
Rudá Moura
2016

# K computer

- Part of the HPC Infrastructure Initiative led by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT).

- RIKEN (Japan's research institute) chose Fujitsu to develop a powerful supercomputer.

- "Design, build, and set up the Next-Generation Supercomputer, the world's fastest and most advanced computer, with a speed of 10 petaflops.". 10 peta (10E16) = one "Kei" in Japanese.

- Location: K computer is installed at the RIKEN which is located on Port Island, Kobe.

# TOP 10 Sites for November 2015

For more information about the sites and systems in the list, click on the links or view the complete list.

| RANK | SITE | SYSTEM | CORES | RMAX (TFLOP/S) | RPEAK (TFLOP/S) | POWER (KW) |
|---|---|---|---|---|---|---|
| 1 | National Super Computer Center in Guangzhou<br>China | **Tianhe-2 (MilkyWay-2)** - TH-IVB-FEP Cluster, Intel Xeon E5-2692 12C 2.200GHz, TH Express-2, Intel Xeon Phi 31S1P<br>NUDT | 3,120,000 | 33,862.7 | 54,902.4 | 17,808 |
| 2 | DOE/SC/Oak Ridge National Laboratory<br>United States | **Titan** - Cray XK7 , Opteron 6274 16C 2.200GHz, Cray Gemini interconnect, NVIDIA K20x<br>Cray Inc. | 560,640 | 17,590.0 | 27,112.5 | 8,209 |
| 3 | DOE/NNSA/LLNL<br>United States | **Sequoia** - BlueGene/Q, Power BQC 16C 1.60 GHz, Custom<br>IBM | 1,572,864 | 17,173.2 | 20,132.7 | 7,890 |
| 4 | RIKEN Advanced Institute for Computational Science (AICS)<br>Japan | K computer, SPARC64 VIIIfx 2.0GHz, Tofu interconnect<br>Fujitsu | 705,024 | 10,510.0 | 11,280.4 | 12,660 |
| 5 | DOE/SC/Argonne National Laboratory<br>United States | **Mira** - BlueGene/Q, Power BQC 16C 1.60GHz, Custom<br>IBM | 786,432 | 8,586.6 | 10,066.3 | 3,945 |

