IPS

Carnegie Mellon University
Journal of Politics and Strategy

# Spring 2022

Volume 6, Issue 2

Featuring interviews with the 2021-2022 IPS Military Fellows and the Master's Thesis Corner

# TABLE OF CONTENTS

# Why Washington Needs to Get Serious About Semiconductors

JEFFERY YOHAN KO

If we are to take a step back and analyze the implications of pandemic-accelerated supply chain shocks, we can more readily understand that these shocks were inevitable. In the specific context of semiconductors (integrated circuits/transistors/processing units), the disruptions to the fabrication process have demonstrated the need to explicitly define the intersection of innovation and interests. The discussion needs to shift from "semiconductors are important and vital for everyday life" toward a more grounded realism. Every step of the fabrication process, from the design to diffusion, presents unique challenges that require more nuanced discourse in the public policy sphere.

Investment in more advanced domestic semiconductor fabrication should be made mainstream particularly when discussing strategic competition with countries like the People's Republic of China (PRC). Trade wars and military capability buildup do not exist in a separate vacuum of instrumental modality. Semiconductors, both their capabilities and security, are vital components of communications networks, imagery and reconnaissance satellites, threat detection networks, naval ships, and of course, smart refrigerators. [1]Hardware-based encryption supplements software level encryption of data and code to ensure fewer methods of exploitation by ensuring ciphertext codes are communicated to a receiver who has a key to decrypt. For less complicated application specific integrated circuits, such as smart refrigerators (whose market share is set to double by 2025) or televisions, bleeding edge semiconductor technology is not necessary. With that in mind, almost all appliances/devices capable of controlling an integrated instruction program or sending/receiving signals contain some sort of application specific integrated circuits.

For this reason, the Department of Defense has awarded Intel a contract to develop, in conjunction with the Defense Advanced Research Projects Agency (DARPA), new structured application-specific integrated circuits to power more efficient and secure military-use microelectronics. [2]

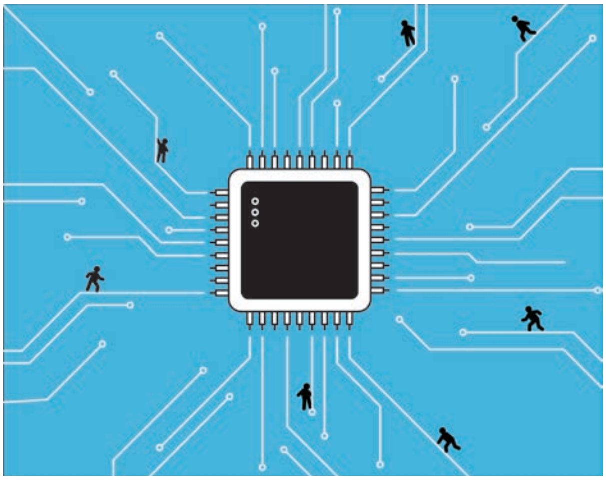
However, that partnership represents only a fraction of the total number of units of secure microelectronics and networks that the military, and other agencies, utilize. Taiwan Semiconductor Manufacturing Company (TSMC) produces the most advanced processors that guide Lockheed Martin's F-35 Lighting II and supplies other manufacturers such as Xilinx

1 Arcuri, Gregory. "The CHIPS for America Act: Why It is Necessary and What It Does." CSIS, January 2022: csis.org/blogs/perspectives-innovation/chips-america-act-why-it-necessary-and-what-it-does
2 Eversden, Andrew. "Pentagon, Intel partner to make more US microchips for military." C4ISRNET, March 2021: c4isrnet.com/battlefield-tech/it-networks/2021/03/19/pentagon-intel-partner-to-make-more-us-microchips-for-military/

**Jeffrey Yohan Ko** *graduated with a Master of Science in International Relations and Politics. He completed his undergraduate studies at Carnegie Mellon University with a Bachelor's Degree in International Relations and Politics with a minor in Cybersecurity. He has focused his research on the role of technology and private military organizations in national security analysis and conflict studies.*

(freshly acquired by AMD).[34] For several CPU architecture generations now, Intel has been falling behind in node technology compared to TSMC, though it should be noted that this applies most specifically to desktop and server grade processors.[5] As modern capabilities require more computational power, strategic competition with the PRC continues to unfold in the military technology space.

