Agenda

- Update of Japanese next generation supercomputer (the K computer) project
- RIKEN Advanced Institute for Computational Science (AICS) --- Sato, 10 min

- Consortium and High-performance Computing Infrastructure (HPCI) --- Ishikawa, 10 min

- Project funding for post-petascale computing research --- Matsuoka, 10min

Objectives of the NGS (the K computer) project

- Design, build, and set up the **general-purpose** next-generation supercomputer to be one of **most powerful** supercomputers in the world. It will have a performance of 10 petaflops in the LINPACK benchmark with a system manufactured by **Fujitsu**.
- Develop and distribute **large-scale software applications** ("Grand Challenge" software) that exploit large fraction of the supercomputer
- Set up a research institute to run the supercomputer, to be a COE **institute** in computer science and computational science (AICS)

The K Supercomputer

Updates

Nicknamed the "K computer"

Kei (京) represents the numerical unit of 10 Peta (10^{16}) in the Japanese language, representing the system's performance goal of 10 Petaflops. The Chinese character 京 can also be used to mean " a large gateway" so it could also be associated with the concept of a new gateway to computational science.

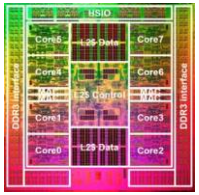
一、 十、 百、 千、 万、 億、 兆、 京、 垓、 杼、 穰、 溝、 澗、 正、 載、 極、
10^0 10^1 10^2 10^3 10^4 10^8 10^{12} 10^{16} 10^{20} 10^{24} 10^{28} 10^{32} 10^{36} 10^{40} 10^{44} 10^{48}

恒河沙、阿僧祇、那由他、不可思議、 無量大数
10^{52} 10^{56} 10^{60} 10^{64} 10^{68}

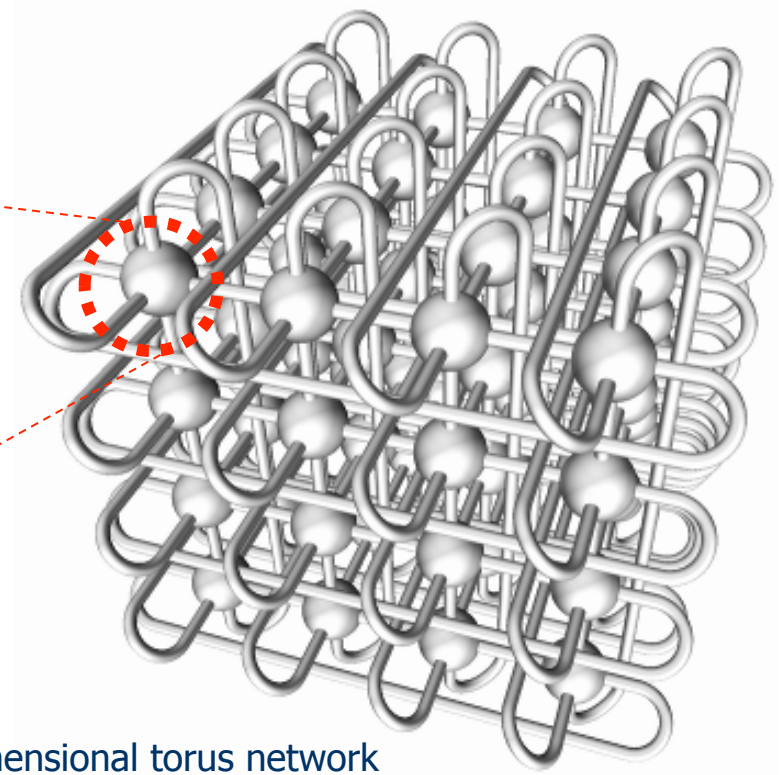
Compute Nodes and network

- Compute nodes (CPUs): > 80,000
  - Number of cores: > 640,000
- Peak performance: > 10PFLOPS
- Memory: > 1PB (16GB/node)

- Logical 3-dimensional torus network
- Peak bandwidth: 5GB/s x 2 for each direction of logical 3-dimensional torus network
- bi-section bandwidth: > 30TB/s



SPARC64™ VIIIfx

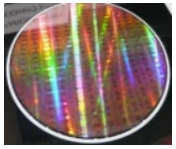


Logical 3-dimensional torus network for programming

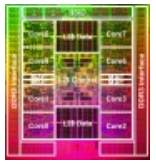
Courtesy of FUJITSU Ltd.

