Testimony of

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of

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Hearing on

IMPLEMENTING SUPPLY CHAIN RESILIENCY

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Introduction

Good morning Chair Cantwell, Ranking Member Wicker, and distinguished Committee members. I thank you for this opportunity to address the Committee on the critical need to bolster the semiconductor supply chain in the United States today and for generations to come. My name is Dario Gil, and I am a Senior Vice President of IBM and Director of IBM Research, the research and innovation engine of IBM. In addition to my leadership role at IBM, I am a member of the National Science Board of the National Science Foundation and the Board of Governors of the New York Academy of Sciences, and serve as co-chair of the MIT-IBM Watson Artificial Intelligence (AI) Lab.

IBM pioneers cutting-edge computing technologies. In May, we unveiled the world's first 2 nanometer chip, which could quadruple cell phone battery life, cut the carbon footprint of data centers, and drastically speed up a laptop's functions. We are also a leader in quantum computing and were the first company in the world to build a programmable quantum computer and make its computing power available through the cloud.

IBM Research is a leading-edge corporate research lab with 3,000 scientists and engineers working to build next-generation technologies that will underpin United States leadership in hybrid cloud, AI, cybersecurity, quantum computing, and accelerate the process of scientific discovery. We are committed to pushing the boundaries of technological and scientific discovery to positively shape our world.

Today, I would like to talk about three key actions the United States government should make to address the supply chain manufacturing challenge in the semiconductor industry and to avert a crisis – **invest**, create effective **partnerships,** and ensure **outcomes that benefit Americans today and in the future**.

Invest in the Semiconductor Supply Chain

First, let me speak about the need to invest in restoring the semiconductor supply chain. At the heart of the current supply chain challenges we face, which every American can now see and feel, is a tiny and often invisible ingredient that is crucial to safeguarding economic growth, national security, and our continued ability to achieve technological and scientific advances. Semiconductors. Semiconductors are the beating heart of modern electronics – they power every sector of our economy and every facet of our lives. This phone, every American's phone, could not function without them.

Semiconductor advances will be essential to unlocking fresh advances in technologies such as AI, 5G, and hybrid cloud. The set of manufacturing processes used in different generations of chips are referred to as technology nodes. A smaller technology node results in a faster and more efficient chip.

At IBM, we define advanced semiconductors as those below 10 nanometers. While the global leaders churn out advanced nodes at 5 and 7 nanometers, the United States does not manufacture any advanced nodes under 10 nanometers.[1] Some say we should not care about manufacturing advanced nodes. But we had better. This phone runs on them, and iPhones have used 5 and 7 nanometer chips since 2019.[2] And that's just phones – picture a world where laptops and other advanced machines did not work – or do not work that quickly or well. This could be our reality if the United States does not take action to address the current semiconductor shortage and ensure it does not happen again.

The facts are simple: although the United States maintains 47% of the global market for semiconductors and electronics, we only manufacture 12% of the world's capacity.[3] When it comes to the production of ultra-advanced nodes at 7 nanometers and below, just two countries – Taiwan and South Korea – dominate 100% of global production.

While the governments of other countries have invested in research and development and manufacturing incentives to boost advanced semiconductor nodes and manufacturing capabilities, the United States has not kept pace. In the last 30 years, total federal investment in research and development has never represented more than 1.2% of our GDP, and federal research and development constitutes a smaller percentage of GDP today than it did in 1964.[4] A 2019 report from the Organization for Economic Cooperation and Development (OECD) found that all countries with significant chip industries *except* the United States employ government incentives.[5] Analysts have concluded that our failure to incentivize the semiconductor industry has helped push chip manufacturing abroad.

These stark facts raise three key issues, which collectively inject an unacceptable degree of uncertainty and risk into our economy, national security, and innovation ecosystem.

First, a dearth of domestic semiconductor manufacturing capacity at all nodes crimps our access to basic ingredients that power even the most elementary devices, such as garage door openers. As a result, nearly all industries in the United States are vulnerable to global semiconductor supply chain disruptions. In 2021, semiconductor shortages idled auto production in multiple states.[6] And a lack of point-of-sale machines means that restaurants are struggling to make up business lost to the pandemic.[7] Projections show that by year's end, the shortage will impact 169 industries, and shrink 2021 GDP growth by half a percentage point.[8] This threatens both our post-pandemic recovery, and our long-term uninterrupted access to the building blocks of critical technologies.

