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Author:
Edward Wilford, Senior Principal Analyst
Sam Lucero, Chief Analyst, Quantum Computing

Connecting the dots on the CHIPS+ Act and applied intelligence

Omdia view

Summary

In August 2022, President Joe Biden signed into law the CHIPS and Science Act (also known as CHIPS+, with "Chips" here standing for "Creating Helpful Incentives to Produce Semiconductors"). CHIPS+ provides unprecedented funding and support for various areas of the semiconductor industry in the US. Over $50 billion will be made available to support manufacturing facilities for semiconductors inside the US. A further $170 billion is earmarked for research and development (R&D) into cutting-edge semiconductors, specifically focusing on artificial Intelligence (AI) and quantum computing (QC). The bill represents perhaps the largest investment in R&D ever made in the US and will undoubtedly have a profound effect on the semiconductor industry as a whole and in AI, the Internet of Things (IoT), and QC. However, as with any project on a massive scale, open questions remain on how best to use the available funds to foster and strengthen the industry.

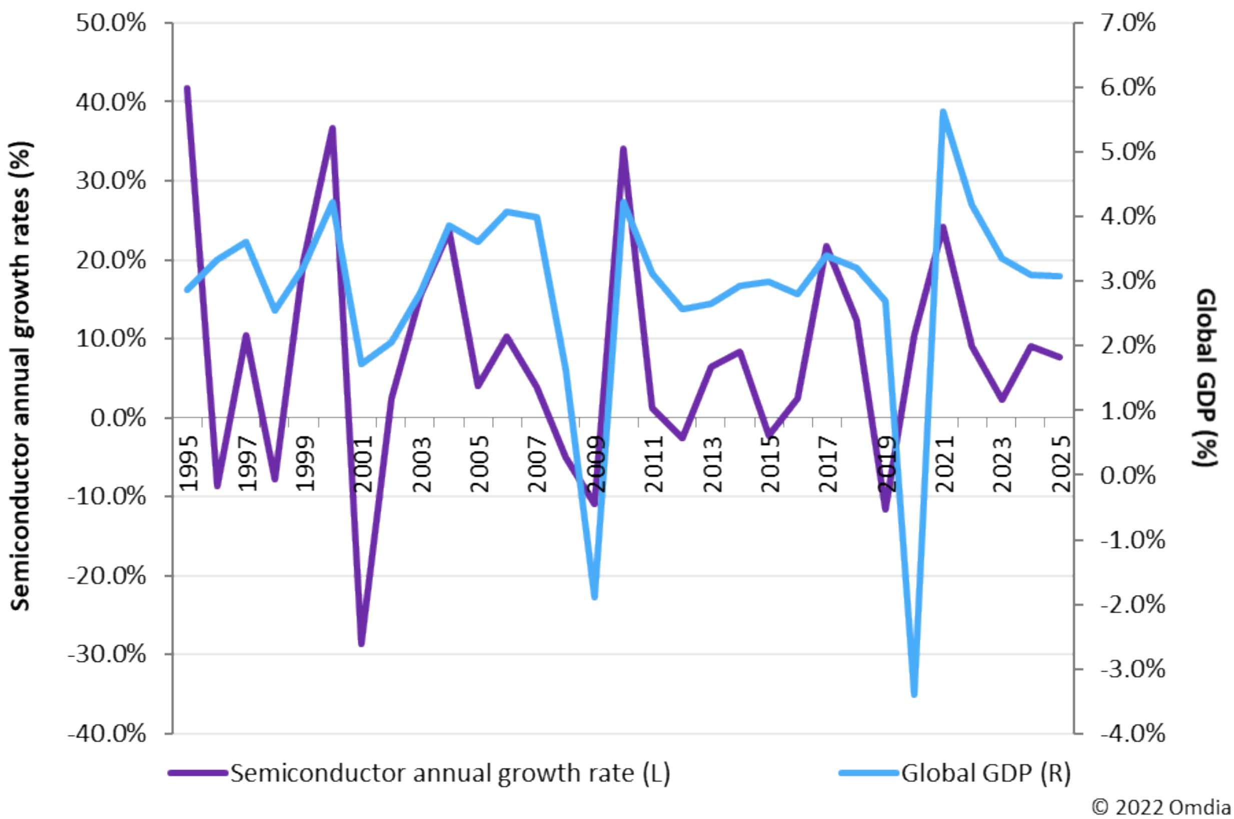
A new age of government support for the semiconductor industry?