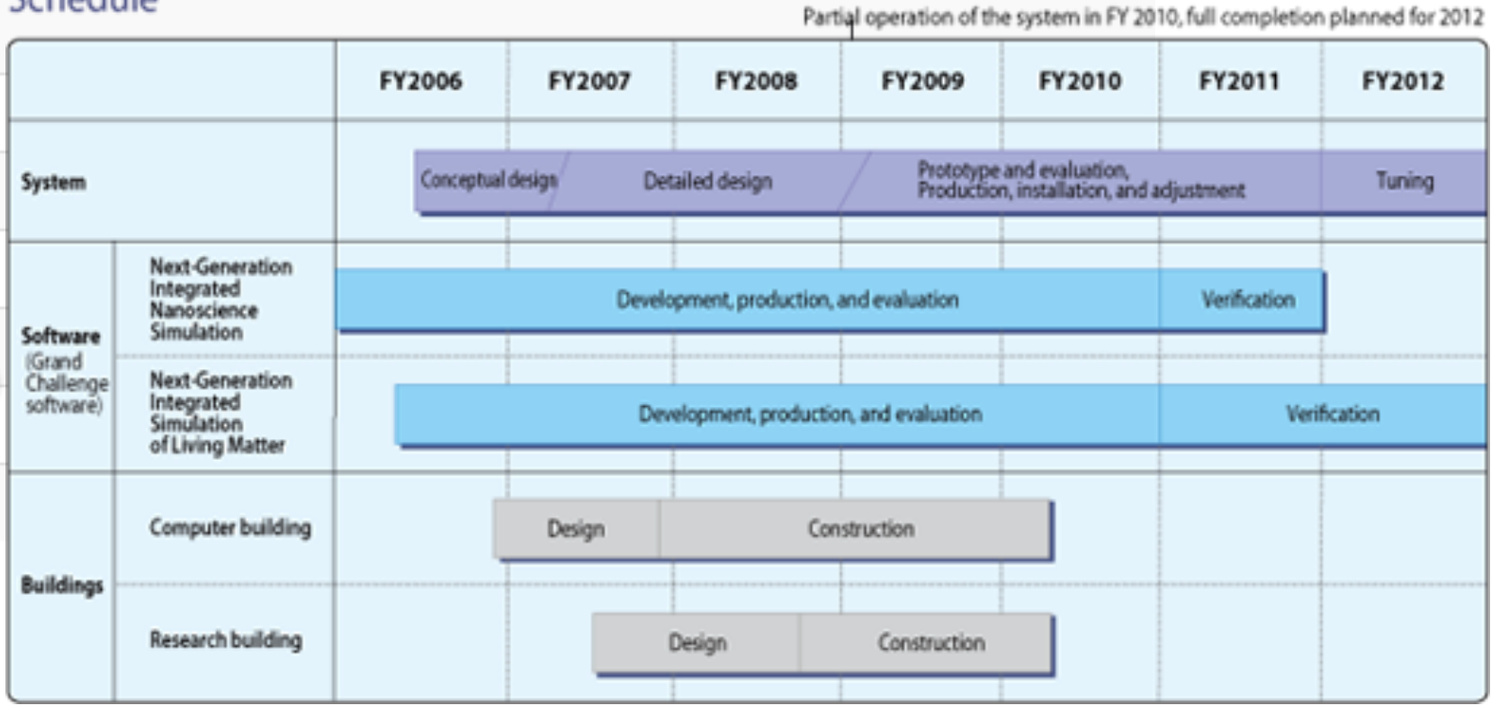
# RIKEN Advanced Institute for Computational Science (AICS)

| | |
|---|---|
| **URL** | http://www.aics.riken.jp/en/ |
| **Segment** | Research |
| **City** | Kobe |
| **Country** | Japan |

SYSTEMS | HISTORY

| LIST | HIGHEST RANK | SYSTEMS |
|---|---|---|
| 2015/11 | 4 | 1 |
| 2015/06 | 4 | 1 |
| 2014/11 | 4 | 1 |
| 2014/06 | 4 | 1 |
| 2013/11 | 4 | |
| 2013/06 | 4 | |
| 2012/11 | 3 | |
| 2012/06 | 2 | |
| 2011/11 | 1 | |
| 2011/06 | 1 | |
| 2010/11 | 172 | |

