Demonstration Trial Commences with a View to Developing Eco-Friendly Supercomputers

In seeking to reduce the impact on the environment, the wave of going green is reaching the world of supercomputers and their continually growing size and power consumption. NII, Tokyo Institute of Technology and Hokkaido University are jointly exploring environmental friendliness in supercomputers, which are now essential for industry, academia, research, and daily life.

A crisis in supercomputer power consumption

Supercomputers have computing capacity, huge memory and high-speed networks far superior to those of ordinary personal computers. Supercomputer-based simulations have paved the way for cutting-edge studies including illumination of mysteries behind the creation of the universe, genetic analyses and for creation of long-range golf balls and unbreakable cell phone handsets. The demand for supercomputers is growing in a wide range of fields.

However, a problem has emerged concerning their huge power consumption. "One supercomputer is said to consume about 16 megawatts. Assuming that a general household consumes 2 kW, this power consumption is equivalent to that of 8,000 households. That tells you how huge they are," explains Dr. Satoshi Matsuoka, a professor at the Tokyo Institute of Technology and a visiting professor at the Organization for Science Network Operations and Coordination of NII.

As supercomputers' power consumption is nearing socially tolerable limits, it is becoming harder to further increase supercomputers and further sophisticate their functions. Their power consumption will inevitably need to be reduced from the perspective of cutting CO_2 emissions responsible for global warming.

Under these circumstances a move toward green supercomputers emerged around 2006. In April 2011, NII, Tokyo Institute of Technology and Hokkaido University jointly launched a large-scale demonstration trial of a new-concept supercomputer (see figure).

Gathering strengths of individual partners for green supercomputer research

"There are various approaches for cutting car energy consumption, such as body weight reduction and engine efficiency improvement. For supercomputers, there is no one-stop technology for reducing power consumption," he says. This is the very reason for conducting joint research that brings together various ideas and technologies. The large-scale demonstration trial aims to develop an efficient cooling technology and achieve practical application of an independent operation system for operating supercomputers from remote locations. Hokkaido University has a cooling technology developed by capitalizing on its cold local climate. The Tokyo Institute of Technology holds a technology for remote operation of supercomputers. NII has a science information network that boasts high speed and high capacity. All these strengths are effective in the trial.

Development of an efficient cooling technology was defined as a priority objective given that a considerable amount of power is currently consumed for cooling supercomputers. Existing supercomputers are continually cooled to a range of 15-20°C to prevent any failure due to their own heat.

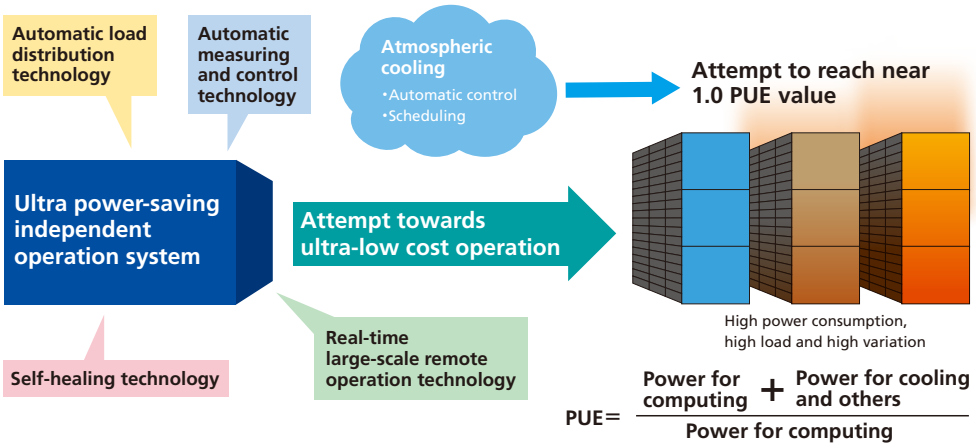
Power usage effectiveness (PUE) serves as an indicator of efficiency in supercomputer operation. Any surplus over the value of 1 indicates unnece-

Satoshi Matsuoka

Visiting Professor,
Organization for Science Network Operations and Coordination, NII
Professor, Global Scientific Information and Computing Center,
Tokyo Institute of Technology

In pursuit of eco-friendly supercomputers

The large-scale demonstration trial has two major objectives. The first is creating the world's first supercomputer with a PUE value of 1.0 by taking advantage of atmospheric cooling at a cold location. The second is ensuring remote operation and maintenance with the remote independent operation system to bring about massive cuts in operational cost.



ssary power used in non-computing functions. The larger the surplus, the more waste is generated. Cooling is responsible for a large proportion of this wasteful power consumption. With a conventional air conditioner, it is difficult to make the PUE value any lower than 1.5. The trial studies a new cooling method for bringing the PUE value as close to 1 as possible. It is naturally advantageous to perform it in a cold location. Shifting the viewpoint from "cooling of supercomputers" to "using heat from supercomputers," would enable a view that these computers do not consume so much power relative to the heat they give off. Regional locations can provide an environment where it is easy to use the heat generated. Hokkaido is suited to the demonstration study given that it has large district heating systems and that it is possible to use heat at a high level of efficiency.

Kento Aida

Professor by Special Appointment,
Center for Grid Research and Development, NII

Practical use of remote independent operation

Moving supercomputers to a cold region is by no means easy. Professor Matsuoka and co-researcher Dr. Kento Aida, a professor by special appointment at the Center for Grid Research and Development of NII, assert that is necessary to change the conventional idea that supercomputers must be located nearby. After transfer of supercomputers, the organizations owning them will have to operate them remotely.

Supercomputers handle important data, are under tremendous load and require a high level of operational skill. They have typically needed meticulous care. In order to be prepared for failure and other abnormal circumstances, they have never been operated unmanned. A remote independent operation system is there to overcome these hurdles. This enables construction of a network with sufficient capacity for smoothing the transmission of bulky data and maintaining supercomputers with instructions from remote locations.

"NII operates SINET, a science information network for linking among universities and research institutions across Japan," Professor Aida says. "This network will enable remote independent operation." He adds that development of the network will in the future provide an environment that allows anyone wishing to use a supercomputer to immediately use one that is available. In anticipating this situation, he also conducts research on scheduling that determines who uses them, when and how.

How the technologies and systems derived from the large-scale demonstration trial will be applied to ICT equipment cannot be predicted.

Expanding the future of supercomputers

Japan's supercomputers have world-leading capabilities but for those using them in research and product development their capacity is far from satisfactory. Both Drs. Matsuoka and Aida expect relentless pursuit of supercomputers to continue. More powerful supercomputers would allow disease mechanisms and occurrence of natural disasters to be simulated with higher precision than today, and let us enjoy a greater level of safety and reassurance. However, the current issue surrounding power demand complicates further improvements of speed and performance. Green efforts in supercomputers are a key not merely for creating environmentally friendly supercomputers but also for expanding the future of these machines.

The large-scale demonstration trial has only been underway for a short while and it is unclear what technologies it will lead to. Technologies created there will be applied to the Tokyo Institute of Technology's Tsubame 3.0 next-generation supercomputer currently being developed for inauguration in 2015. It is exciting to wait and see what will become possible.

(Written by Akiko Ikeda)