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# Semiconductor Shakeup

A look at key concepts in the semiconductor supply chain and what recent events mean in the competition over its control.

BY ELIOT CHEN - SEPTEMBER 11, 2022



A worker at a chip factory in Jiashan, China, May 26, 2021. Credit: TopPhoto via AP Images

It's been a frenetic month of news in the semiconductor industry, following a flurry of regulatory activity in Washington aimed at boosting American chipmaking capacity and stemming the flow of advanced chips to China.

As technology competition heats up, policymakers and observers even beyond the chip sector must familiarize themselves with an expanding vocabulary of chip-related concepts. Electronic design automation software, chips for AI, 12 nanometer vs 7 nanometer: what does it all mean, and how does it affect U.S.-China relations?

This week, *The Wire* explains key concepts in the semiconductor supply chain and what recent events mean in the competition over its control.

### The Semiconductor Supply Chain

Most chipmakers used to perform all of these steps themselves, but increasingly each stage is being conducted by specialized companies. Some firms, such as Intel, are "Integrated Device Manufacturers" (IDMs), meaning they still manage all stages in-house.



Data: White House 100 day supply chain review <u>report</u> 🖄, market reports

### ON NODES AND NANOMETERS

A n integrated circuit — also known as a chip — is a device composed of billions of transistors: computational devices that can be switched on (1) and off (0), which together are able to perform calculations at remarkable speeds.

Listen to experts compare chips and you will hear plenty about nanometers. This refers to the microscopic distance between individual transistors on a chip — just nanometers (nm) apart, or less than one-ten thousandth of the width of a human hair — with smaller distances allowing transistors to be packed more densely, increasing computing power.

Marketing and discrepancies between foundries mean the numbers (or nodes) have lost their literal meaning, but by convention firms still refer to their most advanced chips as 14nm, 10nm, 7nm and so on.

Companies at the forefront of chip development are largely located in Asia. Taiwan's TSMC and South Korea's Samsung offer 5nm chips, which Chinese producers have struggled to match. Part of what's keeping China back is export restrictions on "extreme ultraviolet" (EUV) <u>lithography machines</u>, a critical piece of hardware made by Dutch firm ASML which is needed to produce 7nm chips and smaller at scale. <sup>1</sup>The CHIPS Act, passed in August, <u>forbids</u> recipients of federal funding from investing in new plants in China that produce chips with nodes 28nm or smaller.

That's why the <u>news</u> last month that Chinese state-backed chipmaker <u>SMIC</u> had shipped a batch of 7nm chips came as a surprise: Many policymakers had assumed <u>SMIC</u> lacked the knowhow and hardware to produce such advanced chips. <u>Some</u> experts argue that <u>SMIC</u>'s reliance on older technology (deep ultraviolet, or DUV, lithography machines) may still prevent it from cost effectively producing 7nm chips at scale.<sup>2</sup>

### Chip Production Capacity by Region and Chip Type

While China and the U.S. account for 22 and 13 percent of total global logic chip capacity respectively, Taiwan and South Korea dominate the most cutting edge chip manufacturing.



Taiwan — China — U.S. — Europe & Middle East — S. Korea — Other

Data: CSET

### AIMING FOR AI

A major reason countries are eager to develop advanced chips is for artificial intelligence (AI). "AI chips" are hugely powerful integrated circuits, capable of performing demanding calculations. The process of 'training' a leading AI algorithm can require a month of computing time and cost tens of millions of dollars, according to an <u>analysis</u> by the Center for Security and Emerging Technology (CSET), a Washington D.C.-based think tank. It estimates that only nodes of 12nm and below are suitable to train and run the most complex neural networks: Older chips would require orders of magnitude more time, electricity and money.

China is a major buyer of AI chips, which are coveted by its consumer tech companies and research institutions, but also by its military, where applications include image recognition for scanning satellite imagery for weapons, or surveillance, such as by scanning audio communications for intelligence.



Chip Companies' Share of Annual Revenue from China

Almost all the AI chips that the People's Liberation Army (PLA) acquired between March and December 2020 came from American companies namely Nvidia, Xilinx (now part of AMD), Intel and Microsemi — according to a CSET <u>analysis</u> of its procurement data. In each case, the PLA acquired those chips via Chinese intermediaries, underscoring the shortcomings of U.S. export controls focused on military end-users. The records also revealed not a single contract for Chinese-made AI chips, highlighting the PLA's dependence on superior U.S.-designed technology.

Last week, the U.S. government introduced new export restrictions on the sale of high-end AI chips



to China and Russia. Nvidia, which is on the verge of releasing a groundbreaking new AI chip called "<u>Hopper</u>," has warned the ban could cost the firm

400 million in sales this quarter; AMD says it does not expect the restrictions to have a material impact.  $^3$ 

Chipmakers are among the most dependent on China for their sales among U.S. <u>multinationals</u> that disclose their regional revenue breakdowns.

### NOT JUST HARDWARE

While Asian economies dominate in chip fabrication, American firms lead in chip design and related tools. Three U.S.-based companies — Synopsys, Cadence and Mentor Graphics — <u>dominate</u> the market for electronic design automation (EDA) software, which integrated circuit designers use to design chips.<sup>4</sup>

Beijing <u>identified</u> the development of China's own EDA software as a priority in its latest five year plan. Several <u>veteran</u> engineers from Cadence and Synopsys have founded or joined Chinese EDA startups in recent years.

Last month, the Commerce Department <u>announced</u> we new restrictions on the sale of EDA software which can be used to design certain high-end chips, in line with an agreement between 42 countries. The new export control affects over 150 countries, including China. But some experts have <u>questioned</u> the degree of consensus among participating countries to the export control agreement, which <u>includes</u> most of Europe as well as Russia and India.

The U.K. government's move last month to block the Chinese acquisition of a British EDA software company shows that other countries are taking note. Then-business secretary Kwasi Kwarteng — who is now Britain's finance minister — blocked the <u>takeover</u> of EDA software provider Pulsic Ltd. by a Hong Kong holding firm controlled by Shanghai-based <u>UniVista Industrial Software Group</u>, a

### No Deal

In August, the U.K. government blocked the acquisition of EDA software maker Pulsic Ltd. by a Hong Kong company ultimately controlled by Shanghai-based UniVista Industrial Software Group. Western countries are tightening control over the sale of electronic design automation software to China.



### WireScreen

Data: <u>WireScreen</u>, Hong Kong Companies Registry

Chinese government-backed two year-old EDA software firm that is partly financed by China's national chip investment fund, also known as the "Big Fund."



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The IP Odyssey

### BY GRADY MCGREGOR

For over a decade, China's film industry has passed around and fought over the IP rights for "The Three-Body Problem" for ever-increasing sums of money — a saga that is nearly as complex and drama-filled as one of Liu Cixin's novels.