-private partnerships. Dr. Lin stated the RFI responses enabled the identification of technologies and the best investments for packaging. He added that the approach to NAPMP is to create an R&D environment that advances state-of-the-art concepts and ideas in advanced packaging, primarily looking to the future. He noted NAPMP will be mindful of developing ecosystem support and allowing for the creation of a competitive edge. Dr. Lin recognized that these programs in connection with the NSTC must be clearly and closely aligned.

Dr. Lin highlighted that the R&D team has been listening and looking to define carefully what a pilot and packaging facility would look like. The team has been working to prototype pilot integrations of components. The team has also identified a need to work in partnership to connect to the broader ecosystem.

Dr. Lin moved on to discussing the Manufacturing USA Institutes. He reviewed that up to three new public-private partnerships have been authorized, and they are meant to be focused in pre-competitive technology space. The RFI summary report is currently on CHIPS.gov. Dr. Lin reiterated that the Manufacturing USA Program is a network of institutes and that, together, they are an amazing network to connect with the CHIPS R&D ecosystems. He further stated he is looking for potential ideas for semiconductors to advance.

Dr. Lin discussed the recently published RFI key points. He acknowledged there wasn't a full consensus on some topics. There was consensus on the coordination, structure, and governance to ensure NSCT could be run effectively. Furthermore, the RFI and the IAC members emphasized the importance of the sustainability and longevity of the NSTC.

Dr. Lin handed the presentation over to Dr. Marla Dowell to discuss the CHIPS R&D Metrology Program. Dr. Dowell thanked Dr. Locascio, Dr. Lin, and everyone else across NIST, industry, and academia for their hard work and for getting the Metrology program where it is today. Dr. Dowell stated that what IAC was being presented with was a cumulative effort, showing the resources collected over the past two years to support a vibrant metrology program and ensure CHIPS is successful. NIST was chosen due to its longstanding role in metrology. Dr. Dowell stated that metrology is important due to its role in reducing costs and catalyzing innovation. Dr. Dowell stated that the industry is at a crossroads because many technologies to measure next-generation-electronic components do not exist. She stated that measurements and open source can help in catalyzing innovation. The vision of metrology is to be a means of catalyzing innovation with an emphasis on measurements that are accurate, precise, and fit for purpose. The mission is to develop and measure innovations that will maximize speed and impact. Metrology is foundational and fundamental to all R&D. Metrology tools are delivered to other CHIPS R&D programs, which conduct high-impact research. Dr. Dowell added that metrology should reach a commercial scale. Dr. Dowell stated industry input is vital and that last fall, a report was released identifying seven grand challenges in evaluating U.S. manufacturing for semiconductors. These were:

- Metrology for materials purity, properties, and provenance
- Advanced metrology for future microelectronics manufacturing
- Enabling metrology for integrating components in advanced packaging

- Modeling/simulating semiconductor materials, designs, and components
- Modeling/simulating semiconductor manufacturing processes
- Standardizing new materials, processes, and equipment for microelectronics
- Metrology to enhance security and provenance of microelectronic based components and products

Dr. Dowell added that these challenges were developed through stakeholders, government, academia, and industry feedback. Two grand challenges will begin to move forward: advanced metrology for future microelectronics manufacturing, and modeling and simulating semiconductor designs and components. These two challenges will demonstrate paths forward and become guides for challenges to come. Dr. Dowell reiterated that research infrastructure needs to be strengthened in NIST.

Questions and Remarks:

No questions were asked.

V. [CHIPS Act and National Microelectronics Strategy](#)

Mr. Davis turned the meeting over to a presentation from Dr. Friedersdorf on the CHIPS Act and the National Strategy on Microelectronics Research. Dr. Friedersdorf thanked the Committee and stated she was excited to hear today's recommendations and was looking forward to the discussion on interagency collaboration. She stated the meeting would move on to the other agency's presentation after she finished setting the stage for the Committee. Dr. Friedersdorf went over the history of the White House Office of Science and Technology Policy (OSTP), including the mission of OSTP, which is to advance the use of science and technology for all American citizens. Dr. Friedersdorf stated that the whole-of-government approach allows each department and agency to have their own roles and responsibilities, and these departments and agencies are putting in great work.

Dr. Friedersdorf stated the CHIPS Act has a number of provisions and funding, aimed at establishing American leadership and innovation in semiconductor and microelectronics through research, development, and supporting infrastructure. Dr. Friedersdorf reminded the IAC members that the mechanisms to organize the interagency efforts are tied to the Executive Order from the White House to coordinate the industry. Dr. Friedersdorf then went over the steering council and the members of the guiding council, co-chair, and director of OSTP, Arati Prabhakar, Lael Brainard, Jake Sullivan, and Ronnie Chatterji serving as CHIPS coordinator. Furthermore, Dr. Friedersdorf stated OSTP coordinates policy at the executive level, and has been working incredibly close together and taking all these efforts seriously. Dr. Friedersdorf further reminded IAC members that the duties of the subcommittee are to be responsible for the development of the national strategy and keep consistent with national policy.

Dr. Friedersdorf stated the government has made significant, wide-ranging investments in microelectronics. The Subcommittee on Microelectronics Leadership (SML) has been developing a structural framework, including having monthly meetings with the various

committees. One working group is looking at developing talent, as the nation is looking at a worker shortage, and is working on better understanding the private sector, researchers, and discoverers. Another working group is currently focused on international issues critical to working with allies and partners and is moving to identify mechanisms for international collaboration.

Dr. Friedersdorf stated that the SML is looking at the entire picture and needs to connect the pieces of the agency's activities together. This includes looking at the R&D infrastructure, which is important for every stage of microelectronics manufacturing and reviewing the infrastructure's support. Dr. Friedersdorf also stated that lab-to-fab infrastructure is absolutely required and that these efforts will allow for the democratization of science, providing mechanisms for access. Infrastructure is critical to the development of students and the workforce. Dr. Friedersdorf reminded the Committee members that the CHIPS Act allows for historic investments and addressing the semiconductor industry's critical needs, including the Department of Defense (DOD) Microelectronics Commons hubs and cores. The SML also looks at federal R&D investments, the Defense Advanced Research Projects Agency (DARPA) Programs, and other Department of Energy (DOE)/DOD programs. OSTP needs to leverage coordinated efforts with respect to the infrastructure and user facilities and needs to consider the entire microelectronics R&D ecosystem.

Questions and Remarks:

Questions were held for the Panel.

