

Ten Years of Spartan: From an Innovative Experiment to a World-Class Supercomputer



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Research Computing Service HPC Services Team

Previous Presentations

- There have been many presentations and papers about the Spartan HPC and our HPC training programme since 2016.
- Presentations include: Multicore World, New Zealand, 2016, eResearch Australasia, (2016, 2017, 2020, 2021, 2024), Several European HPC centres (Frankfurt University, Stuttgart University, Freiburg University, CERN, CINES, CNdS) (2016), Linux Users of Victoria (2016), OpenStack Summit (2016), HPC-AI Advisory Council (2017, 2018, 2019), Australia National Data Service workshop (2018), International Supercomputing Conference (2018), eResearch NZ (2021, 2022), Supercomputing Asia (2024), A-NZ RSE Conference (2025)
- Chapters, papers, etc include: The Crossroads of Cloud and HPC (2016, 2017), IEEE International Conference on e-Science (2017), Advances in Science, Technology and Engineering Systems Journal (2019), Journal of Computer Science Education (2019, 2020), Cybersecurity and High Performance Computing Environments (2022).
- *This presentation is going to concentrate on infrastructural software choices.*



Conception and Birth

- Prior to Spartan, UniMelb's general purpose HPC was "Edward" (2011-2016) and the one prior to that was "Alfred". These followed the typical architecture for a small cluster. Actual analysis of job metrics revealed that 76% of tasks were single core and low memory.
- Limited budgetary resources (the laconic pun "spartan") meant the new system had a small traditional HPC layout ("physical partition", 200 cores with RoCE interconnect) and with virtual machines making about the majority of compute resources ("cloud partition", 3000 cores) from NeCTAR.
- Some interesting software choices: Slurm as the scheduler (open source, good reporting tools, modular extensions). Cloudbursting with Slurm was also implemented. CephFS as the file system (open source, integrated with Cloud, first HPC system globally to use), EasyBuild and Lmod for software builds and environment (global collaboration, replaced customised shell scripts), and Karaage for user and project management (originally from VPAC, Django, AAF authentication).
- Edward completed 375,000 jobs in 2015, Spartan complete over a million in its first year. Promotional tour of New Zealand and Australian conferences, European HPC centres, OpenStack summit Barcelona in 2016. Last year Spartan clocked its job IDs and now runs over one million jobs *per month*.

