Sovereign Data

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High performance computing in US-China relations

The focus of an emerging trade dispute between the US and China highlights political rivalry over technology developments.

New US and Chinese policies aim to boost national supercomputing through internal investment and export controls. Justifications range from national security to stimulating domestic industries, and are intimately related to an ongoing political and economic conflict between the US and China over high-tech and computing issues. Supercomputing has been an essential component of 'big science' since the 1960s, especially in nuclear weapons development and cryptography. Now, it is a central feature of 'big data' analytics as a commercial service.

Sovereign Data examines this renewed attention to supercomputing and its implications for the sovereign interests of the world's two superpowers.

Recent shifts in policy

On 29 July 2015, US President Obama issued Executive Order 13702, authorising a National Strategic Computing Initiative (NSCI) 'to maximize [the national] benefits of high-performance computing (HPC) research, development, and deployment'.[1] Key objectives include delivery of an 'exascale' HPC system two orders of magnitude faster than present supercomputers; increased 'big data' analytical capabilities; and improved public-private HPC collaboration across government, industry and academia. The aim of NSCI is to 'sustain and enhance' US HPC leadership, a heritage dating to the early Cold War and its key role in the development of nuclear weapons and national security cryptography.[2]

Despite the illustrious history of American HPC, since 2013 the top-ranked supercomputer has been a Chinese government machine, Tianhe-2, at the National Super Computer Center, Guangzhou. Tianhe-2 is the result of government and academic collaboration and is twice the speed of the second-placed machine, Titan, operated by the US Department of Energy.[3]

President Obama referred to Tianhe-2 in his 2011 State of the Union address and its dominance directly influenced the introduction to Congress in June 2013 of the American Super Computing Leadership Act.[4] This bill became a victim of Congressional lethargy but its provisions are reflected in the new NSCI. Obama's executive order reflects the aims of the original Act and is intended to bypass legislative torpor.

China's HPC rivalry with the US has been described as an 'arms race' for at least a decade.[5] The White House rejects such language but HPC is a key facet of an animated US-China dispute over the politics of high technology. In February 2015, the US Department of Commerce cited Tianhe-2 – and its older sibling, Tianhe-1A – for use in 'nuclear explosive activities'.[6] The cross-departmental End-User Review Committee also added four technical centres associated with Tianhe-2 to its proscribed 'Entity List' for acting contrary to US national security interests.[7] Building on this ruling, in April 2015 Commerce aborted US firm Intel's continuing export of microprocessors to these HPC centres.[8]

China responded by announcing export restrictions on its supercomputing hardware, effective as of 15 August 2015, citing unspecified national security concerns and the need to protect domestic high-tech industry.[9] Companies manufacturing supercomputer components now require export licences detailing product and client

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specifications and attract civil or criminal penalties for breaching this process. These policy reprisals occur against a background of diplomatic tension between the US and China. As *Sovereign Data* reported previously, this dynamic is fuelled by accusations of foul play and is always framed in terms of national interest and sovereignty.[10]

HPC infrastructure and investment

The US HPC market dwarfs China's roughly tenfold but China has invested significantly in HPC infrastructure since the National Computing and Networking Facilities of China initiative of 1989 kick-started sectoral investment.

The US has invested more in HPC infrastructure, and for longer, than any other state.[11] In the 1960s, the first supercomputer clients were national laboratories in the US Atomic Energy Commission network, purchasing next-generation machines from innovators like CDC and IBM. CDC, driven by the engineering brilliance of Seymour Cray, cornered the government supercomputing market, while IBM dominated commercial data-processing. Cray prioritised computational speed over business compatibility, generating brute computing power compatible with the needs of national laboratories modelling nuclear weapons design.[12] Computational power remains the critical factor in HPC design, although uses have diversified greatly to include aerodynamics, meteorology, genetics and a range of 'big data' analytics (High Performance Data Analysis) requiring massive parallel processing power to structure and interrogate vast data sets. Precise figures for US government HPC funding are hard to discern but the Department of Energy's Advanced Scientific Computing Research (ASCR) program alone is seeking USD 442 billion for HPC in the next fiscal year.[13]