The opening paragraph of the recently released report from the President's Council of Advisors on Science and Technology makes it clear that Americans (and people worldwide) "rely on semiconductors every day without even realizing it." Chips have become deeply embedded in the modern world, so much so that whole segments of society cannot function without semiconductors—specifically connected semiconductors. For many applications, there is simply no backup.

Many recent articles discuss semiconductor shortages affecting industries as a whole. Yet, it is worth looking at how the shortages affect industries and how renewed investments in foundries could help address those shortages. Meanwhile, it is also worth acknowledging new foundries on their own will do little without a robust supply chain serving the foundries and a sensible plan for addressing key components.

The semiconductor industry is still expected to grow considerably, despite global inflationary concerns (boiling over into recession in some countries) and the continued drag of supply line issues, worker shortages, and lingering effects of the worldwide pandemic. Despite a predicted flat period from the second half of 2022 through 2023, the industry is projected to recover to positive growth quickly. Investments in the industry from sources such as the CHIPS+ Act will doubtless be a factor in this, demonstrating confidence and commitment, if nothing else.

Figure 1: Global GDP vs. Omdia's global semiconductor growth rates (1Q22 update)



Sources: Omdia and IHS Markit

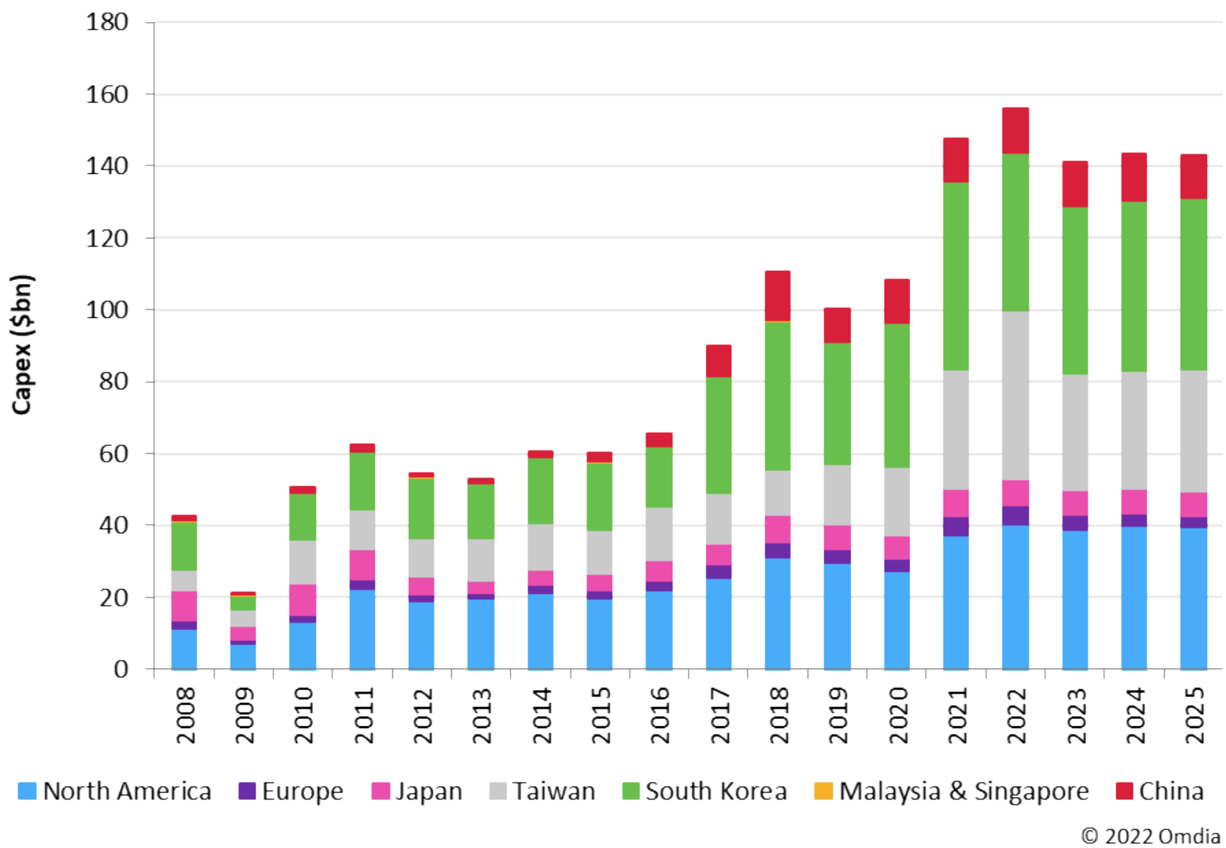
The CHIPS+ Act and its international analogs