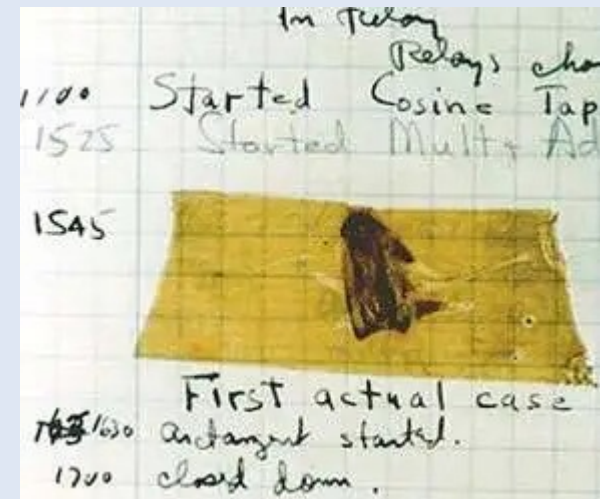


Spartan Launch, 2016

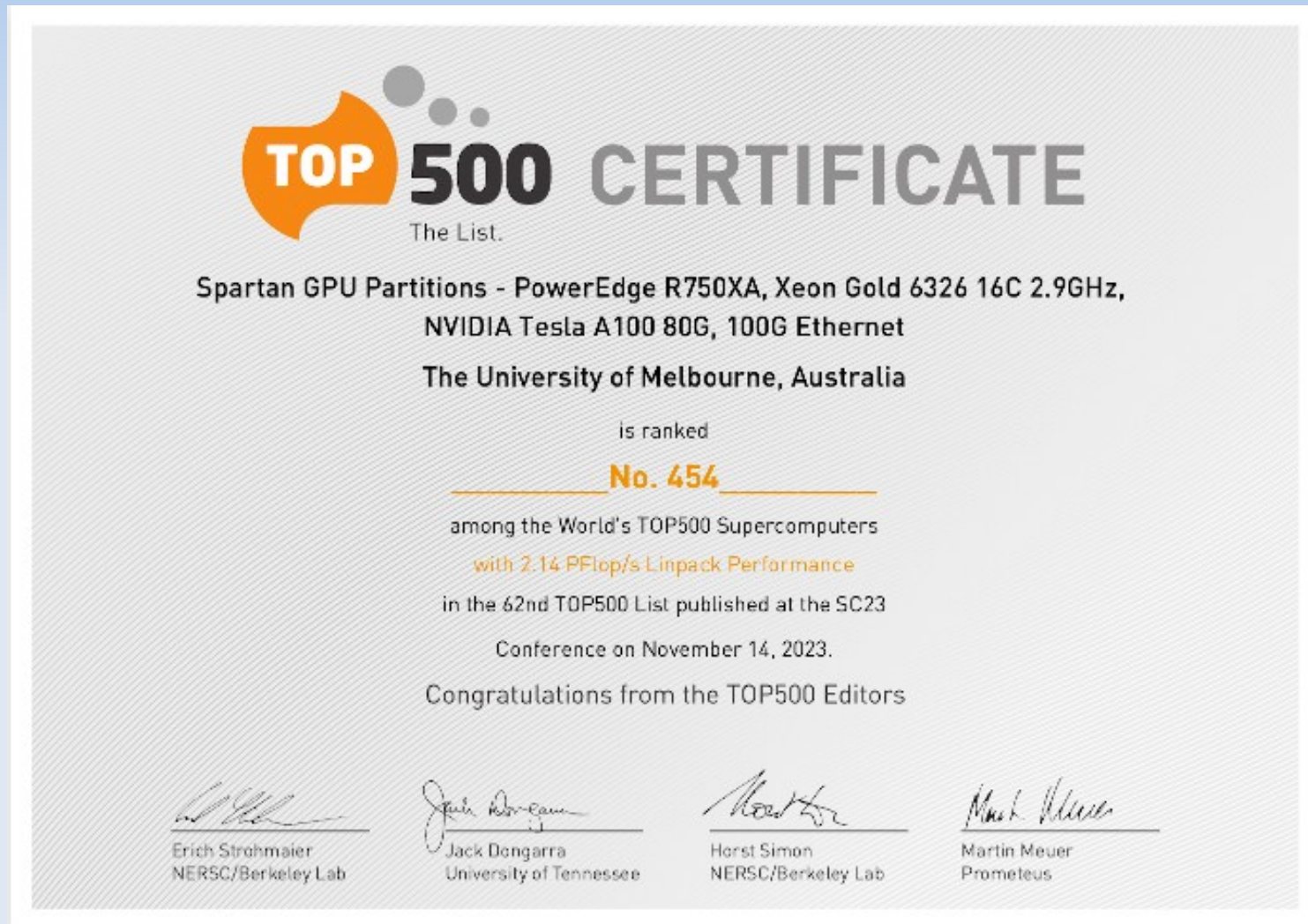


Spartan's Growth

- Spartan expanded with additional compute nodes from specialist projects, departments, and research agencies etc. By 2018 there was a big expansion with of 68 nodes and 272 nVidia P100 GPGPU cards, funded by a LIEF grant LE170100200 from the Australian Research Council. Spartan now uses A-100, H-100, L40s).
- Spartan transformed from a successful innovative and experimental system to tier one system for Australia and with sufficient performance to be counted in the Top 500 (we estimated around #200).
- In the course of these early years some software concerns led to changes:
 - (a) Use of VMs had to be deployed on a one-to-one basis; the use of over-commit, typical in most cloud scenarios, could lead to time mismatch errors.
 - (b) The use of cloud VMs and physical machines in a hybrid manner was challenging to CephFS, moved to Spectrum Scale (aka GPFS).
 - (c) Cloudbursting was not really necessary and the main use case would have been any SLAs; plus there was a cloudbursting bug (mismatch of states in virtual nodes) in Slurm v16 .
 - (d) Structured ordering of toolchains introduced with EasyBuild modules in 2019. *Users not following instructions* led switching between toolchains within a job.