VI. Microelectronics Programs and Intra-agency Coordination

- **DoD Presentation**

- **DoE Presentation**

Mr. Davis turned the meeting over to Microelectronics Programs and Intra-agency Coordination for a number of presentations, starting with Dr. Alison Smith.

Dr. Smith started by stating that the DOD Microelectronics Commons is currently in source selection and discussed the program's current status. For the lab-to-fab transitions, the Commons aims to enable the prototyping of domestic facilities and to foster a pipeline of semiconductor talent. The focus of the Commons is to facilitate innovation, processes, and materials for the numerous areas of the CHIPS Act to be supported in the Commons. Dr. Smith stated that small and midsize companies and universities have difficulty transitioning from lab to fab. She highlighted that the DOD Microelectronics Commons is assisting the transition from labs to manufacturing. Dr. Smith stated that the Commons being domestic is important. Dr. Smith further acknowledged that some of the major roadblocks include gaining the investment in microelectronics technologies and access to facilities to explore and prototype. The second barrier is innovators' access to those technologies. The Commons aims to reduce those barriers.

Dr. Smith demonstrated the scale of early-stage research, which is supported by various government agencies. She pointed out that more investment is put into prototyping than early R&D, which creates a high hurdle, and startups and small entities need to be included in the ecosystem. Dr. Smith added that venture capital can add necessary support; however, venture capital is not typically interested in the early stages of hardware microelectronics. At-scale prototyping is high risk, so small and midsize companies and universities have difficulty bridging that lab-to-fab gap. She added that there is a need to sustain these efforts and to be part of these efforts from the start. The Commons will be able to sustain these efforts in the longer term but is not lab-to-market. The Commons will utilize technology demonstrations closer to application platforms. Through the NSTC, the Commons will offer capabilities and validate concepts before moving to a commercial track.

Dr. Smith turned the presentation over to Dr. Barry Johnson. Dr. Johnson stated he would be giving an update on National Science Foundation (NSF) activities over the last few months. He also stated his part of the presentation would be verbal remarks. Dr. Johnson stated that through the implementation of the CHIPS Act, an executive steering group has been established within NSF, including five of the eight directorates, and the group reports to the NSF Director, Dr. Panchanathan. The group is responsible for developing the NSF's current strategy and implementing the CHIPS and Science Act. Dr. Johnson stated the existence of the executive steering group is an important step, they meet weekly, and two papers have been submitted to the DOC and others. One paper focuses on R&D activities, the second is for workforce development. Both papers look directly at existing programs that could be leveraged immediately. Dr. Johnson noted the response to the program has been overwhelming, and there have been more responses and many more proposals than funding can support. For example, the program on the future of semiconductors was developed in collaboration with industry and had a distinct focus on co-design. The AI Institute envisions developing the requirements for semiconductors. The Workforce Development Program was excited to provide a webinar intended for potential customers, including advanced technical training programs. Dr. Johnson stated this was a sign of progress. He added that the activity is ongoing, and a long-term strategy is under development. The agency has acquired $200 million for workforce management. He added that in this current fiscal year, funding is going toward developing the workforce and education for the future of semiconductors.

Dr. Johnson turned the presentation over to Dr. Andrew Schwartz of the DOE. Dr. Schwartz thanked everyone for including the DOE in this program, and appreciates its interagency development. Dr. Schwartz stated the DOE's missions in energy, science and innovation, and national security rely on and support advanced computing and semiconductor technologies. The agency has been investing in microelectronics, including high powered CPUs, and stated a focus on energy efficiency is important. Dr. Schwartz stated that the DOE's Advanced Materials and Manufacturing Technologies Office (AMMTO) recently launched Energy Efficiency Scaling and a road map has been created to move forward in reducing energy for microelectronics. The project was kicked off with workshops emphasizing interagency cooperation. Dr. Schwartz stated AMMTO has developed seven working groups to develop the different aspects of this roadmap, including materials and devices, advanced packaging and heterogeneous enterology, metrology, and benchmarking. Dr. Schwartz announced that across the DOE, a working group was developing efficient coordination and information exchange

within the department and interagency engagement last year. The DOE can contribute to the CHIPS programs, including providing members, and the DOE is currently on multiple panels regarding semi-electronics. Maintaining American superiority is key. Dr. Schwartz also discussed the DOE's established Microelectronics Science Research Centers, stating these centers would perform mission-driven research to address foundational challenges and focus on fundamental science and early-stage research.

Questions and Comments:

VII. Whole of Government Roundtable

Mr. Davis turned the meeting over Dr. Christie Canaria of NIST to moderate the government roundtable which consisted of Dr. Lisa Friedersdorf, Dr. Alison Smith, Dr Barry Johnson, Dr. Andrew Schwartz, and Dr. Eric Lin.

Moderator: This session is meant for IAC engagement. The panel is how the agencies work with one another. The first questions went to the DOC and DOD, regarding the recent vision and strategy paper released in April. The questions touched on the relationship between the Commons and NSTC.

Lin: Dr. Lin stated the starting point between NSTC and the Commons is open communication. He stated, at the top level, efforts build on this communication and that both programs are distinct. The NSTC is developed based on end-to-end technology and the readiness level. He acknowledged that there is still capacity to be filled even though both programs can overlap in some levels of technology readiness. He pointed out that the Commons is much more specific to commercialization of specific areas than the NSTC. Dr. Lin believes there will be common areas with the NSTC that will allow for inviting researchers from the Commons.

Smith: Dr. Smith noted that the NSTC is distinct from the Commons. The Commons focuses on developing microelectronics, processes, and devices that meet national defense needs. Dr. Smith noted that some of the Commons' efforts will be similar to the NSTC's, but the Commons has different targets. This means maturation will occur using subsequent programs. Dr. Smith noted that, regarding coordination, the Commons has subject matter experts across multiple agencies, all serving on the source selection team. The DOC has a deep level of insight on DOD investments. Those ideas could be developed within the NAPMP and NSTC. NIST is discussing the packaging program with the DOD and determining how to best focus on advanced packaging technologies. These efforts are still in progress and Dr. Smith is excited about leveraging all these technologies together.

Moderator: How do the other agencies participate in these programs?

Johnson: NSF has really enjoyed the involvement. If the agencies were to look at how NSF is contributing to this, they would see these activities feeding into those centers. NSF is looking for proof of concept and is looking at the new director of partnerships, focusing on that transitional space. Dr. Johnson added that an important element is workforce development. This

includes looking for engagement with the industry and addressing the industry's needs.