## Schedule

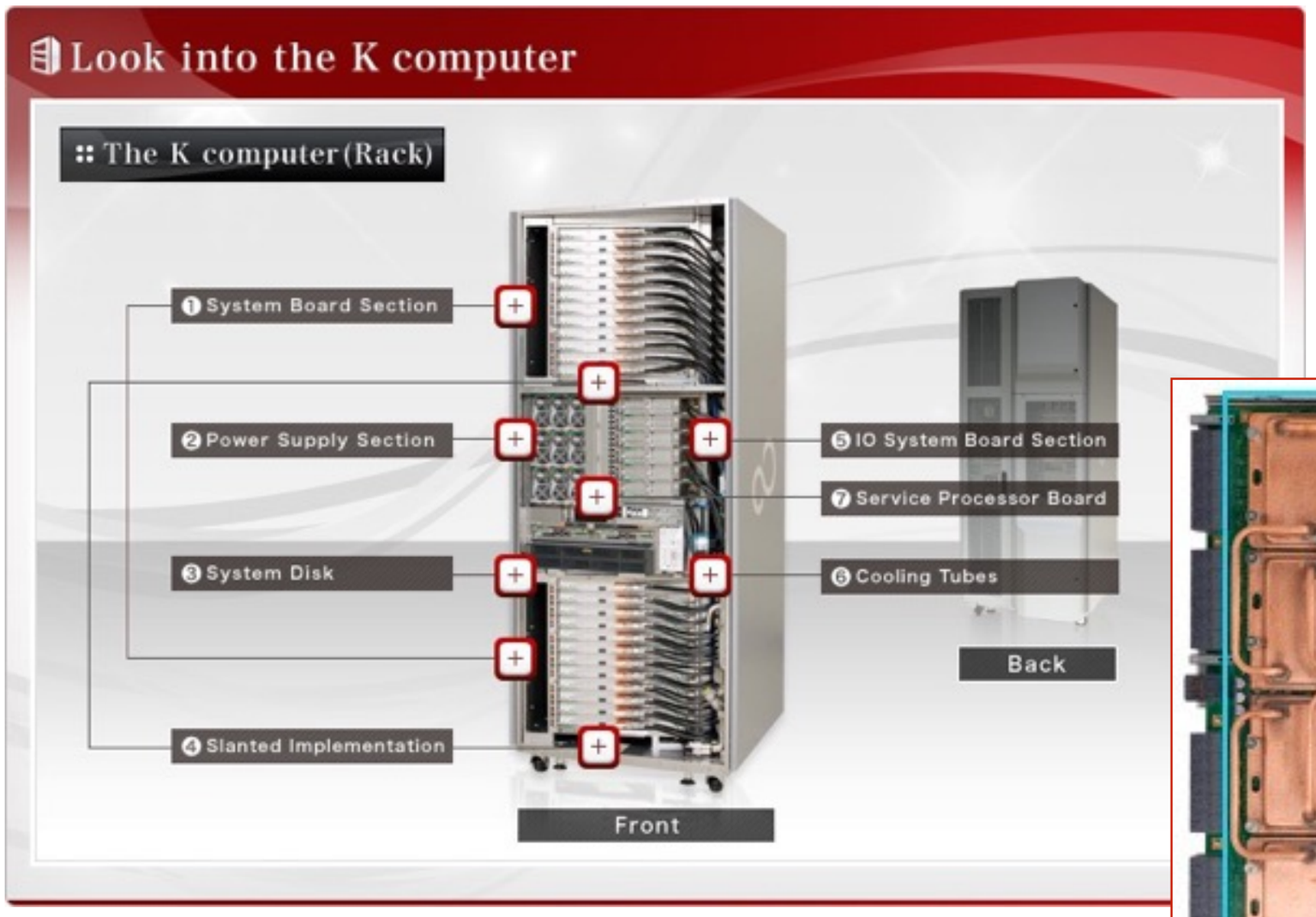


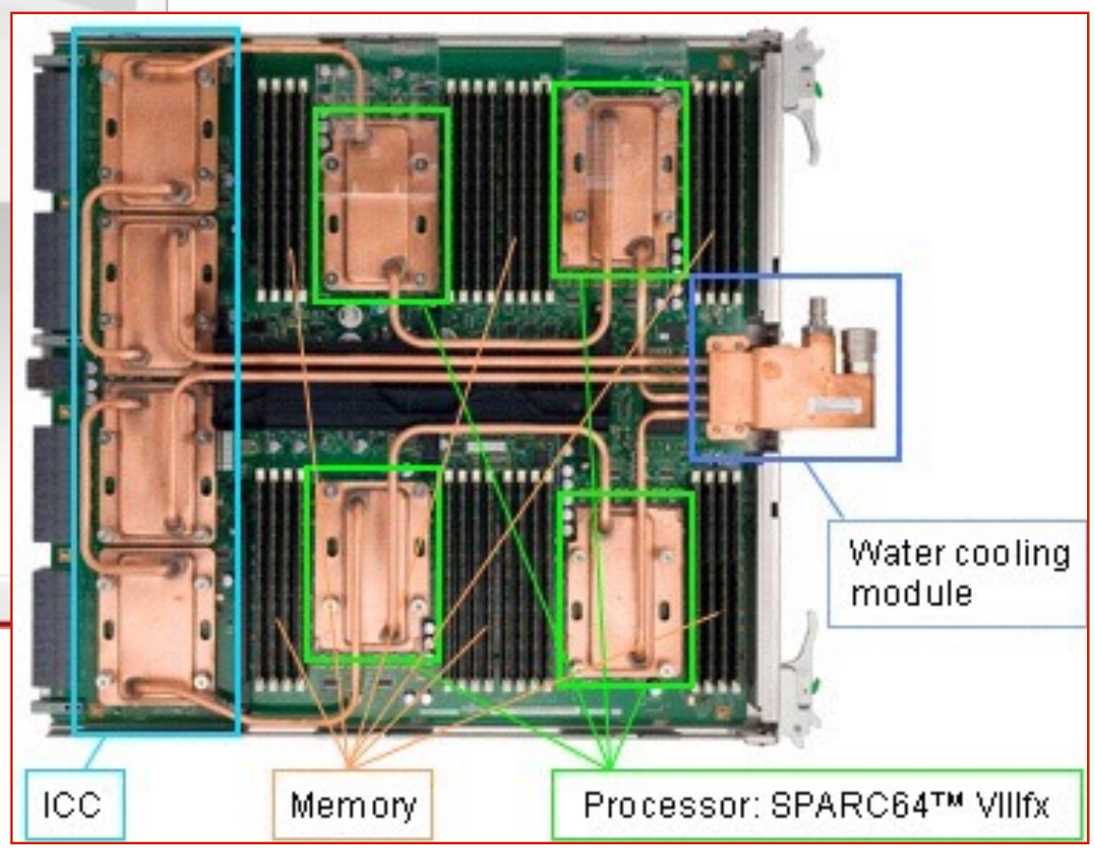
## The Green500 List

**Listed below are the November 2015 The Green500's energy-efficient supercomputers ranked from 201 to 300.**

| Green500 Rank | MFLOPS/W | Site* | Computer* | Total Power (kW) |
|---|---|---|---|---|
| 201 | 875.33 | Navy DSRC | Kilrain - iDataPlex DX360M4, Xeon E5-2670 8C 2.600GHz, Infiniband FDR | 373.97 |
| 202 | 875.32 | Army Research Laboratory DoD Supercomputing Resource Center (ARL DSRC) | Hercules - iDataPlex DX360M4, Xeon E5-2670 8C 2.600GHz, Infiniband FDR | 347.26 |
| 203 | 874.02 | Saudi Aramco | Makman - iDataPlex DX360M4, Xeon E5-2670 8C 2.600GHz, Infiniband QDR | 505.50 |
| 204 | 869.26 | Government | Sugon TC6000, Intel Xeon E5-2630v2 6C 2.6GHz, 10G Ethernet | 540.00 |
| 205 | 865.01 | CSIR Fourth Paradigm Institute (CSIR-4PI) | Cluster Platform 3000 BL460c Gen8, Xeon E5-2670 8C 2.60GHz, Infiniband FDR | 386.56 |
| 206 | 859.67 | Government | Sugon TC6000, Intel Xeon E5-2630v2 6C 2.6GHz, 10G Ethernet | 600.00 |