Spartan's Top 500 Certificate



Visualisation, Reproducibility

- As Spartan grew, we introduced interactive visualisation nodes, initially with FastX and Open OnDemand. *Notably, Conda would often cause a conflict with the former.*
- A very substantial change occurred in 2023 when we decided it was time to do a major update of the RHEL operating system from a 7.x (which we first installed in 2015) to 9.x.
- This required re-installing most of the applications, but we also kept the RHEL7 installs as an Apptainer container for reproducibility (without multi-node access). As of September 2026 Spartan has installed, as modules (not including extensions): 4469 (2015-2019), 2680 (2019-2022), 2806 (2022-2026) = 9955 *all reproducible*.
- Python extensions (“modules”) have been challenging; early instructions (2015-2019) recommended use the same version and use `pip --user`. Later versions recommended using `venv`. Users are often are more familiar with Conda. Both `venv` and Conda protect against Open OnDemand forwarding conflicts.



New User Management Issues

- Two new major issues in 2026; account requirements and user management integration.
- Previously, researchers from outside the university could access Spartan (the project PI had to be from the University) for collaborative reasons. Now they require a guest or honorary University email address. The procedure for obtaining this is *non-trivial and not solvable by software*.
- Karaage has been retired and its functionality integrated into the Research Computing Services Portal (including data services and cloud). Decoupling of accounts and projects and accessibility has meant increased applications. *Problem is solvable by software and administration changes*.
- Our prior methods were successful; we are in a challenging situation in processing user applications and ensuring institutional collaboration.

```
$ tree -L 4 Cladistic_Map/
Cladistic_Map/
├── life/ (Root: all life)
│   ├── animals/ (Synapomorphy: multicellularity, heterotrophy, no cell wall)
│   │   ├── eumetazoa/ (Synapomorphy: true tissues)
│   │   │   ├── bilateral/ (Synapomorphy: bilateral symmetry, cephalization)
│   │   │   │   ├── protostomia/ (Synapomorphy: protostome development)
│   │   │   │   │   ├── annelida/ (e.g., earthworms, leeches)
│   │   │   │   │   ├── arthropoda/ (e.g., insects, crustaceans, spiders)
│   │   │   │   │   └── mollusca/ (e.g., snails, clams, octopus)
│   │   │   │   └── deuterostomia/ (Synapomorphy: deuterostome development)
│   │   │   │       ├── echinodermata/ (e.g., sea stars, sea urchins)
│   │   │   │       └── chordata/ (e.g., fish, amphibians, mammals)
│   │   │   └── porifera/ (Sponges; lack true tissues)
│   │   └── choanoflagellata/ (Outgroup: closest living relatives to animals)
│   └── plants/ (Outgroup to animals: multicellularity, cell wall, autotrophy)
12 directories, 0 files
```

Lessons and The Future

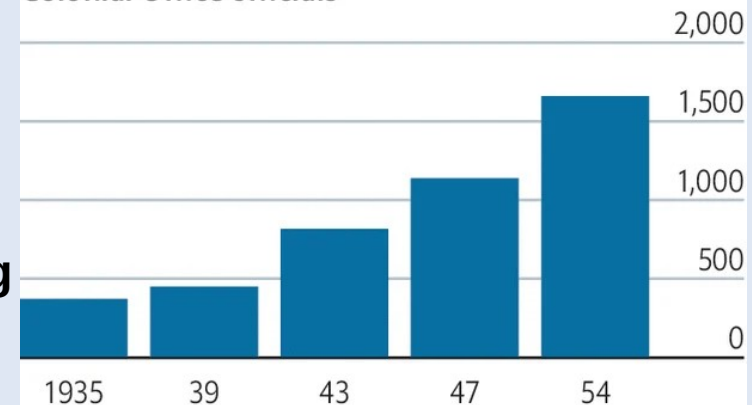
- **Lesson: Principles of computer science will not change. You will run into physical constraints. Race conditions are real, latency is real.**
- **Lesson: Loose-coupling of systems is wise to limit the work in a given area. All parts of a system must grow in tandem to avoid bottle-necks and pain-points. Apply UNIX-toolkit approach (resilient, simple, and modular), in administration as well as software.**
- **Lesson: Users will surprise you with their creativity, persistence, ability to read the wrong documentation, and inability to transfer conceptual knowledge and skills from field to field. User training has priority over interface improvements (skill-up the user rather than dumb-down the interface)**
- **Lesson: Where corporate-competitive behaviour increases at the expense of collaborative research, bureaucratic and cybersecurity gatekeeping ("damaged goods") will make HPC administration more frustrating. University senior leadership will need to take the initiative here.**