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[1] "2021 Factbook," *Semiconductor Industry Association*. https://www.semiconductors.org/wp-content/uploads/2021/05/2021-SIA-Factbook-FINAL1.pdf.
[2] "Apple iPhone 12 Will Be Powered by The A14 Bionic 5nm Chip, Already Seen In The New iPad Air?" *News 18*, October 13, 2020. https://www.news18.com/news/tech/ahead-of-iphone-12-launch-apple-execs-shed-light-on-a14-bionic-design-performance-2958803.html.
[3] "Global Wafer Capacity, 2021-2025," *IC Insights*. https://www.icinsights.com/data/reports/5/9/brochure.pdf?parm=1625240565.
[4] "How Much is Enough?," *Center for Strategic and International Studies*, April 21, 2021. https://www.csis.org/analysis/how-much-enough.
[5] "Let the chips fall where they may: A story of subsidies and semiconductors," *The Organization for Economic Cooperation & Development*, December 4, 2019. https://www.oecd.org/trade/let-the-chips-fall-where-they-may/.
[6] "Ford to Idle or Curb Output at More Plants Because of Chip Shortage," *The Wall Street Journal*, June 30, 2021. https://www.wsj.com/articles/ford-to-close-or-curb-output-at-some-plants-because-of-chip-shortage-11625068975.
[7] "No Chips, No Tips: How the computer Chip Shortage threatens Thousands of Restaurant Service Jobs," *The Washington Post*, June 11, 2021. https://www.washingtonpost.com/business/2021/06/11/restaurant-workers-computer-chip-shortage/.
[8] "The Semiconductor Shortage of 2021," *Goldman Sachs*, March 17, 2021. https://www.goldmansachs.com/insights/pages/the-semiconductor-shortage-of-2021.html.

Second, the lack of domestic semiconductor manufacturing capacity, especially for advanced nodes under 10 nanometers, also saps our ability to work with allies to promote United States-designed and manufactured chips in global markets. America could be exporting advanced semiconductors under 10 nanometers to supercharge our technological and scientific leadership abroad. But, in lacking production capacity for advanced chips, we are foreclosing on the prospect that emerging technologies will be pioneered and manufactured in the United States. We must reverse this trend.

Third, the lack of investment in research, development and prototyping undermines our efforts to retain strong American leadership in this strategic gateway technology. Using history as a guide, the United States should recall that we have not always lacked domestic manufacturing capacity: as recently as 1990, we manufactured 37% of global semiconductor capacity.[9] We can produce a significant percentage of chips in the United States again. The United States government has played a significant role in supporting manufacturing and research in key areas, and it needs to step up once again to secure onshore semiconductor production and secure supply chains.

Thankfully, the President's 100-Day Supply Chain Review, and a bipartisan consensus in Congress, demonstrate a will to address both short and long-term supply chain manufacturing challenges through investment. And, they recognize that while new manufacturing in the United States is important to improving the resilience of our supply chains, we must also invest to maintain leadership in advanced research and development. Crucially, the United States Senate has provided a strong catalyst for investment by overwhelmingly voting to support USICA and the CHIPS Act.

Forge Partnerships

I have spoken about the need for investment, and now let me turn to the need for partnerships. At IBM, we have a strong track record of semiconductor innovation. These innovations are the product of decades of research and development carried out by IBM in New York State. These innovations stem from partnerships – where IBM scientists work in close collaboration with public and private sector partners to push the boundaries of logic scaling and advanced semiconductor capabilities.

As a nation, we must build on this collaboration and take full advantage of existing semiconductor ecosystems. IBM strongly supports the recommendation contained within the President's 100-Day Supply Chain review aimed at strengthening our semiconductor manufacturing ecosystem by promoting collaboration.[10] At IBM we understand the power of collaboration and have expertise in creating successful partnerships that cut across domains. In addition to our semiconductor innovation ecosystem – which led to the 2 nanometer chip – during the pandemic we worked with the federal government, industry, and academia to create the COVID-19 High Performance Computing Consortium – which provides access to the world's most powerful supercomputing resources to support COVID-19 research. The consortium was launched and scaled with unprecedented speed when competitors all came to the table to mobilize for a greater purpose.

