Prometheus from Krakow took 289th position on the TOP500 list

The most recent edition of TOP500, the list of fastest supercomputers in the world, has been published on June 22nd, 2020 at the ISC High Performance 2020 Digital. Once again the Polish supercomputer Prometheus took a high position on this list.

Prometheus - number one among Polish supercomputers

Prometheus with its 2,65 PFlops of theoretical performance has been listed at 289th position. This top-efficient supercomputer located in Poland has been built by Hewlett-Packard according to requirements and partial design provided by Cyfronet.

Prometheus consists of more than 2,200 servers based on HP Apollo8000 platform, combined with super-fast InfiniBand network with 56 Gbit/s capacity. Its energy saving and high-performance Intel Haswell latest-generation processors offer 53,748 cores. These are accompanied by 283.5 TB DDR4 RAM in total, and by two storage file systems of 10 PB total capacity, and 180 GB/s access speed. Prometheus has been also equipped with NVIDIA Tesla GPGPUs.

To illustrate Prometheus' speed, one would have to harness the power of more than 50,000 first-class PCs, in their strongest configuration, additionally connected to super-fast network and managed by special software, to catch up with its abilities – says prof. Wiatr, Director of ACC Cyfronet AGH.

The Prometheus architecture responds to the diverse needs of researchers by providing computing resources organized in partitions:

- classical cluster of computing servers with highly efficient CPU nodes equipped with Intel Xeon Haswell and Intel Xeon Gold processors,
- cluster of servers equipped with graphic accelerators GPGPU NVIDIA Tesla K40 XL,
- acceleration partition including GPGPU NVIDIA K80 cards as well as Intel Xeon Phi 7120P and Nallatech FPGA accelerators,
- set of servers designed for Cloud computing,
- partition dedicated to calculations related to artificial intelligence, equipped with GPGPU NVIDIA Tesla V100 graphics accelerators. It is worth mentioning that this partition is a system with computing power over 4 PFlops for tensor operations and 256 TFlops for standard calculations performed on double precision numbers, which makes it the fastest dedicated solution for artificial intelligence available for the needs of scientists in Poland.

Prometheus has been installed in a high-tech computing room, exclusively adapted for its operation. The supercomputer's proper functioning is additionally supported by the accompanying infrastructure, including such systems as guaranteed power supply with an additional generator, modern air-conditioning and gas extinguishing.

Prometheus - the fastest and the greenest

The Prometheus supercomputer, built according to the assumptions developed by Cyfronet experts, at the time of launch in 2015 was the first in Europe and one of the largest installations in the world based on direct liquid cooling technology. After several years of operation, it is still one of the most energy-efficient computers of its class (142nd place on the Green500 world list, June 2020).

Thanks to the innovative technology of direct liquid cooling, Prometheus is also one of the most energy-efficient computers in its class in the world. This was achieved by using the cooling liquid having a temperature of 28°C. To cool down the liquid to such a temperature in our climate it is
enough to use cheap in use dry-coolers, instead of ice water generators, consuming relatively large
amounts of electricity and classic technological air conditioning systems. The liquid cools both CPU
and GPGPU processors as well as memory modules using a special hermetic system of heat pipes
and contact heat transfer between the servers and the system in which the liquid circulates. The
servers themselves remain "dry" - they can be removed at any time without the risk of liquid
leakage in the cooling system. Liquid cooling has also made it possible to achieve a very high
installation density - up to 144 computing servers in a single rack.

The Prometheus PUE factor is comparable with some of the largest data centres in the world, such as
Google, Amazon or Facebook. Furthermore, liquid cooling allows for extremely high installation
density, therefore Prometheus, weighing of more than 40 tons, covers 18m² area and is placed on 20
racks only. To achieve the same computing power in case of Zeus (Prometheus' predecessor), it
would have to take about 160 racks. Baribal, the predecessor of Zeus, with computing power of 1,5
TFlops was placed on 8 racks. To achieve the computing power of Prometheus it would take as many
as 12,000 Baribal's racks - points Cyfronet's Director.

Zeus supports Prometheus

For less demanding computing tasks, supercomputer Zeus still offers its computing power. The
heterogeneous architecture of this supercomputer consisting of four dedicated hardware partitions
provides 25,468 computing cores and 204 GPGPUs with total theoretical computational power of 374
TFlops. This is accompanied by 60 TB of RAM and 2.3 PB of disk storage. Zeus is built of over 1,300
individual blade servers, interconnected via high-speed 40 Gb/s InfiniBand network.

