The Earth Simulator
Current Status

SC13
Nov. 2013

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http://www.jamstec.go.jp
JAMSTEC Organization
Japan Agency for Marine-Earth Science and Technology

Research Sector (700)
- Research Institute for Global Change
- Institute for Research on Earth Evolution
- Institute of Biogeosciences

Development and Promotion Sector (300)
- Marine Technology Center
- Earth Simulator Center
- Data Research Center for Marine-Earth Sciences
- Center for Deep Earth Exploration
- Advanced Research and Technology Promotion Department

Management Sector (100)
- Planning Dept.
- Administration Dept.
- Finance and Contracts Dept.
- Safety and Environment Management Office
- Audit and Compliance Office
Location of Earth Simulator Facilities

Tokyo

Yokohama

Earth Simulator Site

Yokosuka Headquarter
Earth Simulator

Peak Performance : 40 T Flops
Main Memory : 10 T Bytes

Earth Simulator (ES2)

March, 2009 ～
Peak Performance : 131 T Flops
Main Memory : 20 T Bytes
ES2 System outline

Processor nodes (PNs)
- SX-9/E 160 processor nodes (PNs)
- (including interactive 2 nodes)
- Total peak performance: 131TFLOPS
- Total main memory: 20TB
- Data storage system: 500TB
- Inter nodes network (IXS): 64GB/sec (bidirectional)/node

Login server

Storage server
- 4Gbps Fiber Channel
- SAN (Storage Area Network)

FC Switch

User Network
- Labs, User Terminals
- 10GbE (partially link aggregation 40GbE)

Usable Capacity 1.5PB
RAID6 HDD

Operation Servers
- NQS2 batch job system on PNs
- Agent request support
- Use statistical and resource information management
- Automatic power saving management

Operation Network

Maintenance Network

Nov 2013
## HPC Challenge Benchmark

### HPC Challenge Awards

**Class 1**

Best performance on a base or optimized run submitted to the HPC Challenge website. The benchmarks to be judged are: Global HPL, Global RandomAccess, EP STREAM (Triad) per system and Global FFT.

http://www.hpcchallenge.org/

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### TOP500 (Linpack) Performance

<table>
<thead>
<tr>
<th>System</th>
<th>#cores</th>
<th>G-FFT</th>
<th>Effective Ratio</th>
<th>#cores</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAMSTEC ES2 (SX-9)</td>
<td>122 TF</td>
<td>1,280</td>
<td>Rank 3</td>
<td>9.1 %</td>
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<tr>
<td>RIKEN AICS (K Computer)</td>
<td>10,510 TF</td>
<td>705,024</td>
<td>Rank 1</td>
<td>1.94 %</td>
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<tr>
<td>Ratio</td>
<td>x 86</td>
<td>x 550</td>
<td>x 17.3</td>
<td>x 4.7</td>
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</table>
Projects FY2013

- JAMSTEC Research Projects 40%
- Contract Research Projects 30%
- Proposed Research Projects 30%
- Research projects organized by JAMSTEC and Collaboration Projects
- Earth Science 30% (24 Projects)
- Program for Risk Information on Climate Change (SOUSEI) 27% (3 themes)
- The Strategic Industrial Use 3%

Total resource 1,300,000 node·hour
L batch nodes 156 * 24 hour * (365 – 17.7 maintenance days)
Users

- 515 Users
- 137 Organizations (January 2013)
- 64 Universities, 15 Labs, 41 Companies, 17 Overseas

Graph showing the number of users from 2002 to 2012, with categories for Overseas, Companies, Labs, and Universities.
Over 90% operation was achieved.
Post-ES2 system
### The Earth Simulator Roadmap

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<tbody>
<tr>
<td>ES</td>
<td></td>
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<td>Operation until March 2009</td>
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<td>Half system operation, data migration</td>
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<tr>
<td>ES2</td>
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<td>3rd system (5 years?)</td>
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<tr>
<td>Future System</td>
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<td></td>
<td>6 years operation from March 2009 to February 2015</td>
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**Operation Details:**
- **ES:** Operation until March 2009
  - Half system operation, data migration
- **ES2:** 6 years operation from March 2009 to February 2015
  - 3rd system (5 years?)
  - FS target
  - 4th system

**Timeline:**
- March 2009 to February 2015

**Note:**
- The Earth Simulator Roadmap covers a range of years from 2007 to 2020, detailing the operational status and timeline for each year.
Positioning of ES in JAMSTEC long-term vision

One employment of observation and a simulation is a strong point of JAMSTEC.

long-term vision (Next 15 years)

(i) Analysis and prediction of global environment change
(ii) Plate dynamics and disaster prevention research of an earthquake and tsunami
(iii) Evolution of a life, and the history of a sea life
(iv) Resource engineering of a material and energy
Science Targets for the post-ES2

- Global environment change
  - Submesoscale (ensemble calculations)
  - Extreme Events Prediction, Guerrilla rainstorm, urban heat island
  - Nesting/downscaling
  - data assimilation

- Earthquake, Tsunami
  - Seismic tomography, plate tectonics, database of earthquake scenarios
  - Information of the optimal evacuation route/place from tsunami

- Geo-marine-bio science
  - Life model building which took in the information on a meta-genome

- High technology development
  - High resolution analysis of VIV (Vortex Induced Vibration) problem with long cable
  - The on-the-ocean operation real-time supporting system of a vessel
  - Planning of the energy-saving efficient operation schedule of a vessel
In order to advance main researches of the earth science field in post-ES2, (1) 10 times or more faster calculation performance, (2) and 5 times or 10 bigger memory capacity are need on the assumption that resource allocation and execution efficiency comparable as ES2.

There are many users who are thinking the B/F performance as important and this can be called common view from the position of promoting earth science.
Key point of post-ES2

• Peak Performance: \(1.3 \sim 13\) PFlops (10 times or more faster than ES2)
• Memory Capacity: \(100 \sim 200\) TB (5 times or 10 times bigger than ES2)
• Storage Capacity: \(10 \sim 20\) PB (5 times or 10 times bigger than ES2)
• High data bandwidth between CPU and main memory (High B/F)
• Cooperation with other small systems
  • Shared memory based storage
  • Cooperation job scheduler system

The most important problem is a benchmark program for an assessment system. Communication with a main user is required.
Summary

- **ES2 current operation**
  - 6 years operation from March 2009 to February 2015
  - Top 500 rank: 217th and HPCC G-FFT: 3rd in November 2012
  - Calculation resource is centralized on earth science.

- **Future Plan**
  1. Feasibility Study of exa-scale system in 2018 or later.
  2. Post-ES2 system in March 2015.
    - Peak Performance: $1.3 \sim 13\text{PFlops}$ (10 times or more faster than ES2)
    - Memory Capacity: $100 \sim 200\text{TB}$ (5 times or 10 times bigger than ES2)
    - High data bandwidth between CPU and main memory (High B/F)
    - Cooperation with other small systems
    - The main user required benchmark programs for an assessment system are need.
Thank you for your kind attention!

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