The continued investment into more advanced semiconductor technology is critical for staying ahead of hardware vulnerabilities that stagnant development presents. In 2018, the security vulnerabilities Meltdown and Spectre were made publicly aware and raised discussions about the penetration process and payload type.[6] While the extent to which these vulnerabilities could present critical issues to military-use technologies is unknown, it is well-known that malicious actors can exploit a processor's internal buffers to extract encrypted information and keys. Though there has been no attributed actor, Meltdown and Spectre exploits have been detected in products from almost all major firms (Intel, AMD, ARM) ranging across several architecture generations. Aging military technology and the vast quantities of equipment that can store encrypted information mean that potential targets and exploits are likely more numerous than mainstream discourse makes it appear to be.



Given these realities, current partnership programs and Congressional funding for domestic semiconductor fabrication are woefully inadequate in addressing the tantalizing impact of sourcing the majority of electronic and circuit components from Taiwan, which has been subject to constant encroachment by mainland China.

Worse still, current legislative efforts are inadequate. For example, the Creating Helpful Incentives to Produce Semiconductors (CHIPS) for America Act fails to address the timeframe in which its lofty ambitions fall subject to. And although passed by Congress last January, the act has yet to authorize any funding for the programs laid out in its mandates.[7]

Intel, meanwhile, is years behind the bleeding-edge node technology that TSMC has made readily available at the consumer level. For example, Intel has finally transitioned from nearly a decade of 14nm FinFET technology to 10nm (which it conveniently labeled Intel 7) whilst TSMC enters the final phases of its risk production of 3nm node technology. Intel designs and manufactures its own semiconductors, whilst TSMC supplies the physical die to fabless companies like Advanced Micro Devices (AMD). All these discussions continue as Congress has yet to agree on the actual allocation of funds to the programs designed to alleviate the issues I highlight.

3 Qi, Ciel. "Taiwan's bargaining chips." Techcrunch, December 2021: techcrunch.com/2021/12/02/taiwans-bargaining-chips/
4 Gartenberg, Chaim. "AMD's $35 billion Xilinx deal has gone through." The Verge, February 2022: theverge.com/2022/2/10/22927040/amd-35-billion-xilinx-deal-fpga-chips-regulators
5 Areej. "Intel's Foundries Expected to Lag Behind TSMC for At Least Another 4-5 Years." Hardware Times, February 2021: hardwaretimes.com/intels-foundries-expected-to-lag-behind-tsmc-for-at-least-another-4-5-years/
6 meltdownattack.com
7 Arcuri, Gregory. "The CHIPS for America Act: Why It is Necessary and What It Does." CSIS, January 2022: csis.org/blogs/perspectives-innovation/chips-america-act-why-it-necessary-and-what-it-does

The one element that permits this lengthy and on-going discussion is the fact that China has yet to successfully produce highly-advanced semiconductor technology domestically.[8] It has largely been forced to import the more advanced processors from the US and has significantly invested into the design, testing, and diffusion of semiconductors that are beyond the low-level logic chips that it currently produces in bulk.[9] And yet, that certainly is not to say that the current state of domestic semiconductor production in the U.S. can continue indefinitely.

It is time for Washington to seriously consider the future of its capabilities through the lithography of advanced computing. Because fabrication facilities are transistor technology specific, the transition from investment into actualization will take time. Challenges are also presented by the contrasting nature of the leading semiconductor manufacturers. AMD's architecture design is dependent on TSMC's node advancements and stability. Intel designs and validates their own processor architectures and is responsible for developing the node technology required to merge the instruction sets to hardware. Balancing security concerns with market competition ultimately requires government oversight with industry cooperation. While high-level contracts with semiconductor suppliers are likely insulated from supply-chain disruptions (as Apple was during the silicon shortage resulting from the pandemic), growing standoffs with China can affect the US' ability to consistently import processors from fabrication facilities in Taiwan. [10]

8 Kharpal, Argun. "China is pushing to develop its own chips — but the country can't do without foreign tech," CNBC, October 2021: cnbc.com/2021/10/25/china-pushes-to-design-its-own-chips-but-still-relies-on-foreign-tech.html

9 Thomas, Christopher. "Lagging but motivated: The state of China's semiconductor industry." The Brookings Institute, January 2021:

10 Wu, Debby. "Apple Finally Falls Victim to Never-Ending Supply Chain Crisis." Bloomberg, October 2021: bloomberg.com/news/articles/2021-10-13/apple-finally-falls-victim-to-never-ending-supply-chain-crisis