The US HPC market dwarfs China's roughly tenfold but China has invested significantly in HPC infrastructure since the National Computing and Networking Facilities of China (NCNFC) initiative of 1989 kick-started sectoral investment.[14] Sunk costs on the Tianhe-2 project are upwards of CNY 2.4 billion (USD 390 million) as of 2013, although, as part of China's local government financing platform (LGFP) structure, most of this funding comes from the Guangzhou city government rather than directly from Beijing.[15] State funding is also provided by the National High-Tech Research and Development (863) Program, which promotes innovation through public investment.[16] This helped establish the National High Performance Computing Environment (NHPCE) across China, with key supercomputing nodes in Beijing, Shanghai and other major cities. The emphasis of NHPCE has shifted from technical performance to providing HPC services to nearly 3000 government, industrial and academic clients, mirroring the diversification in the US. Unlike the US, however, there is no long-term national research and development program for exascale computing, widely perceived as the next step in HPC technology.[17]

Winners and losers?

US and Chinese HPC policies stress the importance of high performance computing for economic competitiveness. In the US, recent initiatives aim to consolidate and harmonise an extensive policy landscape and a highly diverse industrial and commercial environment with several decades experience of internal investment and export success. Challenges consist in convincing Congress to disburse the necessary funds and in aligning commercial and political imperatives. The Chinese situation has experienced recent success but the sector is relatively under-developed despite investment in HPC and other high-tech infrastructures.

The Chinese HPC market is somewhat constipated and there are doubts about the commercial prospects of even the mighty Tianhe-2. It is reportedly difficult to use due to anaemic software investment and high operating costs. For example, electricity consumption runs at up to CNY 600,000 (USD 100,000) a day.[18] One official described it as 'a giant with a super body but without the software to support its thinking soul' and, as of June 2014, it had 120 clients utilising only 34% of its capacity.[19] In addition to national security, its civilian applications include astrophysics, climate modelling, genetics, earthquake simulation and infrastructure design, but its operating problems may discourage Chinese and external clients without further significant investment.

There are opportunities for Chinese markets, however. The US Department of Commerce export ban of Intel chips may benefit China. The four HPC centres proscribed by the US use only mainstream Intel chips, so China can source these on the global market, reducing direct Chinese reliance on US firms. (Intel appears to have hedged against potential losses by signing a USD 200 million joint contract with Cray to build a new US Department of Energy supercomputer.)[20] It may also boost domestic hardware production and deployment, including a proposed 'China Accelerator' central to a forthcoming upgrade to Tianhe-2. Domestic manufacturers like Inspur, already a key government partner, may also benefit from revised US trade policy.[21] Given its importance to Chinese defence and security, Tianhe-2 will become even more opaque to external eyes.[22]

However, the Chinese HPC export sector is far from robust. China's export restrictions apply to hardware supporting processing speeds of eight teraflops a second or more. At present, the only Chinese machine operating at these speeds is Tianhe-2. What this communicates is ambiguous, as the wider HPC export sector is unaffected by new export restrictions. It may intend to draw potential foreign clients' attention to the processing dominance of Tianhe-2 and therefore its possible commercial applications (notwithstanding the problems described above). It may also protect future sales, particularly if China finds a way of stimulating its domestic HPC manufacturing sector.

Outlook

The US and China are not the only players in the HPC sector. Japan and Europe also have major interests. Exascale computing is an important goal of the European Commission-sponsored Human Brain Project, for instance, which views exascale computing as equivalent to the processing power of the human brain and therefore essential for neural modelling.[23] Japan is the fastest-growing HPC innovator and South Korea is now the second-ranked user of HPC in the global market.[24] Advances are also being made in India and Russia but the eye-catching story remains the US and China, not least as HPC connects to deeper geopolitical and macroeconomic rivalries.

The economic potential of HPC is substantial but it might not matter in everyday terms which country has the technological edge if the real battle is for international bragging rights. Supercomputing has always been a blue ribbon pursuit and the opportunity to demonstrate technological prowess in somewhat muscular fashion is something few leaders could resist. The HPC 'arms race' is better understood as a key component of economic and political competition, but like the US-Soviet supercomputing rivalry of the Cold War its resonance extends beyond the purely quantitative.

National narratives of greatness and destiny require maintenance. In the nuclear context, France and Britain retain nuclear weapons as symbols of status and prestige justified as strategically necessary 'independent' deterrents. This translates to their continued influence as members of the nuclear-only UN Security Council, and satisfies domestic constituencies concerned with the projection of national power and support for defence industry. Unlike the waning influence of the UK, France and (arguably) Russia in global affairs, US and particularly Chinese power is on the rise. High-cost national investment projects like supercomputing serve to elevate global status rather than arrest its decline.