Schwartz: Dr. Schwartz added that this is not a new investment; it is a significant investment in a historic field. He added that he has been impressed with the recommendations and that there will be barriers and challenges, but the effort in the early stages is encouraging. He stated that thinking about those challenges early and deeply is vital to overcoming them.

Lin: Dr. Lin thanked the other agencies and reiterated that the NSTC is a public private consortium where a concrete vision will be realized. Currently, the NSTC looking at how to set up the purpose and goals of the NSTC.

Smith: Dr. Smith added that this is a lot of money, and they need to build these connections. Dr. Smith stated it is hard, but she hopes there will be discussions to move this conversation forward.

Moderator: This question is for the whole panel. What do you see as the barriers to expertise?

Friedersdorf: Dr. Friedersdorf stated the US government is making efforts and, as NSF is working with the DOC team and the others, they are having discussions to facilitate interagency collaboration. This includes looking at various aspects that would block access.

Lin: Dr. Lin acknowledged that some of the challenges are significant and realizing the value of a multilateral coordination is difficult. The multilateral approach is much more difficult but will pay greater dividends. Another challenge is sharing important information, highly valuable intellectual property (IP), and designs to ensure the safety of the IP. He stated the landscape is exciting, but the challenge is to think about the people in the ecosystem and what they see. To keep this mindset, transparency is important.

Schwartz: Dr. Schwartz stated he has been part of the nano-technology initiative, which is a great model, for over fifteen years and he remembered the early challenges for agencies to receive funding and money for the initiatives. He remembered that a senior staff member had mentioned that the real problem is the different processes, considering each agency has a different process and structure with which to work. Dr. Schwartz stated that discussing the different authorities and processes and navigating those hurdles is key to moving forward.

Smith: Dr. Smith stated that the Commons is currently in source selection, they require offers to develop access models and processes for how members will access those models. This also includes prototyping pathways for members' access to that information. These offers included the researchers themselves and those barriers will be taken into account for these proposals.

Johnson: Dr. Johnson commented that challenges are opportunities. The gap between research and commercialization and basic research can be an issue. He added that industry understands the use of research, and researchers will need to utilize the tools available within industry to overcome the gap. Dr. Johnson commented that industry already knows how to bridge this gap, adding that when you have questions, you need the market in the room to decide on what basic research questions to study. It is important to have market in the room.

Moderator: Dr. Canaria acknowledged that the IAC is very fortunate to have market in the room as part of the Committee membership. She also added that diversity is part of the mandate for basic research programs, adding perspective to what IAC and NIST are trying to build and bringing challenges and opportunities. What are the interagency tools needed to support expertise for these government-funded programs?

Friedersdorf: Dr. Friedersdorf stated there are already examples of working together, mechanisms like joint review of programs as they are rolling out, and there is awareness across agencies. Other examples include the comparison of different agencies' infrastructure, what is being considered, and taking into account the other resources of those that already exist or are being planned between agency programs. She stated it can't be overstated how important it is that the interagency is working together and aware as these things are being laid out. Having people on a review committee is important.

Lin: The spirit is to make it easier for the funded parties to negotiate with other funded parties and share goals. New instruments are challenging and invigorating, and success leads to a model for government agencies moving forward, which is why having everyone get involved with the NSTC program is important.

Friedersdorf: Dr. Friedersdorf stated she is looking at the agreement and the processes, on assignment to the CHIPS office, and is leaning on that expertise for details. The research strategy will provide overall opportunities and a guiding document.

Moderator: Workforce challenges are well documented. How are agencies looking to address workforce needs?

Johnson: Dr. Johnson stated the workforce is critical. It is an opportunity at multiple levels, from high school to researchers. They need programs that cover the entire spectrum, and Dr. Johnson said he cannot overstate that. One of the challenges is understanding the path and what those careers are. It is understanding the job needs, not training people for jobs that don't exist. Less than half of college students stay in science, technology, engineering, and mathematics (STEM), which lowers workforce numbers.

Lin: Dr. Lin stated that workforce needs are exceedingly challenging. Looking into this has been eye opening. Dr. Lin stated that one way of thinking is to find where the ideas and issues are in building the STEM technologies. Looking at supporting academic and educational institutions, looking on the employees' side, and looking at competency models and developing training is key. All this can benefit from the government to convene and discuss further development.

Smith: Dr. Smith added that the scope of the need is broad. We have to engage in K-to-gray education. The Commons specifically recognizes that offers are provided with the flexibility to integrate a workforce development approach into their hubs that is tailored to their regional ecosystems. It is critical to have industry be involved, but industry will already be involved in the hubs in Commons. The hubs will be the source of learning and expertise, providing a

foundation for students being supported by Commons. For example, if the DOD coordinates with NSF, the former will have subject matter experts from the latter so that the latter has deeper insight into the investments of the former.

Johnson: Dr. Johnson added that, of all PhDs, only 10 percent work in an academic career. NSTC will be a great place for graduates to get internships, get the skills needed in industry, and get out of the lab.

Schwartz: Dr. Schwartz stated the DOE labs are looking to engage students directly, not just in microelectronics but across the entire agency. Those types of programs can be expanded into microelectronics programs.

The moderator turned to questions from the IAC members.

IAC: Mr. Splinter thanked the board for the agency's collaboration. He stated he is interested in how conflicts are resolved. Is there a body that deals with this?

Lin: Dr. Lin stated the agencies have entities that coordinate with each other. That is the purpose of the Steering Council, which is very engaged in the implementation process. The Steering Council manages any significant conflicts.

Johnson: Dr. Johnson agreed that the point of the Steering Council is to be where the decisions are made. The Steering Council set up and developed the priorities of critical calls and focuses on resolving issues before they hit the group.

Lin: Dr. Lin added that there are multiple places to resolve conflict at every level. There are designated representatives working with the agencies on how to make decisions and a rapid process to achieve goals. Having these representatives helps expedite and create stronger solutions.

IAC: Mr. Michael Fritze thanked the roundtable for the development of a national strategy. He asked what the timeline is for completing the strategy?

Friedersdorf: Dr. Friedersdorf stated there is no timeline, but it will be a public document. Things are moving very quickly in CHIPS. As things become clearer, they are working hard.

IAC: Mr. Dan Armbrust asked if the roundtable has any comments on how AI will overlap with CHIPS?

Johnson: NSF and other agencies have been funding AI, as well as driving up infrastructure for AI. We want to leverage these immediately.

Friedersdorf: There are coordinated efforts on all aspects of AI. AI is recognized as being very important to what the agencies are doing. AI is integral to research.