For several years, the increasing importance of semiconductor foundries has been evident to governments and corporate leaders. The recently passed CHIPS+ in the US addresses several key areas of semiconductor production. Of the funds earmarked for the bill, the largest share—almost $170 billion—is intended to bolster R&D in semiconductors, with the funding designed to secure the US' position as the leader in cutting-edge semiconductors.

A significant amount, totaling $500 million, is intended to provide training for semiconductor foundry workers. This is especially crucial, as the work is skilled and demanding, and while it could and should be a supply of excellent region-defining jobs, there simply isn't a ready workforce to staff the new foundries the scheme should see developed. The current labor shortage in many areas of the country (and the world) is a concern for anyone in the semiconductor industry.

Other nations have also acted to shore up their national semiconductor foundation. China, although now to some extent downplaying the status of the Made in China 2025 policy (which intended to source 70% of China's semiconductor needs internally), has significantly boosted the internal supply of chips, with government expenditure on the industry generally estimated to have passed $150 billion by the end of 2021. South Korea has also seen a joint public and private investment project promising over $450 billion in investment, with global chip giant Samsung providing roughly a third of the capital. Industry leader Taiwan Semiconductor Manufacturing Company Limited (TSMC) promised more than $40 billion in investment in future chipmaking technologies in 2022 alone.

1. Figure 2: Global semiconductor capex, 2008–25 forecast by company location



Source: Omdia

AI and QC are squarely addressed

Two components of the bill, the $50 billion to subsidize manufacturing and the $200 billion for semiconductor R&D, have a specific focus on AI and QC. Omdia's calculation shows that $60 billion of funding tailored to AI research is available. This research funding will include funds for more academic research and scholarships, including a scholarships-for-service benefit and expansion of a National Science Foundation (NSF)-directed research into AI. The goal is to enable the US to continue holding a leading position in AI research. The bill addresses not just current needs but, in Omdia's opinion, also contains significant and impactful specifics related to technical training and aspects such as data science education, which are critical to power a robust and efficient AI.

The Act also represents an important investment in emerging technologies in the US, such as QC and quantum networking. The Act authorizes various investments relevant to quantum technology, totaling about $757 million over five years, although these still require appropriation by Congress.

While the major thrust of the Act's investment in the classical semiconductor industry will be to increase US-based fab capacity, the emphasis on quantum technology will differ. Quantum technology is a nascent "deep tech" still grappling with fundamental scientific and technological development challenges. As such, the need is not for capital investment for manufacturing capacity but investments that facilitate US-based R&D, ecosystem development, and workforce training. The Act provides this as an important follow-up to the 2018 US National Quantum Initiative (NQI), which had authorized $1.25 billion of federal investment for quantum technology to be administered by the Department of Energy (DOE), NSF, and National Institute of Standards and Technology (NIST).

Furthermore, advances in AI and quantum technology will largely rely on expanding "chiplet" packaging, where multiple integrated circuits (ICs) with very specific functionality are packaged together to create a larger, more powerful processing module. Because chiplet technology isn't reliant on a single foundry's output for a particular processor, it gives added flexibility to the supply chain without necessarily requiring added foundry capacity. However, a rush to chiplets may create a newer bottleneck at outsourced semiconductor assembly and test (OSAT) suppliers, as the packaging of the module is crucial.

Supply lines, power consumption, and trade-offs

One of the major motivations behind the CHIPS act (and similar initiatives in Europe and Asia) is to ensure supply chain issues such as those encountered in 2021 and 2022 do not again disrupt the economy or threaten national security and sovereignty. However, simply building foundries and relocating the point of manufacture within a nation's borders is not enough. The whole supply line serving the foundry itself must be recreated, supplying adequate raw materials—it may not be a simple endeavor to guarantee a steady supply of germanium or neon. The silicon itself must be of a certain standard of purity—the purification process is extremely energy-intensive. At the same time, a foundry also requires millions of liters of purified water daily. The sourcing of all these materials will be a major concern, with each element becoming a potential chokepoint for the supply chain. The semiconductor industry in Taiwan is widely estimated to consume between 8% and 10% of the island's fresh water, or about half as much as all household use. Also in Taiwan, TSMC has negotiated the purchase of the entire power production of an Orsted-owned offshore wind farm for 20 years, with 920 megawatts of power expected annually—enough to power over 800,000 homes. There will doubtless be political considerations to placing facilities, even on a smaller scale, in areas unaccustomed to the demands of the industry and significant challenges in satisfying the foundry's relentless water and power consumption.