A magnificent Navy on land

Admiralty statistics

	1914	1928	% change
Capital ships in commission	62	20	-67.7
Officers and men in Royal Navy	146,000	100,000	-31.5
Dockyard workers	57,000	62,439	9.5
Dockyard officials and clerks	3,249	4,558	40.3
Admiralty officials	2,000	3,569	78.5

Colonial Office officials

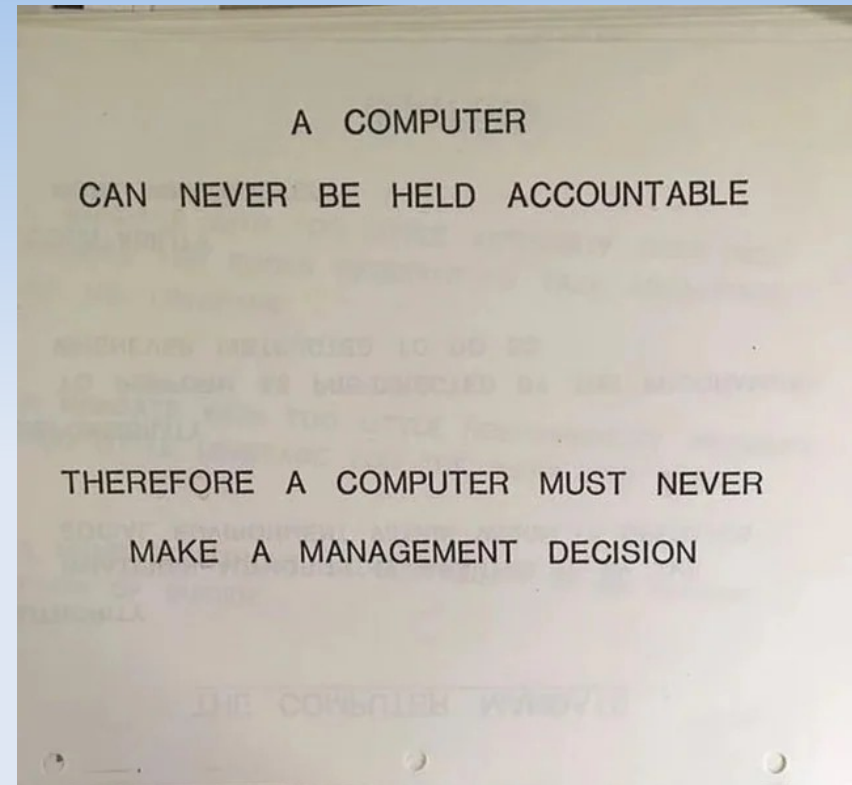


Source: *The Economist* archives

The Economist

Lessons and The Future

- **Future: Within an organisation, Parkinson's Law ("The Law of Multiplication of Work") and Putt's Law ("those who understand what they do not manage and those who manage what they do not understand") combined are a Wicked Problem. This can only be avoided by empowering technical staff to manage their technical environment.**
- **Future: Users will have access to new technologies and will (mis)use them in creative ways. Do not allow code editors which connect externally (e.g., VSCode) to run code through those external code editors.**
- **Future: We assume AI and agentic operations will increase on the platform. Avoid going into a tokens-based arms race. Any agents performed on the platform are the responsibility of the user. *The computer is not responsible.***



THANKS FOR WATCHING



& LISTENING PATIENTLY