| 207 | 855.79 | Internet Company S | Sugon TC5000, Intel Xeon E5-2420v2 6C 2.2GHz, Gigabit Ethernet | 380.00 |
| 208 | 851.89 | TOTAL | Laure - SGI ICE X, Xeon E5-2670 8C 2.600GHz, Infiniband FDR | 319.00 |
| 209 | 848.69 | Sandia National Laboratories | Dark Bridge - Appro Xtreme-X Supercomputer, Xeon E5-2670 8C 2.600GHz, Infiniband QDR | 315.90 |
| 210 | 846.42 | Leibniz Rechenzentrum | SuperMUC - iDataPlex DX360M4, Xeon E5-2680 8C 2.70GHz, Infiniband FDR | 3,422.67 |
| 211 | 846.15 | Maui High-Performance Computing Center (MHPCC) | Riptide - iDataPlex DX360M4, Xeon E5-2670 8C 2.600GHz, Infiniband FDR | 251.20 |
| 212 | 837.69 | Technische Universitaet Darmstadt | iDataPlex DX360M4, Xeon E5-2670 8C 2.600GHz, Infiniband FDR | 255.20 |
| 213 | 837.19 | Lawrence Livermore National Laboratory | Zin - Xtreme-X GreenBlade GB512X, Xeon E5 (Sandy Bridge - EP) 8C 2.60GHz, Infiniband QDR | 924.16 |
| 214 | 1,051.00 | RIKEN Advanced Institute for Computational Science (AICS) | K computer, SPARC64 VIIIfx 2.0GHz, Tofu interconnect | 10,000.00 |