The expected softening of the semiconductor market, transitioning from undersupply to a general oversupply, is also a well-timed reminder that added foundry capacity is always a long-term solution and never a short-term one. A flat market from 2022 to 2023 will undoubtedly have returned to strength by the time any new foundry capacity comes online. Omdia believes that a period of reduced economic growth is an ideal time to invest in the industry's fundamentals, with dollars spent on infrastructure, research, and training, in particular, all assisting in arresting the economic slide today and paying dividends in a forecast future economic expansion.

When the cutting edge might be a little too sharp

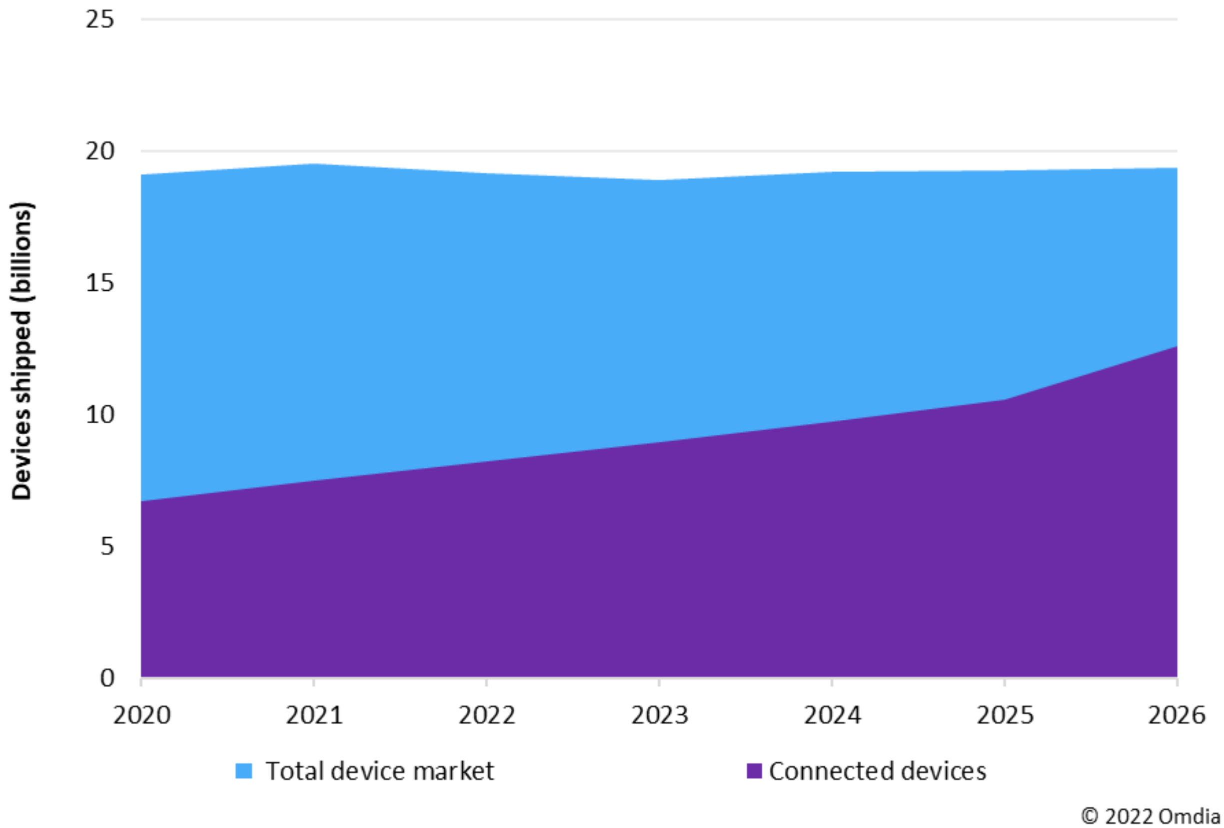
Finally, there will be a huge temptation to attempt to attract the highest-value chips (and the partners specializing in them) for these new foundries. Foundries operating in North America will be required to pay wages far above what equivalent foundries in East Asia typically pay, as the cost of living is significantly higher. Consequently, it will be difficult to supply chips with lower margins at a competitive price. Furthermore, there is money and prestige in manufacturing the biggest, the most powerful, and the most state-of-the-art. It is worth remembering, however, that the lack of the smallest, least-expensive chips can prevent a device from reaching the market. When Ford released long-delayed vehicles for delivery of missing components, it was climate-control and power-monitoring chips that were holding up completion. A vehicle with the most advanced cockpit domain controller and a raft of state-of-the-art advanced driver assistance system (ADAS) processors minus the functional safety or secure connectivity chips is essentially not a drivable car.