Schwartz: Dr. Schwartz stated that the computer research offices and others have had a great

deal of discussion about AI and how it is used for what is being done in CHIPS. Workshops are being held on how to use AI to bring ideas together.

Smith: Dr. Smith stated they have discussed how their agencies are working with AI.

Lin: Dr. Lin added that a trustworthy AI will be a market driver, including key factors.

IAC: Mrs. Diedre Hanford reflected on a comment from a prior conversation. She thanked the agencies for how quickly comments had been made. She observed how the many existing teams had tightened together, including the California, Texas, and New England teams, to accomplish so much. The Committee stated there is now a list of facilities that exist. How will the Committee leverage that collection for NSTC going forward?

Smith: Dr. Smith stated even now, the list involves source selection and is sensitive. Legal will work with all offers but at this time, until there is an announcement, the list cannot be used.

IAC: Dr. Bill Chappell stated that everything is more expensive; the challenge is how do we think about the coordination of the requirement?

Lin: Dr. Lin stated they recognize the issue of how to work with one another and how to identify gaps. They have NSTC to articulate grand challenges and the broadest range of impact. This includes roadmaps and specifications to start nailing down details. Right now, the majority of that type of funding is in the Commerce program. The presentations showed how much must be leveraged to accomplish the program's goals and to get the biggest impact.

IAC: Dr. Mukesh Khare stated global industry and the CHIPS Act created the leadership for the ecosystem, and it calls for like-minded nations. Other nations have created CHIPS Acts of their own. Is the government looking at partnering with other CHIPS Acts in other nations?

Lin: Dr. Lin stated that partner and ally nations are looking at the United States for what needs to be done. The key is shared goals between these groups. The starting point would be identifying the strongest points to work together on and maintain cohesion, and the mechanisms for this coordination are being worked on now by various agencies and offices. He added that this is the early stage to set the conditions.

Friedersdorf: International engagement is critical to developing a consistent and stable global supply. The United States can't do this alone, and working with allies and partners is vital to CHIPS' success.

IAC: Dr. James Ang stated that presumably, there is an endgame for lab-to-fab and industry engagement. What is the endgame in three to four years' time? How does tech move from NSTC to commercial?

Lin: Dr. Lin stated there are multiple pathways, and NSTC is looking to fill in the gaps. They want to set the specifications and conditions. They want to create and broaden the option space. NSTC wants other performers to join NSTC so that they are engaged and aware, collecting a

focal point and adding expertise. This allows the whole process to be more efficient. These different programs coupled together can help bridge the gaps. Dr. Lin also noted that NSTC has an investment fund, and there are incubation funds across the government such as the SBIR program, and these tools will be tailored to deal with gaps and barriers.

Johnson: There are a lot of innovations and funding startups is key. NSF wants to be the first to fund these commercials. The hope is that NSTC will be a source of leverage for startups. This is a great level of synergy, and NSF has multiple programs to assist startups and keep them from failing and help them create a product-market fit.

Smith: Dr. Smith is encouraged by the level of investment of everyone involved in working hand-in-hand to maximize solutions. The United States continues to be a new and leading source and will leverage an innovation system. She is optimistic that the Commons and NSTC will leverage the United States' innovation engine to establish a long-term, sustainable ecosystem.

Schwartz: Dr. Schwartz added that these handoffs are not a one-time event but occur at many different points in the whole process. In recent activities between the DOE and DOD, these efforts were documented clearly, as well as the needs that could be met in commercial manufacturing as part of the incentives program. It is important to invest in the fundamental sciences and lab-to-fab and that these continue to be talking points.

Friedersdorf: Dr. Friedersdorf stated it is not about a single puzzle piece but connecting the dots and bridges to afford communication and development, which is not linear. Building that overall ecosystem is our most challenging and important task. She stated she is so excited by Commerce and that they have to get these early processes right. The IAC's input has been supported, and the dedication is beyond expressed.

The meeting broke for lunch and reconvened at 1:00 pm EST.

VIII. Sequencing Working Group

Mr. Davis turned the meeting over to Dr. Willy Shih. Dr. Shih stated that the charge of the new working group, which included recommendations on investment strategies so the NSTC can have an impact. He stated this was very much a team effort. The charge had four team members who also had R&D and Organization and PPP work as well. The group looked at the constraints of overall funding, such as the Design Enablement Gateway, and looked at what was available for technical centers, but also created structure. Their approach included identifying the range of possible activities that might be carried out at proposed technical centers. The working group also identified examples of existing facilities that might be enhanced, and examined a series of case studies for new technologies.

Dr. Shih discussed use case studies and stated they are a good way to identify specific needs across different contexts. An example is the 100x energy efficiency boost through advances in logic metrology and heterogeneous integration. Another example the group used was a new

memory startup beyond NAND & DRAM Challenges. They examined the principles and procured access to capabilities from existing facilities and commercial entities. The working group looked to utilize brownfield capabilities or enhance existing facilities, as well as establish new capabilities and execute projects only if they cannot or will not be realized without government assistance.

Recommendation 1-1: NSTC should focus investments on two critical stages of the R&D pipeline that represent significant gaps in US capabilities. One was mid-to-late-stage prototyping beyond pathfinding. The second was early-stage concept hardening beyond university research.

Dr. Shih stated the working group established different categories of technical center capabilities. The first type was for 300mm capabilities, which could be multiple facilities. The types were as follows for 300mm:

- Type 1 Late-stage prototyping at Advanced Nodes, no process changes.
- Type 2 Mid/late-stage prototyping, CMOS+X Changes: Mostly BEOL, some FEOL. Would be an extremely attractive place to get worldwide interest.
- Type 3 Pathfinding new materials/process development, process experimentation.

200mm had the following types:

- Type 4 Mid/late prototyping CMOS+X new material allowed.
- Type 5 Concept hardening to mid-stage changes/new materials allowed.
- Type 6 NSTC enhanced University Facilities Coupons 100/200mm.

Packaging types were as follows:

- 7a Late-stage prototyping standard chiplet interfaces.
- 7b Pathfinding.
- 7c Early stage.

Mr. Davis put the presentation on hold, acknowledging that Madam Secretary of Commerce, Gina Raimondo, asked for the opportunity to speak to the IAC.

