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Japan Agency for Marine-Earth Science and Technology
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Earth Simulator, Top-ranked the Global FFT in HPC Challenge Awards

The Earth Simulator(*), a supercomputer operated by the Japan Agency for Marine-EarthScience and Technology (JAMSTEC), won first place in the Global FFT, one of benchmarks in the High Performance Computing (HPC) Challenge Awards(*1), with an outstanding performance of 11.876TFLOPS(*3). The award was announced on November 16, 2010 at SC10 Supercomputing conference held in New Orleans.

The Global FFT, or Fast Fourier Transform(*2), evaluates a system's ability to transform signals from one domain to another. It is an important tool and widely used in scientific applications, especially in fields requiring analysis of global-scale flow systems, such as weather forecasts and climate change projections. The Earth Simulator was first launched in 2002 and upgraded to a new system in March 2009.

The high-performance Earth Simulator has been making significant contributions to better understanding of global environmental issues and geoscience processes. This includes research into more reliable climate change projections and impact assessment of global warming for the Fifth Assessment Report of the IPCC (Intergovernmental Panel on Climate Change). Sophisticated computer simulations of earthquakes and tsunamis it produces are used to develop strategies for disaster mitigation. JAMSTEC promotes the use of the Earth Simulator in a wide spectrum of areas, in partnership with the industrial community.

*1 HPC Challenge awards

The HPC Challenge awards complement the LINPACK, the current standard used to determine the TOP500 supercomputers. Developed in the U.S., the HPC challenge awards evaluate supercomputers from a broad set of HPC hardware and software capabilities, including computing, CPU-memory data transfer rate, and intra-CPU networking.

There are two classes in HPC challenge competition: Class 1: Best Performance, and Class 2: Most Productivity.
Class 1 focuses on the following four key measures:

- Global HPL :floating point rate of execution for solving a linear system of equations (Linpack TPP)
- Global Random Access: Rate of integer random updates of memory

- EP STREAM (Triad) per system: Sustainable memory bandwidth
- Global FFT: Rate of execution for Fast Fourier Transform

*2 Fast Fourier Transform

Signals with periodic intervals can be described by using sinusoidal signals as building blocks. The discrete Fourier Transform (DFT) is a method to transform complex periodic signals into discrete (digitalized) frequency components. A fast algorithm of such a transformation is called the Fast Fourier Transform (FFT). FFT is utilized in a variety of applications, including large-scale scientific computing, and contraction and expansion of multimedia data.

*3 Flops

Flops, or FLoating point OPerations per Second, is a measure of computer's performance. One teraflops is the computing power capable of calculating one trillion floating points per second. One petaflops is 1000 trillion calculations per second.

Photo: Earth Simulator

Earth Simulator

The Earth Simulator is a parallel vector supercomputer put into operation at JAMSTEC in March 2002. It was upgraded to the NEC's SX-9/E in March 2009. The new system consists of 160 computing nodes, each of which equipped with eight CPUs and 128GB memory. The system as a whole connects 1280 CPUs and total combined memory of 20TB. The theoretical peak performance is 131.072TFLOPS, which boosts the world's fastest CPU core of 102.4 GFLOPS. In June 2009, the system achieved the world's highest computing efficiency, by leveraging its large shared memory, fast data transfer rate between memory and CPU, and high intra-node network speed. With such powerful computing capability, the Earth Simulator is used in a wide range of oceanographic and geoscience applications, including climate change

projections, oceanographic physiology, and earthquake and crustal change predictions. Computational simulations are being introduced for a variety of technologies, including nanotechnology, biotechnology and engineering, to enhance scientific and technological advancement in Japan. The industry is also beginning to use the Earth Simulator in research, development, design and manufacturing of products.

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