CHIPS+ earmarks $2 billion in 2022 for “legacy” chip production, although this most likely relates exclusively to legacy semiconductors used by the automotive and defense industries. As part of the “guardrails” provision, companies benefitting from CHIPS+ funds may not conduct a “significant transaction” relating to expanded semiconductor production in China (listed among other “countries of concern”). However, the bill specifically and narrowly discounts “legacy” chips, which it defines as those using the 28-nanometer (nm) process or greater. Semiconductor companies could use this specific exclusion to build inventory and supply chains for various crucial chips, including those related to connectivity. Presently, 28nm technology broadly dominates connectivity chips, which Omdia expects to continue in the near future (see the “28nm to be a long-lived node for semiconductor applications in the next five years” opinion by Omdia Research Director Hui He).

Make connectivity and security priorities

Two areas need particular, even preferential, treatment in expanding foundry capacity: connectivity and security. In 2021 and early 2022, Wi-Fi chipsets frequently suffered from lead times of a year or more. Similar problems befell other types of connectivity, both short range and long range (LoRa). As connectivity types and protocols continue to expand, the variety of available chips also grows, meaning the supply chain is not just stretched but made more complex simultaneously. No longer will a simple Wi-Fi/Bluetooth combo chip be enough; a device may need an 802.15.4 standard such as ZigBee or Thread and Bluetooth Low Energy (BLE), or an industrial specialist may require a proprietary standard for sensitive equipment. Remote equipment may rely on LoRa and remote equipment without the capacity to send or receive data wastes resources. As **Figure 3** demonstrates, Omdia predicts the overall share of connected devices to increase from 35% in 2020 to 65% in 2026; in an industry experiencing up to a full year’s lead time for connectivity chips at its present rate of demand, fulfilling this promise will require careful planning.

2. Figure 3: Global connected devices as a share of the total device market, 2020–26



Source: Omdia

Foundries must be encouraged to work with a wider range of chip vendors to ensure they have the correct lithography to produce connectivity and security chips when they come online (which is not expected for some years). A pile of unconnected and unconnectable high-end application processors produced at 7nm will do the industry no favors and be a poor return on the investment promised by CHIPS+ (and by extension to the initiatives offered by governments and industry worldwide). All initiatives towards producing cutting-edge chips should ensure that connectivity and security are fully accounted for, with legacy chips sourced as needed.

Sensors may provide simple data, but in aggregate, that data provide insights, and it is to provide insight into that the IoT exists in the first place. AI cannot progress without data to train it (with much of that data gleaned from microcontrollers and sensors), and quantum computers need to be connected to be more than an expensive demonstration. A cellular module, a simple gateway, a cloud-connected sensor, a piece of security hardware, a chip offering Thread connectivity and enabling a Matter network: all these devices permit the larger device to function; without them, the main processor is an undefended island. No amount of funding can compensate for the lack of secure, stable connectivity.

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Appendix

Further reading

AMFT Shipment: World & Regions – 3Q22 Update (September 2022)

Pure Play Foundry Market Tracker – 1Q22 Analysis (July 2022)

IoT Devices Market Tracker – 1H22 Database (June 2022)

"28nm to be a long-lived node for semiconductor applications in the next five years" (November 2020)

Authors

Edward Wilford, Senior Principal Analyst, IoT Hardware

Sam Lucero, Chief Analyst, Quantum Computing

askananalyst@omdia.com

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omdia.com

askananalyst@omdia.com