Secretary Raimondo thanked the IAC, and acknowledged the pace is fast. She thanked the Chairs of the Committee for their hard work and stated she knows just how hard everyone has been working. She stated, like any startup, it is a lot of work and they have been working at an unsustainable level. Getting into a cadence of hard work at a sustainable level of hard work has to be done and is worth more. Secretary Raimondo stated she was struck by the level of commitment and by the level of compromise and collaboration. Secretary Raimondo stated, even though they were at different levels, a consensus has been reached and that is huge. The IAC has exceeded expectations, doing what is right for the country. Secretary Raimondo reiterated that, despite all the press coverage related to the money being spent and incentives, what the IAC is doing is significant and will shape things moving forward. She stated she is counting on the IAC to be successful. Secretary Raimondo announced that Dr. Lora Weiss will

be joining as the new incoming CHIPS R&D Director, and provided thanks again to Dr. Eric Lin, who will stay as deputy director. She also welcomed Neil Alderoty, Richard-Duane Chambers, and Dr. Marla Dowell. Secretary Raimondo stated they will soon announce the selection committee members for the NSTC.

Mr. Davis returned the meeting to the Sequencing Working Group.

Dr. Shih continued to point out in the presentation the areas where facilities would have to be built in full or could be acquired by NSTC. The slides showed examples of these facilities, and were color coded. He used some of the case studies, addressing the possible locations for 100x energy boosts. All these case studies were used to map the type of coverage needed.

Recommendation 1-2: Expedite startup of operations and minimize duplication, starting by leveraging existing facilities worldwide and utilizing 9902 funding.

Recommendation 1-3: To further broaden participation across the board. To establish an enablement gateway to help NSTC performers access information. This is to reduce entry barriers for startups and help facilities with priorities. Dr. Shih stated that surveying what is available within geographical locations could help get agreements for the various types of facilities needed.

Recommendation 1-4: Secure access to test flows and test structures.

Recommendation 1-5: Recommend NSTC management start with a request for information.

Dr. Shih stated this is a partial picture to establish NSTC's methodologies for prioritization, establish a financial model, establish how to use capabilities from companies supporting the investment fund, and establish how to leverage capabilities for workforce development and the ecosystem. Dr. Shih then accepted questions from the Committee.

Questions and Comments:

Q: What is the affordability of these measures?
A: Very expensive, and there isn't enough money. Prioritization is vital. It is going to be tough to say no to a lot of people. Leverage what exists. Build on what we already have.

Q: Did you consider how you measure success?
A: The group spoke about a lot of things, including the success matrix. They focused on bridging the apparent gaps. There is a very diverse range of needs. They can't meet all those needs but are focused on providing the broadest possible services.

Q: With the spectrum of being demand-driven, how did you debate that, and where did you land?
A: The group didn't talk a lot about it. One of the important parts was having government policy stimulate a secure access map. The message of secure access was the focus. The

demand-driven concept was talked about on the demand side to meet the supply side push.

Q: Have you thought about how this sequencing can inform the NAPMP and how you would layer that part into it, so they are intimately involved with each other?
A: The group thought about a lot of things. The group discussed this, and kept the packaging and mainstream technology together. There is an acute awareness that packaging is where the country lacks, so a disproportionate amount of attention was paid to getting those facilities up and running. The group assumed NSTC will have the prototyping capability, and the group focused primarily on infrastructure.

Q: How do you envision materials developers and equipment manufacturers are going to be involved in this?
A: Traditional research institutions are going to be valuable, but that was the province of the right column. The group would argue that a lot of the ecosystem is going to be based on demand signals. When you do not have strong demand signals, people will return to Asia. The group spent most of the time mapping out the capabilities, and asking how do you leverage all this material? The group worries about the lack of a strong demand signal.

Q: How do you see the 9902 funds working together with the NSTC?
A: The group wanted to highlight, due to the funding not being out yet, that this was a good time to ask.

Q: Did you decide universities were not appropriate for prototyping?
A: The group did not want to represent this as nine-point facilities. The idea is that universities might inject more capital and be able to move them more to the center of this discussion.

Consensus Vote:
Recommendation 1-1: 0 opposition
Recommendation 1-2: 0 opposition
Recommendation 1-3: 0 opposition
Recommendation 1-4: 0 opposition
Recommendation 1-5: 0 opposition

A full consensus was reached, and the IAC passed all recommendations.

IX. Organizational and PPP Working Group Report Out and Discussion

Mr. Davis turned the meeting over to Deirdre Hanford from the Organizational and PPP Working Group for a report and discussion. Mrs. Hanford thanked IAC for this charge and stated the group's makeup was unchanged. She stated everyone had been putting in so much time and work, including Ken Joyce, who had been working on packaging and this working group. Mrs. Hanford stated the charge for this group was IP policies and strategies that would lead to increased access to organizations and people to innovate. Additional charges involved data sets, leveraging data generated in and around the NSTC. .She stated the group used sample briefs, hearing from multiple contracting vehicles, agencies, and organizations that are aggregating patents. The group also spoke with universities and received their input, including hearing a list of how important it is for NIST to get the financial tool put together.

Mrs. Hanford stated there are stages of innovations enabling access to NSTC research while protecting members' IP. She stated NSTC's business plan should not be built around monetizing IP. NSTC is not strictly pre-competitive, so the IP model needs to have flexibility. An important principle is allowing members to access research while protecting inventors' IP. While the NSTC is amassing IP over time, the mission should not be the monetization of the program. If these principles are not considered, it will damage the environment of involvement. She then discussed the types of IP and project modes.

- Three project and IP modes
  - Mode I: Research Projects. Work for the general members, cultivated at the early stages. With all degrees of uncertainty, that pre-competitive work needs to be contributed to the NSTC.
  - Mode II: Demo/Development Projects. These may or may not be pre-competitive work. These may be owned by licensed by individual members. Will require work, not licensed work, owned by individual members. An important, distinct bucket.
  - Model III: Prototyping Projects. Typically, not funded by NSTC but by industry coming together.

- Different types of IP
  - Contributed Background IP
    - Always disclosed.
    - Very important to disclose what is coming to the table.
    - Need to disclose background IP that is relevant to the project.
  - Foreground IP
    - IP handling varies by IP type.
    - Inventors will either own it outright or it will be common good.
  - Foundry Background IP

Mrs. Hanford then illustrated additional considerations:
- Universities
  - Facilitate further participation.
  - Same Mode I/II/III rules apply.
- NSTC Patents
  - License terms to prevent use by Non-Practicing Entities (NPEs).
  - Leave defensive pool organization.
- RFPs/NOFOs Multiple Technical Centers
  - Facilitate unified IP.

