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Japan Reclaims Top Ranking on Latest TOP500 List of World's Supercomputers

HAMBURG, Germany—A Japanese supercomputer capable of performing more than 8 quadrillion calculations per second (petaflop/s) is the new number one system in the world, putting Japan back in the top spot for the first time since the Earth Simulator was dethroned in November 2004, according to the latest edition of the TOP500 List of the world's top supercomputers. The system, called the K Computer, is at the RIKEN Advanced Institute for Computational Science (AICS) in Kobe.

The 37th edition of the closely watched list was released Monday, June 20, at the 2011 International Supercomputing Conference in Hamburg. The ranking of all systems is based on how fast they run Linpack, a benchmark application developed to solve a dense system of linear equations.

For the first time, all of the top 10 systems achieved petaflop/s performance – and those are also the only petaflop/s systems on the list. The U.S. is tops in petaflop/s with five systems performing at that level; Japan and China have two each, and France has one.

Bumped to second place after capturing No. 1 on the previous list is the Tianhe-1A supercomputer the National Supercomputing Center in Tianjin, China, with a performance at 2.6 petaflop/s. Also moving down a notch was Jaguar, a Cray supercomputer at the U.S. Department of Energy's (DOE's) Oak Ridge National Laboratory, at No. 3 with 1.75 petaflop/s.

Rounding out the Top 10 are Nebulae at China's National Supercomputing Center in Shenzen (1.27 petaflop/s), Tsubame 2.0 at the Tokyo Institute of Technology (1.19 petaflop/s), Cielo at Los Alamos National Laboratory in New Mexico (1.11 petaflop/s), Pleiades at the NASA Ames Research Center in California (1.09 petaflop/s), Hopper at DOE's National Energy Research Scientific Computing Center (NERSC) in California (1.054 petaflop/s), Tera 100 at the CEA (Commissariat à l'énergie atomique et aux énergies alternatives) in France (1.05 petaflop/s), and Roadrunner at Los Alamos National Laboratory in New Mexico (1.04 petaflop/s).

The New Number One

The K Computer, built by Fujitsu, currently combines 68544 SPARC64 VIIIfx CPUs, each with eight cores, for a total of 548,352 cores—almost twice as many as any other system in the TOP500. The K Computer is also more powerful than the next five systems on the list combined.

The K Computer's name draws upon the Japanese word "Kei" for 10^{16} (ten quadrillions), representing the system's performance goal of 10 petaflops. RIKEN is the Institute for Physical and Chemical Research. Unlike the Chinese system it displaced from the No. 1 slot and other recent very large system, the K Computer does not use graphics processors or other accelerators. The K Computer is also one of the most energy-efficient systems on the list.

Some Other Highlights from the Newest List

- The two Chinese systems at No. 2 and No. 4 and the Japanese Tsubame 2.0 system at No. 5 are all using NVIDIA GPUs to accelerate computation, and a total of 19 systems on the list are using GPU technology.
- China keeps increasing its number of systems and is now up to 62, making it clearly the No. 2 country as a user of HPC, ahead of Germany, UK, Japan and France.
- Intel continues to provide the processors for the largest share (77.4 percent) of TOP500 systems. Intel's Westmere processors increased their presence in the list strongly with 169 systems, compared with 56 in the last list.
- Quad-core processors are used in 46.2 percent of the systems, while already 42.4 percent of the systems use processors with six or more cores.
- Cray defended the No. 2 spot in market share by total against Fujitsu, but IBM stays well ahead of either. Cray's XT system series remains very popular for big research customers, with three systems in the TOP 10 (one new and two previously listed).

Tracking Changes

Since its launch in 1993, the TOP500 List has provided a consistent metric for evaluating the performance of supercomputers. This consistency has made the list a valuable tool for tracking changes in the industry, both over the years and from list to list. Here are some notable changes between the current list and the 36th edition, issued in November 2010.

- The entry level to the list moved up to the 40.1 Tflop/s mark on the Linpack benchmark, compared to 31.1 Tflop/s six months ago.
- The last system on the newest list was listed at position 262 six months ago. This turnover rate has steadily increased during the last few lists and is now above average.
- Total combined performance of all 500 systems has grown to 58.88 Pflop/s, compared to 43.7 Pflop/s six months ago and 32.4 Pflop/s one year ago.
- The average concurrency level in the TOP500 is 15,550 cores per system, up from 13,071 six months ago and 10,267 one year ago.
- The U.S. is the leading consumer of HPC systems with 256 of the 500 systems (down from 274). The European share (125 systems) is still larger than the Asian share (103 systems – up from 84). Dominant countries in Asia are China with 62 systems (up from 42) and Japan with 26 systems (unchanged). In Europe, Germany, UK, and France are almost equal with 30 (26), 27 (24), and 25 (26) respectively.

Some Final Notes on Power Consumption

Just as the TOP500 List has emerged as a standardized indicator of performance and architecture trends since it was created 18 years ago, the list now tracks actual power consumption of supercomputers in a consistent fashion. Although power consumption is increasing, the computing efficiency of the systems is also improving. Here are some power consumption notes from the newest list.

- 29 systems on the list are confirmed to use more than 1 megawatt (MW) of power.
- Average power efficiency is 248 Mflops/watt (up from 219 Mflops/watt six months ago and 195 Mflops/watt one year ago).

- The No. 1 system, the K Computer, also reports the highest total power consumption of 9.89 MW.
- Average power consumption of a TOP500 system is 543 KW (up from 447 KW six months ago and 397 KW one year ago).
- Average power consumption of a TOP 10 system is 4.3 MW (up from 3.2 MW six months ago), and average power efficiency is 464 Mflops/watt (up from 268 Mflops/watt six months ago).

About the TOP500 List

The TOP500 list is compiled by Hans Meuer of the University of Mannheim, Germany; Erich Strohmaier and Horst Simon of NERSC/Lawrence Berkeley National Laboratory; and Jack Dongarra of the University of Tennessee, Knoxville.