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# СУПЕРКОМП'ЮТЕРИ

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# SUPERCOMPUTERS

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In this publication I would like to talk about three supercomputers: Tianhe-2, Titan - Cray XK7 and Sequoia. They are used for solving complex scientific and engineering problems that require the large number of mathematical operations and (or) work with large volumes of data. Originally supercomputers were used almost exclusively for defensive purposes: calculations of nuclear and thermonuclear weapons, nuclear reactors. Then, with the improvement of mathematical tools for numerical simulation of knowledge in other areas of science - supercomputers have been used in "peaceful" calculations, creating new scientific disciplines, such as: numerical weather forecast, computational biology and medicine, computational chemistry, computational fluid dynamics, computational linguistics, etc., - where science achievement merged with the achievements of applied science.

Supercomputers simulate the processes within the atomic nucleus, analyze plasma physics, develop and improve nuclear and thermonuclear weapons, manage nuclear arsenal, simulating nuclear tests.

Tianhe-2 consists of 16 thousand units, each of which includes 2 processors Intel Xeon E5-2600 v2 on Ivy Bridge architecture with 12 cores each (frequency 2.2 GHz) and 3 specialized coprocessors Intel Xeon Phi 31S1P (on Intel architecture MIC, on 57 cores on the accelerator, the frequency of 1.1 GHz) [3]. Each node installed 64 GB DDR3 ECC memory (16 units) and an additional 8 GB GDDR5 every Xeon Phi (total 88 GB). Overall, the total number of cores reaches 3.12 million (384,000 Ivy Bridge and 2736 thousand. Xeon Phi), which is the largest public installation of processors.

Each node occupies half of the motherboard (Compute blade), 8 boards installed in one chassis (Compute frame). In supercomputer it is used 125 racks of compute nodes, 13 racks of network equipment and 24 rack storage system. Productivity: one node reaches 3,432 TFLOPS, of which 0.422 TFLOPS - using processors Ivy Bridge.

In addition to the components of Intel, a supercomputer is also used in Chinese development projects: opto-electronic network TH-Express 2 (topology Fat tree), 16-core processors Galaxy FT-1500 (4096 pieces, architecture Sparc v9, 40 nm, 1.8 GHz) programming model OpenMC, motherboards with high density. OS Kylin Linux is used here. It costs 300.000.000$

Titan Cray XK7 is a supercomputing platform, produced by Cray, launched on October 29, 2012. XK7 is the second platform from Cray to use a combination of central processing units ("CPUs") and graphical processing units ("GPUs") for computing; the hybrid

architecture requires a different approach to programming to that of CPU-only supercomputers.

XK7 is scalable up to 500 cabinets, each contains 24 blades and each blade contains 4 nodes (1 CPU and 1 GPU per node). The CPUs available are of the 16-core AMD Opteron 6200 Interlagos series and the GPUs are of the Nvidia Tesla K20 Kepler series. Each CPU can be paired with either 16 or 32 GB of error-correcting code memory (ECC) while the GPUs have either 5 or 6 GB of ECC memory depending on the model of GPU used. The nodes communicate with each other via the Gemini Interconnect; each Gemini chip services 2 nodes with a capacity of 160 GB/s.

XK7 based machines run the Cray Linux Environment which incorporates SUSE Linux Enterprise Server. The code to run on an XK7 machine can be written in a range of programming languages. The National Center for Supercomputing Applications (NCSA) in Illinois has a machine, Blue Waters, using a combination of Cray XE6 and XK7 nodes. The machine has 3072 XK7 nodes and 22,752 XE6 nodes. Each XE6 node has two Opteron 6276 and 32 GB of memory per CPU.[11] The XK7 nodes also have Opteron 6276 CPUs with 32 GB of memory and a K20X GPU with 6 GB.[11] Blue Waters has performed at over 1 petaFLOPS in benchmarks however the project managers do not believe in the relevance of the LINPACK benchmark used by the TOP500 organisation therefore did not submit a benchmark test for ranking.

The Swiss National Supercomputing Centre (CSCS) machine named Todi was upgraded to XK7 on October 22, 2012. Todi has 272 nodes with Opteron 6272 CPUs with 32 GB of memory and a K20X GPU with 6 GB. Todi has a theoretical peak performance of 393 teraFLOPS and performed at 274 teraFLOPS in the November 2012 TOP500 list taking 91st place. Todi consumes 122 kW and is ranked fourth, one behind Titan, on the November 2012 Green500 list.

IBM Sequoia is a petascale Blue Gene/Q supercomputer constructed by IBM for the National Nuclear Security Administration as a part of the Advanced Simulation and Computing Program (ASC). It was delivered to the Lawrence Livermore National Laboratory (LLNL) in 2011 and was fully deployed in June 2012.

On June 14, 2012, the TOP500 Project Committee announced that Sequoia replaced the K computer as the world's fastest supercomputer, with a LINPACK performance of 16.32 petaflops, 55% faster than the K computer's 10.51 petaflops, having 123% more cores than the K computer's 705,024 cores. Sequoia is also more energy efficient, as it consumes 7.9 MW, 37% less than the K computer's 12.6 MW. As of June 17, 2013, Sequoia had dropped to #3 on the TOP500 ranking, behind Tianhe-2 and Titan. It is still #3 on the TOP500 ranking of November 2013. The supercomputer has been assembled and tested at IBM in Rochester, Minnesota, where the system created a series of Blue Gene, designed for demanding applications computing tasks. The hardware and software was performed by IBM engineers in Rochester and by researchers in IBM's Yorktown, Hayes, New York, in collaboration with researchers from Lawrence Livermore National Laboratory and Argonne National Laboratory (Research Center of Nuclear Energy of the USA).

Having conducted the research I would like to summarize that with the development of supercomputers humanity relieved, because nuclear testing, testing of weapons of mass destruction, biological weapons moved in the virtual world but I am concerned with thought that once a people will wants to experience achievements in reality.