Bringing Australia's supercomputing up to speed

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The Australian Academy of Science calls for strategic planning and targeted investment in next-generation high-performance computing and data (HPCD) infrastructure, including exascale computing—an essential capability of all modern economies.

The issue

In the 21st century, high-performance computing and data (HPCD), or supercomputers, is the cornerstone of global competitiveness, underpinning critical advancements in science, industry and society.

Supercomputers should underpin Australians' everyday lives. They support accurate weather forecasting, improve agricultural productivity, accelerate drug discovery, and drive the development of new technologies, including artificial intelligence (AI), to create jobs and fuel economic growth.

As datasets grow larger, and simulations become more complex, existing supercomputing systems are no longer adequate.

Exascale supercomputing, 1,000 times faster than Australia's fastest supercomputer, can perform at least one quintillion calculations per second. It is the benchmark for global competitiveness. This leap in capability enables unprecedented precision in climate modelling, AI development and advanced research, making exascale infrastructure essential for nations to address critical issues and maintain technological leadership.

The problem

Australia has no plan for the next generation of supercomputing or to replace the computing infrastructure Australia currently relies on.

Australia's HPCD infrastructure is of moderate capacity, oversubscribed and ageing and is no longer sufficient to meet the scientific and societal demands of the 21st century—risking sovereignty and economic competitiveness, limiting rapid responses to emergencies and exposing the nation to national security risks.

- Outdated HPCD hinders rapid data processing, necessary for AI applications, advanced manufacturing and quantum computing. This delays the development and deployment of high-value technologies, limiting job creation opportunities and increasing operational costs, ultimately slowing economic growth.
- Without updated HPCD infrastructure, the government will be slower to respond to public health crises, extreme weather events and energy needs, affecting Australians' safety and wellbeing.
- Supercomputers are key for defence scenario simulations, detecting cyber threats and securing critical infrastructure. Outdated HPCD infrastructure may affect Australia's ability to respond effectively to security risks, leaving the nation unprepared when new critical technologies emerge and more vulnerable to cyberattacks and threats.

Existing HPCD infrastructure lacks the necessary computational power to support the growing demands of modern science. Data-intensive applications in genomics, climate modelling and precision agriculture require faster, more scalable systems to process massive datasets and run high-resolution simulations.

Many of our international peers, including China, the US and European countries, are either already operating or planning for exascale HPCD capabilities and beyond.

The proposal

Without a national strategy to acquire and sustain next-generation HPCD for our science sector, Australia will fall behind peer countries. Our sovereignty will be at risk, our ability to innovate and tackle emerging societal challenges will be limited and we will put our future prosperity and security at risk.

Within six months, a long-term national HPCD strategy and roadmap should be prepared to identify the means to build national capacity, with targeted investment in next-generation HPCD infrastructure. This strategy and investment would be directed towards:

- upgrading and expanding national (Tier-1) and institutional (Tier-2) facilities, ensuring they are equipped to meet the growing demands of advanced research and societal needs
- coordination and co-investment in a regional (Tier-0) supercomputing facility to acquire, deploy and operate next-generation exascale infrastructure
- sector coordination, collaboration and planning across industries and institutions to improve integration of data and computing resources, ensuring co-location of data storage and processing, which will reduce latency and optimise efficiency
- HPC-powered emerging technologies, including AI and quantum computing, to accelerate scientific development and breakthroughs
- developing international partnerships for AI and exascale high-performance computing with like-minded countries.

Benefits

Next-generation HPCD infrastructure will transform Australia's capabilities. It will:

- allow for more reliable climate models, better representation of extreme weather events, and finer spatial detail. This reduces uncertainty in climate projections, enhancing disaster response strategies, enabling targeted climate adaptation and saving lives and resources
- permit geoscientists to realise the potential of geophysical datasets, producing 3D volumetric continental-scale high-resolution models of Australia's subsurface and Earth's interior. This will improve our understanding of valuable mineral resources and natural hazards, such as seismic activity and groundwater contamination, which are critical for a sustainable, resilient future
- allow scientists to run larger, longer simulations of molecular systems, accelerating drug discovery and driving economic, social and environmental benefits
- support the development of quantum industries. Australia can only realise its ambition to become a global quantum industry hub with the requisite HPCD infrastructure to support research and development. Without HPCD, quantum technology development in Australia will stall.

Resources

The Australian Government should commit to a decadal program to secure, coordinate and expand Australia's HPCD capabilities—across government, the private sector and science sector. Such a decadal program would necessitate investments of $200 million a year over 10 years. This investment would support sector coordination and planning, deliver upgrades to current Tier-1 and 2 facilities and co-locate data and computing, and drive coordination and co-investment in a Tier-0 facility.