Development of a High Performance Computing Capability for DST

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INSTRODUCTION

Defence Science & Technology (DST) Group aims to be a world leader in defence science and technology – indispensable in supporting and transforming Australia's defence and national security. The presentation will provide an overview of the new High Performance Computing (HPC) and Computational Science program at DST and its future development. Significant progress in the development of the DST HPC program has occurred over the past year. The talk will cover the major research challenges where DST is applying HPC and computational science. Potential opportunities for collaboration will also be identified.

THE ROLE OF HPC

World-wide research and development have involved the use of computational science to model, simulate and solve contemporary and projected problems ever since computers became common place in the last century. Computational science involves the application of scientific algorithms across data sets to produce outputs relevant to solving problems. As the size of the data sets and the complexity of the problems and algorithms have increased, so has the need for faster and bigger computers, resulting in increased demand for supercomputing capabilities.

As the application of supercomputing has widened and as its technology has become based on the aggregation of standard computing components at a massive scale, supercomputers have evolved into HPC. An increasing range of technical and operational problems can be investigated and solved using computational science on HPC. The application of computational science on HPC is unlike corporate or business process computing due the nature and size of the data sets and the specialised scientific algorithms, altogether requiring specialised capabilities and management for high speed data flows and the optimization of computer performance.

Computational science and its supporting HPC infrastructure are vital enabling technologies that are likely to deliver significant value. In a recent study for the US Department of Energy [(1)], 700 case studies across a range of industry sectors and countries were reviewed, showing estimated financial returns in the order of USD $52.00 of profits/cost savings per dollar invested in HPC. The return to the defence sector was estimated to be USD $141.50 per dollar invested in HPC (noting open sources are likely to result in underestimation for the defence sector). HPC can be used to model or simulate real world systems and scenarios across the widest range of real-world variables and without the risks and opportunity costs associated with physical prototyping and experimentation.

HPC FOR DEFENCE RESEARCH

The 2016 Defence White Paper stated that:

"*The Government will make a significant new investment in information management capabilities to ensure that the right information is available to Defence decision makers at the right time. These investments will ensure that our armed forces are able to respond quickly to emerging threats, as well as ensuring that Defence's business processes become more effective and efficient (p105, para 4.87).*"

In national security and defence endeavours, the earliest and most significant area of use of supercomputers has been in intelligence agencies for highly classified problems. Over time, use has expanded into other problem sets, such as using Computational Fluid Dynamics (CFD) to analyse airflow over aircraft to ensure safe release of their payloads, or to analyse the noise created by the flow of water over submarine hulls and their propellers in order to maximise stealth. Computational science and HPC can now be used to model, simulate and solve complex problems in almost every military domain and application of Defence science and technology, ranging in scale from sub-molecular simulation of cracks in military aircraft components up to the virtual simulation of military battle tactics and force structures.

DST HPC CAPABILITY

The DST HPC capability will consist of a new purpose built state-of-the-art HPC Centre. The HPC Centre will comprise a data hall and associated HPC visualisation facilities and training rooms. Figure 1 below illustrates the proposed new HPC Facility which has now received Government finding approval.

Figure 1: Proposed new HPC Facility for Defence Research

Effective support to Researchers is critical to productive and successful use of HPC. Computational science requires a comprehensive understanding of models being used, software engineering, and code optimisation for efficient running of research tasks. The current team of HPC staff will be expanded to meet the needs of the new HPC capability - see Figure 2. A development and experiential approach to training will be provided, similar to that used by the

Commonwealth Scientific and Industrial Research Organisation (CSIRO) in developing its HPC capability. The HPC Program will provide additional support through training services to the DST Researcher community and will focus on skills development and skills transfer to develop HPC relevant expertise.

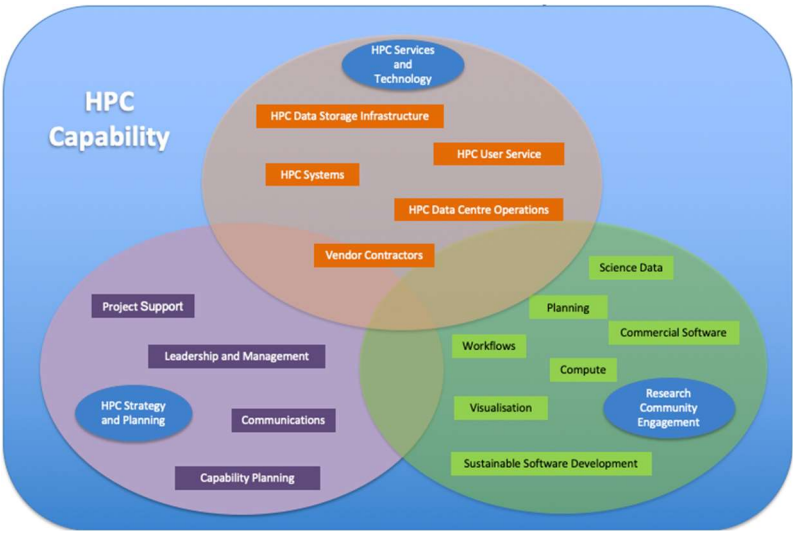

Figure 2: Workforce required to support the new HPC Capability

REFERENCES

1. Economic Models for Financial ROI and Innovation from HPC Investments, International data Corporation, October 2017
2. 2016 Defence White Paper 2016, Dept of Defence, Commonwealth of Australia, Canberra Australia.