It is worth noting that even the highest positions on the TOP500 list, or the latest technologies used
to build high-performance computers, do not fully reflect the importance of this type of computing
resources for the Polish scientific community. The usefulness of supercomputers made available by
ACC Cyfronet AGH as a tool for conducting scientific research is best demonstrated by statistical
data on their use. In 2019 the two most powerful supercomputers in ACC Cyfronet AGH - Zeus and
Prometheus, executed 4 993 639 jobs with a total duration of 44 027 years of CPU time.

Prometheus supercomputer used in the fight against coronavirus

Computing grants dedicated to research on SARS-CoV-2 coronavirus and the COVID-19 disease it
causes have priority in the access queue for Prometheus resources and are given the highest
priority. Over 53 thousand computing cores combined in one machine and accompanying
infrastructure allow for fast processing of large amounts of medical, biological and chemical data.
The research include antibodies present at the time of infection, molecules with potential for
inhibiting infection, and opportunities for vaccine development. Part of the computing power of
Prometheus is made available as part of the European PRACE partnership to conduct a pan-European
hackathon aimed at developing new solutions in the fight against coronavirus. Cyfronet also makes
resources available within the EGI federation - a distributed computing infrastructure that brings
together resources of over 250 units from around the world. The EGI Federation and the American
Open Science Grid (OSG) have joined forces to support research projects on COVID-19. Additionally,
the Haddock tool created at the University of Utrecht, which is used by biomolecular modeling, is
available through the EOSC (European Open Science Cloud) portal developed by Cyfronet. ACK
CYFRONET AGH also participates in the EOSC Synergy project, which made available cloud
computing resources to fight the virus.

Scientific calculations from different fields

Prometheus and Zeus are part of the European cloud and grid infrastructure within the European
Grid Infrastructure (EGI). At the same time, Prometheus and Zeus are important supercomputers in
the PLGrid nationwide computing infrastructure for scientific research in silico (performed with the
help of computers).

Thanks to the PLGrid infrastructure, scientists can intensively use the computing power of Prometheus and Zeus. Dedicated computing environments, so-called domain grids, and specialised IT platforms enable conduction of increasingly complex research problems.

Scientists conducting research with use of the Cyfronet infrastructure represent many fields. Advanced modeling and numerical calculations are used mainly in: physics, chemistry, biology, medicine and material technology, as well as in astronomy, geology and environmental protection. Research topics include: modeling of pollution dispersion, development of a numerical model of heat distribution in the Earth's atmosphere, electronic structure and ion transport in oxide materials or superconductivity in selected physical systems. Researchers also conduct research on conformation of selected enzymes using molecular dynamics simulation, analysis of glued joints in steel structures, research on internal ballistics of hybrid rocket engines as well as electronic and transport properties of new magnetic materials.

Scientific computations do not include simulations only. Computing power is utilised by Polish scientists also within international projects, including experiments like CTA, LOFAR, EPOS, Large Hadron Collider in CERN and the recently discovered gravitational waves in LIGO and VIRGO detectors.

**Use the power of supercomputers in scientific research**

Supercomputers enable to significantly reduce time of computations that using a single computer would often take many years (in specific cases more than 150, 700 or even 1000 years). Here they may be usually performed within a few days. Cyfronet users can benefit from the professional support – starting from access to full documentation, through training, to individual consultations with experts. Information concerning the use of the Prometheus and Zeus' resources by scientists is available on [http://www.cyfronet.pl](http://www.cyfronet.pl) and [http://www.plgrid.pl](http://www.plgrid.pl). It is worth to register in the PLGrid portal [https://portal.plgrid.pl](https://portal.plgrid.pl) and use many unique services.

**Supercomputers from Poland compared to Europe and the world**

Supercomputer Fugaku from Japan took the first position on TOP500, with more than 513 PFlops of computational power (theoretical). The list is dominated by supercomputers from China (226 units) and USA (114 units).

The European countries having supercomputers on the list (15 countries including Russia) occupied a total of 96 positions. The fastest European supercomputer is HPC5 from Italy, ranked 6th. The top ten list also includes another supercomputer from Italy, Marconi-100, in the 9th position and Piz Daint from Switzerland, in the 10th position. The countries in Europe with the largest number of supercomputers on the TOP500 list are: France (19 units), Germany (16 units), and the Netherlands (15 units).

As in the previous edition of the TOP500 list, Prometheus still remains the only supercomputer from Poland.