# K computer


Look into the K computer
The K computer (Rack)
1 System Board Section
2 Power Supply Section
3 System Disk
4 Slanted Implementation
5 IO System Board Section
7 Service Processor Board
6 Cooling Tubes
Back
Front


Water cooling module
ICC
Memory
Processor: SPARC64™ VIIIfx

# Node

- CPU: SPARC64™ VIIIfx 8C, 2.0GHz, 8 cores, L2 cache: 6MB,45nm. Low-Power [water cooled], Fast, Reliable.
- Main memory: 16GB, bandwidth: 64GB/s.
- Network: Tofu interconnect, 6-dimensional mesh/torus topology. ICC (interconnect controller) is a chip that controls the network.
- Individual components are highly fault tolerant.
- Operation speed: 128GFLOPS.
- Computational nodes: 82,944 nodes (10.62PFLOPS).
- Storage: 30PB

"6-dimensional mesh/torus" topology (model)

# Processing Node

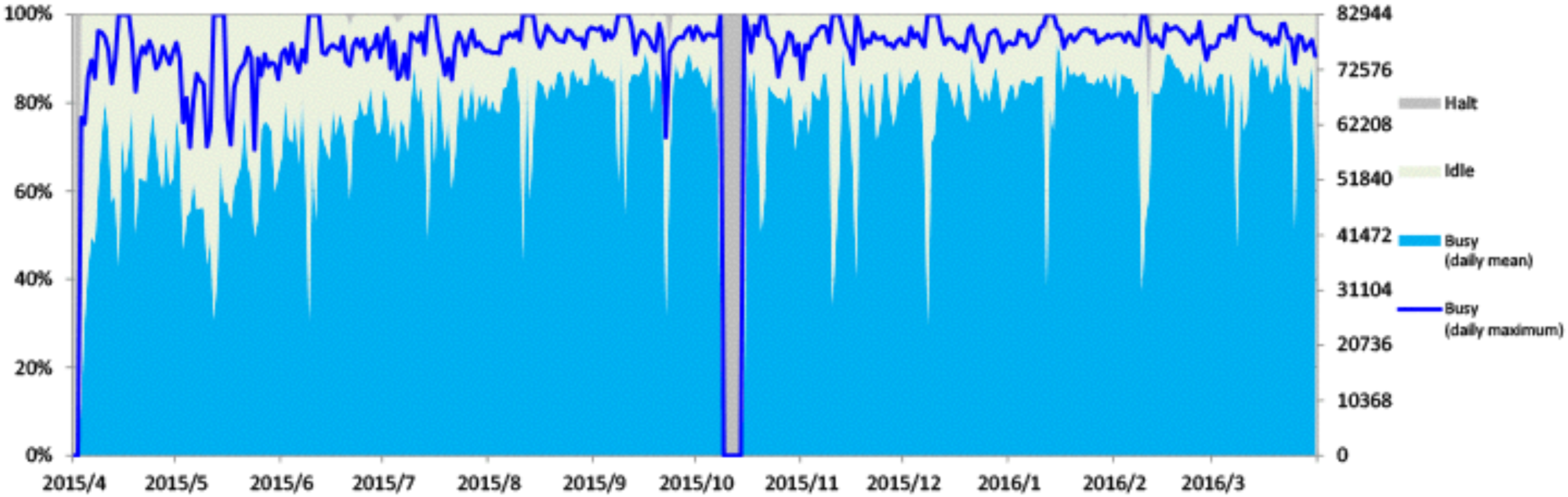
A Pre/Post processing node is available to users of the K computer to perform Pre/Post handling of visualization. In the use, the application is not necessary.

