FROM THE EDITOR-IN-CHIEF

An Incoming World of Decoupling Siliconomy

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When Professor Chris Miller's bestseller book, *Chip War*, was announced in September 2022, I immediately hit the button to pre-order a Kindle copy. Never before had the chip and semiconductor industries received such widespread attention from both the U.S. Government and the general public. Many of us tech enthusiasts felt vindicated when we watched President Joe Biden hold up a silicon wafer at the White House for a semiconductor CEO Summit and join several top CEOs of the chip design industry at Taiwan Semiconductor Manufacturing Company's (TSMC's) "tool-in" ceremony in Phoenix, AZ, USA. Suddenly, terms like foundries, TSMC, EUV (Extreme Ultraviolet), and FinFET became household names. The situation is a stark contrast to a few years ago when I had to painstakingly explain to my fellow Facebook software engineer colleagues about what type of business TSMC is in and what products they make. At the time, they could barely grasp the role of a "fab" in the high-tech ecosystem. Now, I can effortlessly discuss fabs, chip design, and government subsidies with a total stranger sitting next to me serendipitously in a restaurant in Frankfurt, Germany, during my Christmas break.

I have been captivated by the potential long-term implications of geopolitics due to chip supplies since I was first taught the concept of the "Thucydides Trap" by Dr. Morris Chang, founder of TSMC, a few years ago in the quarterly executive meeting during my tenure at this largest chip manufacturer. This term, coined by Prof. Graham Allison of Harvard University, makes a stunning premonition: when a rising power threatens to displace a ruling power, history shows us the clash of the two powers will (75%) likely result in a war. Due to the current intense rivalry between the United States and China for global leadership, the clash is aggravating and gradually unraveling the globalization the world has been enjoying. "Semiconductor chips are the crude oil of the 1980s" as AMD founder Jerry Sanders once declared.

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Over the past few years, we have witnessed escalating concerns and accusations regarding stolen intellectual properties, corporate espionage, and national security threats involving countries beyond the world's two largest economies. In response, governments implemented new regulation and policies to protect their own interests through measures such as business decoupling, technology and material embargoes, disapproval of mergers and acquisitions, and various forms of isolationism—marking a new form of stand-off since the end of the Cold War. Drawing lessons from Asian countries' successful development of their local semiconductor industries through significant national investments and subsidies, the U.S. Congress passed the CHIPS Act. This landmark legislation includes a $39 billion subsidy for onshore semiconductor manufacturing, demonstrating the U.S. Government's determination and commitment to reclaim the semiconductor leadership and reinforce national security. Furthermore, the National Semiconductor Technology Center (NSTC) was established to accelerate the restoration of the semiconductor ecosystem on U.S. soil and reinvigorate United States' leadership in its foundational technologies.

As the United States began regulating the export of high-performance computing chips to China, China reciprocated by introducing new guidelines restricting the domestic use of chips designed by U.S. companies such as those from Intel and AMD. Meanwhile, the Chinese government doubled down on the investment in chips through their National IC Fund, also known as the "Big Fund," to catalyze the establishment of their own chip supply chain, minimizing their reliance on foreign technologies in the long run. Allegedly, China's state-led investment in chips has exceeded $150 billion since 2014. The tactics employed by both governments will only accelerate the bifurcation of today's chip ecosystem, effectively decoupling the "siliconomy" looking forward.

Meanwhile, advanced chip development never slows down its pace. With Moore's Law still very much alive and novel packaging techniques, IC designers do not stop to pack more devices onto the same chip

APPENDIX: RELATED ARTICLES

A1. R. Bhargava and K. Troester, "AMD next-generation 'Zen 4' core and 4th Gen AMD EPYC server CPUs," *IEEE Micro*, vol. 44, no. 3, pp. 8–17, Jun. 2024, doi: 10.1109/MM.2024.3375070.

A2. M. Subramony, D. Kramer, and I. Paul, "AMD Ryzen 7040 series," *IEEE Micro*, vol. 44, no. 3, pp. 18–24, Jun. 2024, doi: 10.1109/MM.2024.3394479.