Today, we find ourselves at another inflection point. And again, IBM is committed to working across industry, government, and academia, this time to leverage the initial down payment provided by the CHIPS Act to boost short and long-term semiconductor supply chain resiliency.

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[9] "Turning the Tide for Semiconductor Manufacturing in the US," *Semiconductor Industry Association*. https://www.semiconductors.org/turning-the-tide-for-semiconductor-manufacturing-in-the-u-s/.

[10] "Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth," *The White House*, June 2021. https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf.

A major first step to building American capacity would be to establish the National Semiconductor Technology Center (NSTC), as included in the 2021 NDAA and the CHIPS Act within USICA. IBM believes the NSTC could be a lynchpin for addressing supply-chain disruptions if it leverages proven ecosystems in the following ways:

First, the NSTC should be established immediately and then move fast.[11] The short-term semiconductor shortage, paired with the specter of long-term global competition for supply, means there is no time to waste building out United States semiconductor innovation capability. The shortest and most efficient path to deliver results is to leverage our strengths, building on billions of dollars in previous and existing semiconductor infrastructure investments, while at the same time working to forge new industry-led innovation pipelines.

Second, the NSTC should leverage existing, proven ecosystems for semiconductor research and development with strong track records of leading-edge innovation. For example, the NSTC could be built around the existing multi-company semiconductor ecosystem infrastructure in Albany, NY, which is already home to advanced photo-lithography capability including EUV (Extreme Ultra-Violet Lithography), advanced logic pathfinding, AI hardware research, and the development of new semiconductor materials. By leveraging proven ecosystems such as the Albany Research Center, the NSTC could be operational in as little as 6-12 months as opposed to years. While IBM is prepared to lead such a consortium, we recognize that success requires maximizing participation of all partners.

Deliver Sustained Outcomes

Investment and partnerships are critical to supply chain resiliency, and now I would like to turn my attention to how we leverage them to deliver outcomes. The President's 100-Day Supply chain review makes note of the extremely complex nature of semiconductor supply chains, and the need for public and private interests to work together to bolster multiple segments of this supply chain. While the United States leads the world in semiconductor research, design and tooling, there is no integrated, collaborative mechanism between industry, academia, and government in advanced development, prototyping and packaging, and advanced manufacturing capabilities. This creates substantial supply chain vulnerabilities.

A well-structured and governed public-private NSTC could address this shortfall. It could also serve as an important link between academic research, government R&D labs and programs, company specific R&D, and product manufacturing. This is what is needed to get this right and to ensure we reap the benefits and protections of our investments long into the future.

The NSTC should be built as an industry-led, agile public-private consortium with widespread industry participation, including small, medium, and large companies, entrepreneurs, and VC's. Having access to NSTC capabilities and expertise can help lower the barriers to entry to the capital-intensive semiconductor industry. Rather than creating another government program office to operate the NSTC, it should use an industry-led consortium model proven in the semiconductor industry and other industry sectors. An agile model would allow the NSTC to have an operating team up and running in months, not years.

Also, leadership, accountability and a strong technical agenda are critical for consortium success. Oversight of funding from federal and state governments as well as the member contributions is critical. A Board of Directors with an Executive Committee consisting of key industry and government stakeholders would

[11] Ibid.

provide this function and determine technical directions and program management with input from a technical advisory committee and consortium members.

The NSTC should take a manufacturing-agnostic approach to be an accelerator in moving designs to multiple fabrication plants in the United States. Such an approach would help spur new capacity and job creation in America, enabling American innovators, big and small, to move semiconductor designs to any manufacturing plant. And it would provide needed flexibility in the United States manufacturing supply chain to support both government and commercial needs.

Finally, I would like to explain why STEM education and developing a semiconductor workforce is critical to ensuring that Americans of all backgrounds can participate and benefit from the investments and partnerships we forge. A robust semiconductor ecosystem requires far more than just the physical assets of research and development labs and manufacturing plants. Ultimately, semiconductor ecosystems are driven by the diverse and constantly evolving talents of American workers. Investments to bolster semiconductor supply chains by supporting ecosystems requires a skilled workforce fluent in semiconductor research and development, manufacturing, and advanced packaging. As a result, workforce development, education, and tight integration with universities, community colleges and other training programs are critical components of the NSTC. Investments in a semiconductor workforce will alleviate supply constraints and enable the creation of semiconductor know-how necessary for future technology developments in hybrid cloud, and AI.

