Technology Policy

By: Jeffrey D. Bean and Andreas Kuehn

Notwithstanding the deserved attention now paid in the United States to semiconductors as enabling building blocks for the economy — and the substantial sums being directed in investment and subsidies — the U.S. defense industrial complex remains hampered by supply constraints when it comes to military-grade semiconductors. Part of the justification for the CHIPS and Science Act 2022 was the importance of retaining U.S. semiconductor leadership for national security purposes. For example, the F-35 Lightning II fighter jet, considered the most advanced and versatile U.S. military aircraft, uses hundreds of chips, including Field Programmable Grid Arrays (FPGAs), custom-built chips that have the flexibility to achieve several different specific functions — like a customized Swiss army knife. Beyond weapons and military platforms, the range of national security uses for advanced chips, from planning and securing communications, to incorporating artificial intelligence, to modeling nuclear weapons through high performance computing systems, is immensely varied and crucial for national security, especially as adversaries are investing in and harnessing advanced technologies to strengthen their own military forces.

At the same time, many of the chips used in today's weapons, including some in the most important systems, are older than those in an 8-bit Nintendo gaming console. The Department of Defense (DoD) has often struggled to keep sourcing these legacy chips for weapons systems, often designed several decades ago, as they often require long periods of production with hardly any other relevant customer than the military. These are still used for avionics, communication systems, radar, and missile guidance systems — such as for the Tomahawk cruise missile or the F-16 fighter — because they can perform and are proven be maintainable under harsh conditions, including with heat, pressure, and radiation tolerances that commercial chips lack.

There are multiple challenges with incentivizing and scaling semiconductor production for military purposes, including many long-standing hurdles in U.S. procurement. More specifically, these include the speed of technological change, the previously referenced extended lifespan and deployment of military hardware across the different branches of the armed services leading to the need for a continual, low volume supply of obsolete chips, the need for reliability, and the sheer variety of applications required for the military, some of which are very specific or niche – such as the ability to operate in bands or frequencies outside of commercial products. When coupled with a minuscule market size relative to the commercial market and the high capital cost of fabs, these requirements make it challenging for firms to find commercially viable pathways when it would be more efficient to just fabricate more commercial chips. Moreover, investments are not necessarily as lucrative as commercial chip manufacturing: in 2023, the global semiconductor market was $526.8

billion, but for military defense and aerospace applications, the size was estimated to be somewhere between only $6.84 billion and $25 billion. Thus, for example, in recent years GlobalFoundries stopped the production of 7nm node chips for defense and commercial applications in East Fishkill, New York, in favor of high volume production of less advanced nodes.

For these and other reasons, the continuing reality is that advanced semiconductor manufacturing remains highly concentrated in East Asia. Given that TSMC and the smaller UMC, both headquartered in Taiwan, are among the primary foundry sources for chips utilized in the F-35, the effort to have advanced semiconductor fabrication facilities onshored in Arizona not only substantially reduces that risk of geographic concentration but brings critical semiconductor capabilities and capacities to the United States, especially if TMSC's advanced packaging capabilities, such as CoWoS (Chip-on-Wafer-on-Substrate) are incorporated in the two new packaging facilities in Arizona. Similarly, the U.S. government announcement that Intel has been awarded $3 billion through the Secure Enclave program under the CHIPS Act. That represents a necessary but insufficient first step to meet military chip procurement needs.

Looking ahead, as the Department of Defense strives to incorporate and utilize more AI chips, it will need to secure access to leading nodes for edge chips and the confidence in pathways to use greater allocations of secure cloud services for advanced computing. Currently, the most advanced trusted foundry producing chips at scale for the U.S. military is the GlobalFoundries Fab 8 in Malta, New York. This will not be sufficient to secure the supply of chips for the full breadth of U.S. military applications going forward; the Secure Enclave program investment in Intel will only partly fill that need on AI chips, and Intel has troubles of its own. Investments in the eight DoD Microelectronics Commons Hubs are also imperative to lift DOD innovation, but constitute long-term research and development efforts. Two and a half years on from the CHIPS and Science Act becoming law, this crucial national security effort is still nascent and will require sustained bipartisan support and leadership from the Trump administration to right-shore relevant semiconductor capabilities and supply chains.

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