A3. J. Howard, J. B. Fryman, and S. Abedin, "The first direct mesh-to-mesh photonic fabric," *IEEE Micro*, vol. 44, no. 3, pp. 25–32, Jun. 2024, doi: 10.1109/MM.2024.3387828.

A4. A. Gholami, Z. Yao, S. Kim, C. Hooper, M. W. Mahoney, and K. Keutzer, "AI and memory wall," *IEEE Micro*, vol. 44, no. 3, pp. 33–39, Jun. 2024, doi: 10.1109/MM.2024.3373763.

A5. B. Kim et al., "The breakthrough memory solutions for improved performance on LLM inference," *IEEE Micro*, vol. 44, no. 3, pp. 40–48, Jun. 2024, doi: 10.1109/MM.2024.3375352.

A6. S. Lie, "Inside the Cerebras Wafer-Scale Cluster," *IEEE Micro*, vol. 44, no. 3, pp. 49–57, Jun. 2024, doi: 10.1109/MM.2024.3386628.

A7. I. Winfield, T. Ouradnik, J. Madril, M. Matthews, and G. Romero, "High-performance cooling for power electronics via electrochemical additive manufacturing," *IEEE Micro*, vol. 44, no. 3, pp. 58–66, Jun. 2024, doi: 10.1109/MM.2024.3360255.

A8. M. Gibbs, K. Woodward, and E. Kanjo, "Combining multiple tiny machine learning models for multimodal context-aware stress recognition on constrained microcontrollers," *IEEE Micro*, vol. 44, no. 3, pp. 67–75, Jun. 2024, doi: 10.1109/MM.2023.3329218.

A9. J. J. Yi, "Analysis of historical patenting behavior and patent characteristics of computer architecture companies—Part X: Patent families," *IEEE Micro*, vol. 44, no. 3, pp. 76–80, Jun. 2024, doi: 10.1109/MM.2024.3394670.

A10. S. Greenstein, "The Worlds I See: Curiosity, exploration, and the discovery at the dawn of AI—Fei-Fei Li (New York, NY, USA: Flatiron Books, 2023, 336 pp," *IEEE Micro*, vol. 44, no. 3, pp. 82–84, Jun. 2024, doi: 10.1109/MM.2024.3390268.

footprint, expanding the computing capability of chips continuously and enabling more jaw-dropping applications interwoven into our daily lives. Today, commercial chips such as latest Blackwell GPU have surpassed the watermark of 100 billion transistors. One technology featured in this Special Issue has successfully surmounted the lithography reticle size limit of 858 mm^2 since its debut in 2019. Chips are never hotter.

In this special issue, we bring to you seven selected works from the 2023 Hot Chips program.[A1,A2,A3,A4,A5,A6,A7] First and foremost, I would like to thank the Program Co-Chairs of this legacy symposium, Dr. Heiner Litz from UC Santa Cruz and Dr. Natalia Vassilieva from Cerebras, who also served as the Guest Co-Editors of this Special Issue on Hot Chips 2023. These selected works include state-of-the-art processor architectures, accelerators, and interconnect fabric design from innovative industry leaders such as AMD, Cerebras, Intel, and Samsung; in-depth performance analysis from Berkeley researchers for modern artificial intelligence (AI) workloads providing insight into model architecture design and deployment in overcoming the scaling disparity between memory and compute; and a novel thermal management technique beyond liquid cooling. Please read the Guest Editorial message by Dr. Litz and Dr. Vassilieva to have a preview of these articles.

In addition to articles selected from Hot Chips, we feature an article that shows how to design a tinyML-enabled microcontroller that is capable of inferring real-time information, from heart rate and electrodermal activity, to aid in stress detection and mitigation.[A8] For the Micro Law[A9] column, in his series, Dr. Joshua Yi continues his analysis of the characteristics of patent families from his article in the last issue. Finally, in the Micro Economics column,[A10] Prof. Shane Greenstein provides a review of Prof. Fei-Fei Li's memoir titled *The Worlds I See: Curiosity, Exploration, and the Discovery at the Dawn of AI*—an inspiring journey through the eyes of the luminary often referred to as the Godmother of modern artificial intelligence. I hope you enjoy the articles in this issue.

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