A May 2021 study commissioned by the Semiconductor Industry Association found that, from 2021-2026, $50 billion in CHIPS Act funding would result in the creation of 185,000 temporary jobs annually and add $24.6 billion annually to the United States economy as new semiconductor manufacturing facilities come online. Beyond 2026, the study found that CHIPS Act investment would add 280,000 permanent jobs to the United States economy.[12]

We should meet this demand for talent by harnessing CHIPS Act funding as a force for inclusive job creation that spurs long-term innovation. The NSTC should lead workforce programs to help train workers for jobs in the industry across the United States.

In addition, to maintain our global competitiveness, we must also dramatically increase the number of individuals from underrepresented communities in STEM fields, as noted in the National Science Board's Vision 2030 report.[13] IBM has committed to investing $100 million in technology, assets, resources, and skills development through partnerships with historically black colleges and universities through the IBM Skills Academy Academic Initiative. But, while the private sector devotes significant funding to STEM education, we need to do more to collaboratively addresses urgent areas of need, share resources, and bring the combined weight of the government and industry together to ensure increased diversity in STEM fields.

For a start, we should reform the Higher Education Act (HEA). For example, Congress could loosen federal work study restrictions to accommodate off-campus work experience in the private sector; expand Pell Grants to cover skills education for part-time students and mid-career professionals; and make career-oriented education beyond bachelor's and other traditional education degrees eligible for federal student loans.

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[12] "Robust Federal Incentives for Domestic Chip Manufacturing Would Create an Average of Nearly 200,000 American Jobs Annually as Fabs are Built, Add Nearly $25 Billion Annually to U.S. Economy" *Semiconductor Industry Association*, May 19, 2021. https://www.semiconductors.org/robust-federal-incentives-for-domestic-chip-manufacturing-would-create-an-average-of-nearly-200000-american-jobs-annually-as-fabs-are-built-add-nearly-25-billion-annually-to-u-s-economy/.

[13] "National Science Board Vision 2030," *National Science Board*, May 2020. https://www.nsf.gov/nsb/publications/2020/nsb202015.pdf.

Also, IBM supports an Executive Order that expands the Department of Labor's Employment and Training Administration apprenticeship efforts to provide good paying sector-based pathways to jobs in the semiconductor industry. This expansion can be built on the successful work started in 2019 to update the traditional apprenticeship model with paid, hands-on learning for the digital era in careers in coding, design, and cybersecurity. This program was particularly attractive to mid-career workers who want to build new skills or break into new industries without incurring student debt or taking time off from work. The program grew twice as fast as expected, and as a founding member of the GTA apprenticeship coalition, we are proud to share our apprenticeship framework with some of America's top employers.

Meanwhile, in 2020, IBM joined with other employers, education institutions — including community colleges — and education service organizations to demonstrate an education and employment record exchange. Improving the technical infrastructure to better support the exchange of education and skills-based credentials would significantly ease the management and exchange of these certifications, empower learners with trusted skills-based information, and align their skills to in-demand jobs. The Department of Commerce played a critical role in the 2020 demonstration and should convene stakeholders to resolve governance issues in the electronic exchange of credentials between educators, and employers.[14]

Lastly, and importantly, in addition to workforce training, IBM also understands that strong semiconductor ecosystems must also include support for medium and small sized enterprises that contribute to supply chain resiliency. The Albany Research Center is a model for how a multitude of partners can drive semiconductor research and innovation — and jobs.

Conclusion

My testimony today focused on the risks posed to the United States by current supply chain disruptions, and the urgent steps we must take to develop a semiconductor ecosystem that supports economic and job growth, and our national security. We have an unprecedented opportunity before us – to unlock fresh advances in technologies and ensure United States leadership. Semiconductor supply chain shortages present a danger with potentially dire consequences for our economy, jobs, and national security. But through investment, partnerships, and maintaining a focus on long-term outcomes, we can succeed in meeting these challenges. Thank you.

[14] "American Workforce Policy Board (9/23): IBM Pilot Video," *United States Department of Commerce*, September 23, 2020. https://www.youtube.com/watch?v=w9y0J0DmPvE.