Observers of global HPC trends are well-served by independent monitors like the Top 500 index that provide open-source reporting and analysis. Both the US and China are also relatively prepared to announce policy changes in open forum. Although the channels appear to be open, the potential severing of links between US and Chinese developers and manufacturers would likely lead to reduced transparency and visibility. The irony is that as the US and China pursue mutual exclusion they may be damaging their own prospects for winning the HPC clients they openly seek. As each other's largest trading partner, the real challenge will involve the US and China striking a competitive balance between the prestige of high technology leadership and the benefits of economic cooperation.

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Notes

1. https://www.whitehouse.gov/the-press-office/2015/07/29/executive-order-creating-national-strategic-computing-initiative, 29 July 2015 [accessed 22 August 2015].
2. Boelie Elzen and Donald Mackenzie, 'The social limits of speed: the development and use of supercomputers', IEEE Annals of the History of Computing 16, no. 1 (1994): 46-61.
3. http://top500.org/lists/2015/06/ [accessed 22 August 2015].
4. Computerworld, 'Fear of thinking war machines may push US to exascale', 20 June 2013, http://www.computerworld.com/article/2498107/high-performance-computing/fear-of-thinking-war-machines-may-push-u-s--to-exascale.html [accessed 22 August 2015].
5. The New York Times, 'A new arms race to build the world's mightiest computer', 19 August 2005.
6. Federal Register 80, no. 2, 18 February 2015, p. 8524-5.
7. Two in Changsha City, one each in Guangzhou and Tianjin.
8. The Register, 'US govt bans Intel from selling chips to China's supercomputer boffins', 10 April 2015, http://www.theregister.co.uk/2015/04/10/us_intel_china_ban/ [accessed 22 August 2015].
9. Xinhua, 'China restricts drone, supercomputer exports to protect national security: MOC', 4 August 2015.
10. Sovereign Data, 'China's ban on virtual private networks', 11 March 2015, http://thesigers.com/analysis/2015/3/11/chinas-ban-on-virtual-private-networks [accessed 22 August 2015].
11. It also has a long history of HPC export control; Robert Johnston, 'US export control policy in the high performance computer sector', *The Nonproliferation Review* 5, no. 2 (1998): 44-59.
12. Donald Mackenzie, 'The influence of the Los Alamos and Livermore National Laboratories on the development of supercomputing', *Annals of the History of Computing* 13, no. 2 (1991): 179-201.
13. ASCR, FY 2016 Congressional Budget, n.d., http://science.energy.gov/~/media/budget/pdf/sc-budget-request-to-congress/fy-2016/FY_2016_Office_of_Science-ASCR.pdf [accessed 23 August 2015].
14. Xing Fan, *Communications and Information in China: Regulatory Issues, Strategic Implications* (Lanham, MD: University Press of America, 2001), pp. 39-40.
15. South China Morning Post, 'World's fastest computer, Tianhe-2, might get very little use', 20 June 2013.
16. InSight and Initiative for Responsible Development, Case Study 13: National High-Tech R&D (863) Program, Harvard University, January 2011.
17. Depei Qian, 'High performance computing development in China: a brief review', 2014 International Conference on Scientific Computing at Extreme Scales, Shanghai, 8 May 2014.
18. HPC Wire, 'China's supercomputing strategy called out', 17 July 2014.
19. South China Morning Post, 'China's world-beating supercomputer fails to impress some potential clients', 30 June 2014.
20. The Wall Street Journal, 'Intel, Cray picked for $200 million supercomputer project', 9 April 2015.
21. Inspur stock rose in May 2014 when China reportedly told domestic banks to consider replacing IBM servers with 'local brands'; Bloomberg Business, 'China said to study IBM servers for bank security risks', 27 May 2014.
22. *The Platform*, 'China intercepts US restrictions with homegrown supercomputer chips', 15 July 2015, http://www.theplatform.net/2015/07/15/china-intercepts-u-s-intel-restrictions-with-homegrown-supercomputer-chips/ [accessed 22 August 2015].
23. https://www.humanbrainproject.eu
24. *The Platform*, 'Top 500 supercomputer list reflects shifting state of global HPC trends', 13 July 2015 [accessed 23 August 2015].