It is the working group's hope that this IP framework will sustain and be pervasive in any technology centers or infrastructure set up in NSTC. Mrs. Hanford stated she wants higher-level recommendations.

Mrs. Hanford handed the presentation over to Dr. Bill Chappell to discuss data in this day and age. Dr. Chappell discussed how daunting dealing with data and conferencing is. He stated the

research value chain is important to display and that the software is pacing everyone regarding value chain research. Semiconductor communities don't have that capability. It would be a huge differentiator to get access to that data. Dr. Chappell stated the tiered framework for IP maps onto the data framework.

Recommendations 6-1 and 6-1.2:

- Data: The research value chain can be enhanced with not just results, but also the process of work. The software world is ahead of us.
- Data Model 1: Focus on creating open data sets for model development. The working group thinks the government should be forceful in mandating that research be public, including sharing the code and the basics.
- Data Model II and III: Stated this one is trickier as the government is not fully funding this work. Focus on standards for data, interoperability, and private sharing techniques. Should focus on standards and look for advanced data standards.

Recommendation 6-2: Mrs. Hanford stated the working group recommends a tiered data governance framework. This framework would differentiate the sharing data model and incentivize the motivation to share it and anonymized data.

Mrs. Hanford then moved on to discussing the NSTC board.

- Board: NSTC is a consortium, a consensus board of trustees. Making sure the organization doesn't get skewed one way or the other is important for the board of trustees. It is important to generate diversity in, both expertise and geography.

Mrs. Hanford discussed the board structure and the composition of the board of trustees.

- Board Roles:
    - Hire and fire CEO.
    - Key Committees:
        - Audit compensation, governance
    - Board Terms:
        - 5-year terms
        - Staggered structure

- Board of Trustees:
    - 11 members of the board of trustees, with one observer from the DOC
        - Four Public Interest Directors
        - NSTC CEO
        - Research Institution Profiles and workforce development representation
        - Four Industry Sector Directors

Mrs. Hanford then discussed requirements needed for the roles, the skill matrix, and the understanding of strategy. The group suggests the Public Interest Directors focus on national security, a technologist, a CFO for a financial view, and a generalized icon for the country. The

industry directors need to understand the industry, so should include a former semiconductor CEO, someone who understands the semiconductor end market domains and supply chains, and someone representing small business. Mrs. Hanford stated a skill matrix will be key to getting the right applicants, with an understanding everyone will not meet all the criteria but will complement each other.

Recommendation 7: 11 directors plus one observer. All with unquestioned integrity; independent stewards of the mission.

Mrs. Hanford then discussed the Technical Advisory Board (TAB).

- Tech Advisors: Relevant semiconductor industry or related experience. The scope includes high-level roadmaps, challenges, and execution of progress. They would bring their expertise in the semiconductor industry, not nosing into NSTC, just focusing on the skill.

Recommendation 8: TAB would include 12–16 members representing their member companies and critical segments. Want to have deep industry engagement. Rather than Technical Advisory Boards, they are councils. A great opportunity for those not on the boards, but still supporting. Allows for engagement at multiple levels.

Recommendation 8-2: Technical Centers have technical advisory councils that are advisory in nature.

Questions and Comments:
Q: Novel work. In the IP area, did you come up with the model green field or other organizational models?
A: Yes, the group looked at Interuniversity Microelectronics Centre (IMEC) for their models. We studied how the government managed those models.

Q: Data is going to be the key currency. Was there any discussion about standardizing data?
A: Yes, the need for standards is identified. We are not bold enough to ignore that. There is nothing standard across the board.

Q: You just mentioned data protection is not being considered. Are we keeping it open for the constituents or for the entire world to see?
A: The consideration is for the membership opportunity, not to make it open source.
Comment: Important to know the difference between design data and process data. There is a great deal of backward process detail.
Comment: The group almost punted this question but wanted to get the conversation on the board.

Q: Regarding IP on the university side, it continues to be a problem of Federal Laboratory Consortium (FLC). Is there a way to make it work?
A: The group got an earful on this matter, stating professors are acting as independent

contractors and don't know what other professors are working on. That can't be an excuse to have professors not working together.

Q: Did you discuss the downside of the CEO's role in helping to coordinate the board?
A: Yes, there are four chairs and a board chair. They do want a board chair but cannot go into further discussion due to time constraints.

Q: How do you keep the CEO accountable for success?
A: Ultimately the board of trustees and the board of the government are responsible for this.

Q: Did the group discuss the time you will select the CEO? Did you think about the full board or a core group for the CEO?
A: The group did not discuss this. We will leave that to the selection committee.

Q: What was their plan for including the packaging representation for the board of trustees?
A: Packaging is included in the semiconductor industry. This representation should be put into the NSTC charter directly to clarify and to make sure that the IAC includes packaging to be represented on the board.

Consensus Vote:
Recommendation 6-1: 0 opposition
Recommendation 6-1.2: 0 opposition
Recommendation 6-2: 0 opposition
Recommendation 7: 0 opposition
Recommendation 8: 0 opposition
Recommendation 8-2: 0 opposition

A full consensus was reached, and the IAC passed all recommendations.

The meeting took a break and reconvened at 2:45 pm EST.

X. R&D Workforce Working Group Report Out and Discussion

Mr. Davis turned the meeting over to Dr. Tsu-Jae King Liu of the R&D Workforce Working Group for a report out and discussion. Dr. King Liu acknowledged the full team's support. She also acknowledged the team officers and notetakers. She stated the workforce group understands the ecosystem in the US, met with experts over 17 times since the last meeting, and has been working to meet the updated charge. They continued to make recommendations on the R&D programs that can be best leveraged to meet both the R&D and manufacturing workforce needs of the microelectronics industry. Dr. King Liu agreed to an initial set of four recommendations, highlighting work programs and infrastructure. The working group wanted to incentivize academic institutions to encourage students in STEM. NSTC is envisioned to serve as a coordinating body and a center of excellence to help scale the technical workforce. The program should create a clearinghouse of research, collect and disseminate a wide range of information, advance opportunities, and serve as a collaborative space.

The additional recommendations emphasize these activities, and the working group met with

experts in the industry and government to engage with the working groups. Dr. King Liu was very appreciative of their time and efforts.

