Technology

US rushes to catch up with China in supercomputer race

World's biggest economies battle to dominate advanced processing power that will affect defence and climate modelling

A US supercomputer at Oak Ridge national lab, where they are building an 'exascale' system. China is thought to have already built 2 advanced supercomputers © FT montage/ORNL/Flickr/CC

Richard Waters in San Francisco MAY 18 2022

The US is about to vault into a new era of supercomputing, with a once in a decade leap forward in processing power that will have a big effect on fields ranging from climate change research to nuclear weapons testing.

But the national swagger usually prompted by such breakthroughs is likely to be muted. China passed this milestone first and is already well on the way to building an entire generation of advanced supercomputers beyond anything yet in use elsewhere.

What makes the advances all the more remarkable, according to US experts in the field, is that China's achievement was made with local technology, after Washington blocked access to the US hardware long considered to be critical to such systems.

The build-up in China's supercomputing program, which dates back more than two decades, has led to a "stunning situation" where the country now leads the world, said Jack Dongarra, a US supercomputing expert.

The most advanced supercomputers are used to improve simulations of highly complex systems, for instance creating better models of climate change or the effects of nuclear blasts. But their secret use in classified areas, such as defeating encryption, is likely to also make them key tools in national security, according to Nicholas Higham, professor of mathematics at the University of Manchester.

China already had more supercomputers on the Top 500 list of the world's most powerful computers than any other country — 186 compared with 123 in the US. Now, by beating the US to the next big breakthrough in the field and planning a spate of such machines, it is in a position to seize the high ground of computing for years to come.

The Chinese breakthrough has come in the race to build so-called exascale supercomputers, systems that can handle 10 to the power of 18 calculations per second. That makes them a thousand times faster than the first of the petaflop systems that preceded them more than a decade ago.

In recent months, work has been under way at the US Department of Energy's Oak Ridge national laboratory in Tennessee to assemble and test the first of three exascale systems planned in the country. If the inevitable "bugs" are ironed out, the arrival of exascale computing in the US could be confirmed at the end of May with the publication of the twice-yearly Top 500 listing, according to Dongarra who maintains the list.

By contrast, China's first exascale system has been running for more than a year and has since been joined by a second, according to a recent presentation by David Kahaner, director of the Asian Technology Information Program, whose research is widely cited as the most authoritative.

China has not officially disclosed that it has two exascale systems. But their existence was confirmed late last year when scientific research run using the machines was entered for the Gordon Bell prize, with one paper taking top honours in the international supercomputing competition.

The country with the most advanced supercomputers has a clear advantage in national defence over its adversaries, said Horst Simon, who until recently was deputy director of the US energy department's Lawrence Berkeley national laboratory.

China's decision to not officially confirm its supercomputing breakthrough is a departure from decades of history in the field, where scientists usually talk openly about their achievements and countries have been quick to claim bragging rights to the top machines. The secrecy may have been to prevent further retaliation from the US, according to experts.

Washington imposed targeted sanctions against five Chinese organisations involved in supercomputing in 2019, then followed up a year ago with another round against seven more groups. The second wave was put in place the month after China's first

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A previous Chinese effort to break the exascale barrier had relied on technology from US chipmaker AMD, leaving it vulnerable to US trade restrictions. In contrast, its current two exascale systems are based on domestic chip designs. The local developers of the chips used in the two giant new systems — Tianjin Phytium Information Technology and Shanghai High-Performance Integrated Circuit Design Center — were both on last year's US sanctions list.

"I think it's quite impressive that they were able to put in place a system based on their own technology over a very short period of time," said Dongarra. He added that it was unclear whether the chips were manufactured in mainland China — which is still years behind in matching the world's most advanced chip fabs — or in Taiwan.

China has been building a domestic industry around supercomputing for years, first shocking its main rivals in the US and Japan in 2000 when it unveiled what was then the world's fastest machine. But the dawn of the exascale computing era could be a chance to grab a clearer lead.

While the US has three exascale systems in the works, China's goal is to have 10 systems by 2025, according to Kahaner. His research shows Chinese companies are now more focused on domestic competition than on what their international rivals are doing. As a gap opens up between the two nations, the US should consider loosening its sanctions against China's leading national supercomputing centre at Wuxi in the hope of "a deeper glimpse into these [Chinese] systems", according to Kahaner.

Despite China's lead in hardware, Kahaner and others point to the breadth of US capabilities as a strength, particularly when it comes to software. Half of the $3.2bn cost of the US energy department's three exascale computers stems from a decade-long effort to write programs to run on the new computing architecture. Also, Chinese research in advanced mathematics seldom shows up in fields related to supercomputers, said Higham.

Regarding his call for greater collaboration between China and the US, Kahaner said: "Access to new systems allows experimentation, which benefits all parties. To the maximum extent possible, consistent with security and fair/balanced competition, more access is better."

But with China yet to publicly acknowledge its new supercomputing prowess and the US still pressing for sanctions against China to try to limit its rise as a tech power, that

US still pressing for sanctions against China to try to limit its rise as a tech power, that may remain a distant hope.