



## Technical Overview of supercomputer Béluga

Béluga is an heterogeneous multi-purpose supercomputer consisting of several different types of components in order to tackle a variety of different workloads. Its four principal components are: a CPU subsection, a GPU subsection, data storage devices and a high speed interconnect linking together the other three subsystems. A small sized Béluga cloud will be added later on.

### **CPU (Central Processing Unit) subsection**

It is assembled out of 700 Intel servers providing 28,000 compute cores of the Intel Skylake generation. This is approximately the equivalent of 10,000 high-end laptops bundled up in the same computer room. A quarter of these servers have been configured with less internal memory (RAM) than the others for those compute workloads that require less memory. Also, a small subset of the servers (12 of them) received significantly more internal memory (equivalent to 48 high-end PCs each).

The compute power of Béluga's CPU subsection has been measured at about 1.35 PFlops<sup>1</sup> using the Linpack<sup>2</sup> standardized test.

### **GPU (Graphical Processing Unit) subsection**

It is the most powerful of its type among the Compute Canada supercomputers. It consists of 688 NVIDIA Volta GPUs distributed among 172 Intel servers. These GPUs are currently among the most powerful on the market for AI applications thanks to the existence of some specialized circuitry and related "instruction sets" that were included in their design compared to prior generations of GPUs.

The compute power of Béluga's GPU subsection has been measured at about 2.278 PFlops using the Linpack standardized test. This ranks Béluga within a handful of the fastest supercomputers in Canada.

### **Data storage**

Béluga is equipped with different data storage systems.

There are three disk-based storage systems which together represent roughly 13 PB of space. One is called "home" for storing the users' working files. Another one is called "scratch" for storing temporary files created during calculations and which may be erased once the corresponding calculations have ended. The third and final one is called "project" for keeping

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<sup>1</sup> One PFlops (peta-flops) represents 1 000 000 000 000 000 (one million billions) floating point operations per second, or multiplications of decimal numbers per second if one prefers.

<sup>2</sup> Linpack is a well-known linear algebra benchmark test used by the [www.top500.org](http://www.top500.org) site that ranks the fastest supercomputers in the world.

large data sets including input data and calculation results. This is where most of valuable scientific results are stored.

Béluga also includes a 67 PBytes tape-based storage system for making daily backups of the users' working data. The tape system can also make multi-copy archives of data for long term storage. This is typically data that may be needed in the future but that will most often not change anymore.

### **Networking**

Béluga's components are linked together using two networks.

The first network is an Ethernet network which can be found in most companies' offices and homes across the country, but Béluga's is a faster version at 25 to 100 gigabits per second. The second network is a high performance InfiniBand network that links together Béluga's compute servers and storage, allowing seamless data transfers between these components.

Since Béluga is a heterogeneous multi-purpose supercomputer, its high speed InfiniBand network has been optimized using a tiered architecture, with a slower global network (20 Gbit/s) on average connecting a set of server islands (varying from 480 to 1760 compute cores) which have a faster internal network (100 Gbit/s).

### **Béluga cloud**

A Béluga cloud service of approximately 80 compute servers will soon be added to the overall installation. This cloud service will also include one petabyte of redundant internal storage.

### **Power usage**

The Béluga cluster consumes on average 450 kWh, 24 hours a day, seven days a week. Over the course of a full year this is roughly the annual energy consumption of 180 Quebec households, including heating during the winter months.