Dr. King Liu then discussed the findings of their efforts. These include the following:

- There is currently a pipeline leaking talent in the U.S.
  - For every 100 that start high school, only 85 graduate.
  - Only 24 get a degree in college.
- Engaging K-14 students is vital to introducing young minds to the role of jobs and careers in engineering and manufacturing. Some suggestions were:
  - Apprenticeship programs
  - Virtual reality for recruitment
  - Hands-on building and coding of robotics
  - Competitions exercising hardware and software skills important to the semiconductor industry.
- NIST developed a roadmap for this kind of engagement.
  - Students can learn the skills through developing and manufacturing.
- Developing the US packaging workforce
- Retaining talent

Recommendation 6: Charge a national rapid action task force to develop a Knowledge, Skills, and Abilities (KSA)-to-Education-to-Jobs framework within the next year. There is no reason to wait until the formal launch of NSTC to start this program.

Dr. King Liu discussed the nationwide coordination of Workforce Development (WFD) Programs. She stated there are numerous benefits and studying various programs for gaps is valuable. She provided an example of such a national network: the NIST Manufacturing Extension Partnership (MEP), which has centers in all 50 states and Puerto Rico to support the needs of small and midsize companies. Regional coordination to establish talent pipelines that are attractive to students and employers is also important. Dr. King Liu stated that it is important that every state workforce industry system be included in the local coordination to put workforce industry dollars to work and establish apprenticeship programs.

Recommendation 6a: Develop an industry-connected, advanced packaging curriculum and education infrastructure to support students at all levels of higher education with a curriculum approved by the NAPMP to advance the needs of that program.

Recommendation 6b: Incentivize trade associations and professional societies to make their education and training programs more relevant and accessible nationwide.

Recommendation 7a: Launch a full-scale national campaign to increase awareness and excitement about microelectronics with an inspiring tagline.

Recommendation 7b: Fund CHIPS R&D programs to expand experiential learning opportunities for students.

Recommendation 8: Require CHIPS R&D program workforce development activities to include effective mentorship and other wraparound services as appropriate.

Recommendations 9: Hold recipients of CHIPS R&D program funding accountable for WFD effectiveness and efficiency, gauged by metrics tied to key performance indicators (KPIs) including awareness, accessibility, training, and results.

Dr. King Liu added some thoughts to the presentation. She stated that to excite students, K-12 teachers must be trained with stand-alone content that is easy to implement as well as accessible online to reach further into rural and underserved communities.

Questions and Comments:
Q: Was it discussed that there should be colleges specifically established for semiconductors and microelectronics?
A: This was not discussed but some colleges have specialized courses. Part of the challenge is multi-disciplinary.
Comment: The group looked at four universities that were very focused on disciplines, and they want people trained in semiconductors and additional disciplines. Have to go through masters' models.

Q: Have you thought about how many should be led by the CHIPS organization and who should be leading these efforts?
A: This is meant to be for the department heads.

Q: Who will be the coordinator of this effort?
A: They want the DOC CHIPS R&D program to be the coordinator. That doesn't mean that other agencies, such as NSF, can't take the lead in different implementations.

Q: Within the programs in the Commerce program, is the coordination more of a horizontal thing? Organizationally, how do you imagine this being run?
A: The first set of recommendations indicates that efforts should be coordinated across CHIPS Act programs. NSTC should serve as the coordinator for this effort.
C: The plan is for the workforce to be a complex landscape.

Q: In six and seven, who is the subject of that sentence? Will the NSTC or the DOC launch?
A: It has been determined. All we know is that a national campaign is needed and should not rely on each region to run their own campaign.

Q: Marketing campaign: How can we educate the youngest students behind the technology? They may not know about the ecosystem.
A: Incorporate these ideas by starting young, including incentivizing teachers.

Q: Jobs are intrinsically local. We don't have the pipeline, so many challenges are involved in an interconnected web of local and regional fields. Did you discuss the mix?
A: There was some discussion, but there was more focus on the integration at the college,

national level than a K-12, regional level.

Q: Is there capacity in the education systems to create these graduates?
A: There is capacity; it's a matter of attracting students, and hiring more teachers. There is a lot of capacity in community colleges.

Q: What infrastructure is required to get this to work?
A: Creating a repository, and the NSTC could contract that out for information.
C: If we look at the number of students, there would be a shortfall. Needs to be broader for multiple colleges.

Consensus Vote:
Recommendation 6: 0 opposition
Recommendation 6a: 0 opposition
Recommendation 6b: 0 opposition
Recommendation 7a: 0 opposition
Recommendation 7b: 0 opposition
Recommendation 8: 0 opposition
Recommendation 9: 0 opposition
A full consensus was reached, and the IAC passed all recommendations.

XI. R&D Gaps Working Group – Report Out and Discussion (Presentation)

Mr. Davis turned the meeting over to Dan Armbrust of the R&D Working Group for a report and discussion. Mr. Armbrust stated there were no changes in the group. Ken Joyce and Gregg Bartlett were added from other working groups, and Mr. Armbrust acknowledged David LaVan for the recordings of the speakers at the meetings. Mr. Armbrust stated every team member worked hard and made a dent in the work. Mr. Armbrust discussed the working group's charge was advanced packaging because packaging is not an industry in the US. Mr. Armbrust reviewed the charge of the working group, and discussed Moore's Law economics and that it would be driven by CHIPS, advanced packaging, and architectures. He stated it would be important for packaging to take a more prominent role. The working group kept thinking about application, keeping that as part of the playbook. Then Mr. Armbrust then discussed the grand challenges and the relevance of advanced packaging.

Mr. Armbrust discussed the schedule and the speakers that were leveraged to get greater expertise on the subject. He stated the group was able to find sixteen R&D roadmaps and ecosystem landscape reports and stated the materials overlapped. The group asked itself who were the most relevant speakers and thankfully, some were multidisciplinary. The working groups asked the presenters about the gaps in the ecosystems and what the CHIPS Act could do for them. The challenge was getting those answers in 20 minutes. The presenters were diverse and were broken into subgroups. Each group decided on who should be the ones the working group should listen to.

Mr. Armbrust then gave some definitions of what packaging is:

- Traditional packaging: a chip wire bonded to a Printed Circuit Board (PCB). Was meant to protect and do no harm.
- Advanced packaging: cramming chips horizontally and vertically together as if all the functions can act on a single piece of silicate.

Mr. Armbrust stated that typically it ends at the subsystem level, including over six orders of magnitude of dimensionality.

Mr. Armbrust discussed the reduction in orders of magnitude, and what an advanced package was. Mr. Armbrust mentioned packaging is a complex composite, and it really challenged the working group's abilities. Mr. Armbrust stated there was a fear of being unable to converge and get consensus regarding the packaging. The NAPMP Tech Centers Concept has enough complexity to require advisory groups. Furthermore, he stated NAPMP will require ethical advisory groups.

