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China Upgrading Milky Way 2 Supercomputer

Supercomputers, the computers with a high level of computing performance, has been developed for over 50 years since the release of CDC 6600 in 1964. During these years, their performances, measured by float operations(flop) per second, has grown tremendously from few Megaflops per second to over a Petaflop per second. While the United States and Japan were the pioneers in this field, China, with its growing economy, is trying to catch up. At IHPC forum in Guangzhou China, researchers from Guangzhou National Supercomputer Center released the MilkyWay 2A supercomputer, upgraded version of the previous MilkyWay 2, to have 95 Petaflops per second calculation power.

The MilkyWay 2A supercomputer is the successor of the MilkyWay and MilkyWay 2 developed by the National University of Defense Technology in China. The MilkyWay supercomputer project started in 2008 and was finished in 2009. It has a peak performance of 4.7 Petaflops, which was the highest among all the supercomputers at that time. (MilkyWay) Two years later, in 2011, the National University of Defense Technology started the second supercomputer project –MilkyWay 2, which was finished in 2013. The MilkyWay 2 has the peak performance of 54.9 Petaflops per second, which is over ten times more powerful than the MilkyWay. (MilkyWay 2) It was the fastest supercomputer in the world until National Supercomputing Center in Wuxi released the Sunway TaihuLight in 2016.

While the previous generations of MilkyWay supercomputers are phenomenal, the MilkyWay 2A achieved even more computing power of 95 Petaflops per second. The major

contributor to this boost is the brand-new computing nodes. Previously, the Milky Way 2's node consists 3 Intel Xeon Phi KNC accelerators and 2 Intel Ivy Bridge CPUs. While the Ivy Bridge CPUs are still there, the Xeon Phi KNC accelerators were replaced by two Matrix-2000 accelerators. Inside each node, two Intel Ivy Bridge CPUs are linked with each other using two Intel Quick Path Interconnects and they use two $\times 16$ PCI Express 3.0 connection to access the two Matrix-2000 accelerators. While the CPUs are equipped with 64GB DDR3 memory, the accelerators have 128GB DDR4 memory, so each node has 192GB of memory and the peak performance of 5.3376 Teraflop per second. Moreover, Milky Way 2A is organized by an interconnection network where 32 compute nodes are packaged in one compute frame and connected to each other using a 32×32 switchboard. The compute frames are then connected through 576-port switches. Overall, the interconnected 17,792 nodes in the Milky Way 2A have the peak performance of 94.97Petaflops per second. (Dongarra 5-7)

With such great computing power, Milky Way 2A could contribute to numerous other projects. For instance, it could calculate the aerodynamic outflow for future airplanes, which requires a large amount of calculation. Since Milky Way 2 has been used to test the Comac C919 narrow-body twinjet airliner, we can expect the same usage of Milky Way 2A on future airplanes. Moreover, it could be used to design new medicines. The Milky Way 2 has been used to calculate the organic small compounds' binding affinity for Shanghai Institute of Materia Medica; with more calculation power, Milky Way 2A could promote the development of new medicine. These are guesses about the potential uses of Milky Way 2A supercomputer because it is still undergoing numerous tests and has not been used yet.

So far, everything about Milky Way 2 sounds great; however, there are a few Challenges. To start with, the Milky Way supercomputers have been notoriously hard to use. According to

Chi Xuebin, deputy director of the Computer Network and Information Center, the functions of the MilkyWay supercomputers are still way behind other countries and some users would need years or even a decade to write the necessary code. (Tianhe-2) The words from Chi Xuebin might be a little exaggerated, but it is true that the software for MilkyWay supercomputers is outdated.

Moreover, according to the data we have now, the MilkyWay 2A has a low efficiency of 64%. The efficiency is the max calculation power divided by the theoretical calculation power, which effectively shows how much potential of a supercomputer has been used. Comparing to the Piz Daint supercomputer, which has an efficiency of 77.4%, and the Sequoia supercomputer, which has an efficiency of 85.3%, Milky Way 2A really hasn't used its full power. (TOP500 Lists)

Furthermore, since the MilkyWay supercomputers are built for the world rank, there are not many consumers of the huge computing power. For instance, since the MilkyWay is located in Guangzhou and is open to public customers, research universities would not use it considering the cost of data transmission, and the military cannot use it for safety reasons. There are some industrial users, but most of them just don't have the software needed to use the supercomputer on real-world problems.

To conclude, using brand-new computing node made from Matrix-2000 accelerators and Intel Ivy Bridge CPUs, Milky Way 2A have an astonishing computing power and could contribute to many other fields. However, the challenges including outdated software, low efficiency and oversupply could greatly limit its impact.

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