| | Model | CPU | Memory |
|---|---|---|---|
| **Hardware** | PRIMEQUEST 1800E | Xeon X7560 (8core/2.26GHz/24MB) x 8 | 1TB |
| | PRIMEQUEST 1800E | Xeon X7560 (8core/2.26GHz/24MB) x 8 | 0.5TB (512GB) |
| | HP DL980 | Xeon X7560 (8core/2.26GHz/24MB) x 8 | 2TB |
| | PRIMERGY RX300 S7 | Xeon E5-2637 (2core/3GHz/5MB) x 2 | 0.5TB (512GB) |
| **Software** | OS: Red Hat Enterprise Linux 6.5<br>● Fujitsu compiler(Cross compiler for computational nodes)<br>● Intel compiler<br>● GCC<br>● OpenMPI<br>● MPICH2<br>● There is also software that is included in the standard package of RHEL6.5. | | |

# Software

- Linux OS providing high portability.
- Fortran, XPFortran, C/C++.
- MPI 3.1 (Message Passing Interface) Library used in advanced data communication for parallelization.
- High-performance, highly functional and system-optimized scientific and numerical library (BLAS, LAPACK, FFTW, OpenMPI).

# Node usage（FY2015）



# Taxonomy (Flynn)

- MIMD (Multiple Instructions / Multiple Data)
  - Multicomputer (multiple homogenous nodes interconnected)
    - NORMA (non-remote memory access)

# Taxonomy (Comercial)

- MPP (Massively Parallel Processors)
- Multiple local memories, message passing, high speed interconnected network, high scalable, high cost, hard to program(?).

# Taxonomy (Johnson)

- DMMP (Distributed Memory, Message Passing).
  - "...include both hypercubes such as the NCUBE or FPS T-serie machines and mesh-connected machines such as the AMETEK 2010."

# Taxonomy (Dongarra/Sterling/Simon/Strohmaier)

- Clustering: Commodity cluster.
- Name space: Distributed name space ("variables of one node are not visible directly to another").
- Parallelism: Communicating sequential processes/message passing.
- Latency: Caches(?).
- c/d/c/c.

# Fujitsu Receives Order for New Supercomputer System

## Large-scale PRIMERGY server-based x86 cluster system to serve as an HPC platform for JCAHPC, and jointly operated by the University of Tokyo and the University of Tsukuba

## Fujitsu Limited

**Tokyo, May 10, 2016**

Fujitsu today announced that it has received an order for a many-core large-scale supercomputer system from the University of Tokyo and the University of Tsukuba. The system will be deployed to the Joint Center for Advanced High-Performance Computing (JCAHPC), which the two universities jointly operate.

The new supercomputer will be an x86 cluster system consisting of 8,208 of the latest FUJITSU Server PRIMERGY x86 servers. These will run on the next-generation Intel® Xeon Phi™ processors (Intel development code name: Knights Landing), and achieve a theoretical aggregate performance of 25 petaflops (PFLOPS[(1)]).

The system is due to be completely operational starting December 2016, when it is expected to be Japan's highest-performance supercomputer.

# References

- K computer [Fujitsu]
- The Development of the Next-Generation Supercomputer [RIKEN]
- K computer [HPCI]
- K computer: How to use [RIKEN]
- Top500 / Green500