Mr. Armbrust concluded that advanced packaging is vast, from the solution to an error, and it is not one size fits all. He added that the Asian ecosystem has dominated the industry and they were starting with no base in substrates. He stated the US has strength in R&D and system design. He added that work needs to be done, including considering the demand-side incentives. Additionally, he noted there is an increased blurring and that wafers are becoming more prominent.

Mr. Armbrust then handed over the presentation to Dr. Ann Kelleher to discuss the recommendations.

Dr. Kelleher stated, with every recommendation, there were considerations.

Recommendation 1: Ensure an independent budget and dedicated executive leader for NAPMP, reporting to the NSTC CEO and NSTC fiduciary board. Keeping the financing independent allows for packaging to be where it needs to be.

Recommendations 2 and 3: Utilizing 9902 to incentivize an existing wafer- and panel-based manufacturer to create prototyping capabilities in the US by establishing a pilot and initial manufacturing line. Also, incentivize at least one existing substrate manufacturer to create a US pilot and initial manufacturing line with an R&D annex to explore advanced substrate options, including glass.

Recommendation 4: Ensure a robust set of programs that establish and extend enabling processes and capabilities, such as bumping line pitch sub-line/space, processing for through-silicon vias (TSVs), and hybrid bonding.

Recommendations 5 and 6: Identify electronic design automation (EDA) advanced packaging and system gaps and create pathfinding EDA tools. Create a community of stakeholders to build a digital twin capability from the R&D stage through the manufacturing stage with a tight integration to EDA/simulation.

Recommendation 7: Set grand challenges, such as achieving a 10x increase in productivity and a 10x decrease in environmental/energy footprint, including eco-benign semiconductor manufacturing.

Recommendation 8: Double the US advanced packaging university footprint. This will ensure there is a sustainable workforce for the future of advanced packaging. Dr. Kelleher stated this recommendation will take time, due to finding the universities and recruiting the faculty.

Recommendation 9: If the IAC were to call out one emerging technology to receive special attention, we believe silicon photonics is a rare general-purpose technology that should merit CHIPS Act investments.

Recommendation 10: A detailed landscape survey and gap analysis of advanced packaging, including both supply and demand in the US, leveraging recent reports of prototyping gaps in key specialty packaging capabilities.

Dr. Kelleher then discussed the measures of success for the NAPMP program.

Measures of Success

- After one year:
    - Stand up NAPMP with meaningful, collaborative demonstrators.
    - Select sites for advanced packaging of wafer-based, panel-based, and substrate producing and prototyping.
    - Solid plan established for digital twins.
    - R&D funding contests to advance unit processes and awards.
- After three years:
    - New packaging centers.
    - Through commercial incentives in 9902, create a demand for substrates and package assembly.
    - Vibrant startup community.
    - Workforce development programs.
- After five years:
    - Packaging R&D centers are up and running.
    - A high demand for workforce to join.
    - Improving automation and reducing the cost of domestic production.

Questions and Comments:
Q: If the executive director reports to the NSTC CEO, how can any budget be assured?
A: As part of setting up the NSTC, there should be a provision that the packaging should be independent.

Q: Any ways to incentivize the packaging part?
A: There was some mixed discussion. Some advised NAPMP was really good. Others said they were out of their territory. Getting past the building of the program will take care of creating the

incentive itself. If it does work, good; if not, start at square one. Government policy can help and change the demand side.

Q: NSTC is more lab-to-fab, and some of the recommendations focus on manufacturing. The NSTC does not cover the manufacturing side of things.
A: The NSTC and the fab should not be divorced from each other. They call it selective engineering. There is no real ideal structure.

Q: If you rely on the supply-side incentive, how does the cost survive the next economic downturn? The concern is what happens with the next downturn.
A: Completely respect the need to control both supply and demand and this is not a simple problem.
C: The roadmaps are fine, but you need to have specific programs to achieve them. Investment streams are the issues. We have the opportunity to not only produce roadmaps, but achieve airlock. Some folks have been doing this for years and they did not see a solution. In general, this is an area that has been underfunded by whole industry. This is where we can get ahead of the game.
C: If we want to properly establish, we need to focus on R&D and come together. The other piece of it is we have to worry about how manufacturers sustain themselves. The optics are going to be high for them.

Q: A complex set of conditions. We have advanced packaging and are opening a new vector. This is the beginning of this vector. Did you parse how NSTC could have open standards, so we can democratize CHIPS?
A: Bottom line, if the NSTC can set standards for customers, then there will be success.
C: Lot of push for our government agencies proving out and excising where these problems lie. It is taking the lead, yet showing leadership. The CHIPS Act will be more robust as it can fund what these standards are and various challenges opposing the standards.

Q: For NAPMP, you want their budget to be segregated?
A: Yes.

Q: How do we incentivize people to get involved?
A: If we have success, then companies will apply. It's about having a very candid production conversation, which is not a very easy thing to do.

Q: Where do you see metrology?
A: Metrology is absolutely key. It is critical in achieving the yield we need. Even if we have good yield, such as chiplets, putting 50 together to the power of 99, we still wouldn't have enough.

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

Recommendation 5: 0 opposition
Recommendation 6: 0 opposition
Recommendation 7: 0 opposition
Recommendation 8: 0 opposition
Recommendation 9: 0 opposition
Recommendation 10: 0 opposition

A full consensus was reached, and the IAC passed all recommendations.

XII. Public Comment Period

Mr. Davis discussed the public comment period. He stated that while the questions asked will not be responded to, they do help inform the Frequently Asked Questions posted to CHIPS.gov and allow the public to express their views in a public forum.

XIII. Summary Remarks and Next Steps

Dr. Locascio provided the summary remarks. She stated that the IAC has done such tremendous work, and the recommendations are valued. Dr. Locascio stated she thought this process of building a new organization was fun and that this is a startup with 11 billion dollars, and she is glad for this shared experience. Very deep prioritization has to occur, including sustainability. Expectations are high, and so many eyes are watching. You add all the various agencies that are involved in and integrated with the CHIPS Act, and we all come together for these shared experiences. Dr. Locascio thanked the group again for breaking down a very complex group of challenges. We are trying to build a program and an institute. People will see the result of all this work done by the IAC. Once more, thank you to the IAC and working group members, the CHIPS R&D, various groups that have come together, and the NIST staff.

XIV. Adjournment

Mr. Benjamin Davis adjourned the meeting at 4:30 pm EST.