System boards and rack installation

Fujitsu's SPARC64 VIIIfx CPU



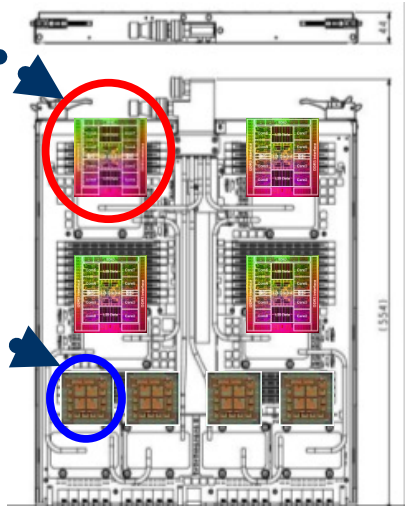
300mmWafer



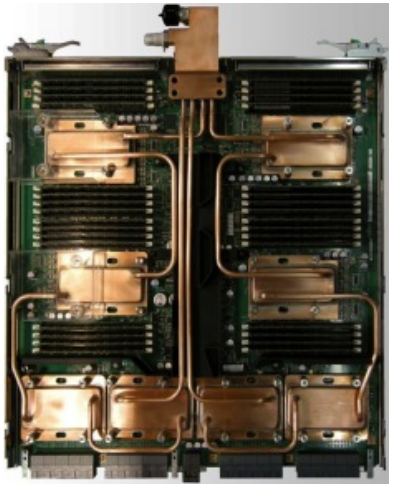
8cores, 128 GFlops

CPU

System Board



512 GFlops



460 mm

560 mm

ICC

LSI for interconnect

24 Boards in a Cabinet

796mm

750mm

2060 mm

Courtesy of FUJITSU Ltd.

12.3 TFlops/Cabinet

1300kg/Rack

K computer Delivery Began in Late September

- The first eight racks of the K computer were delivered to Kobe from Fujitsu on September 28, 2010. More than 800 racks are required for a 10 Peta Flops Performance.
- A computer rack weighs about 1,300 kg in average. The rack contains 96 water-cooled Fujitsu SPARC64 VIIIfx CPU chips, each of which performs 128 GFlops, interconnected with the 3D Torus network that Fujitsu named Tofu.

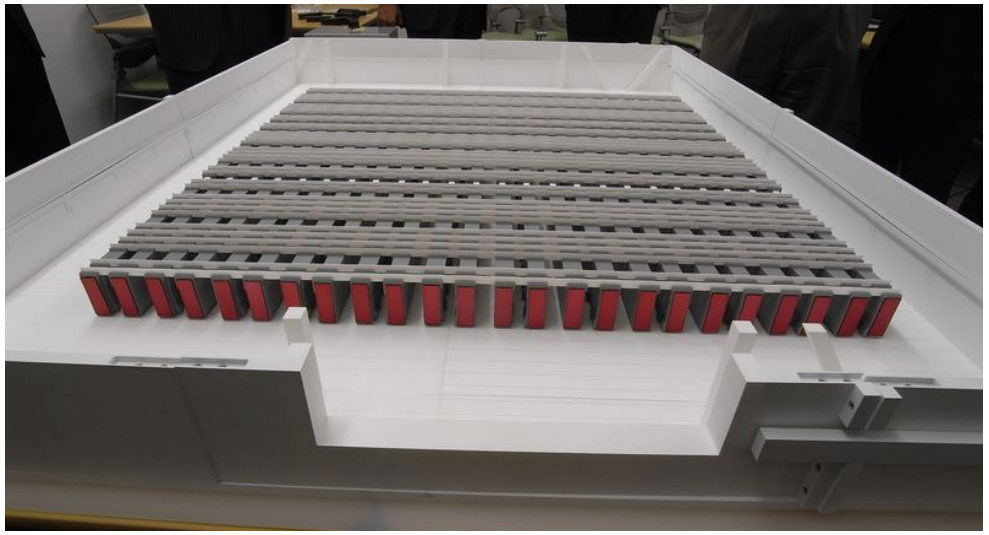
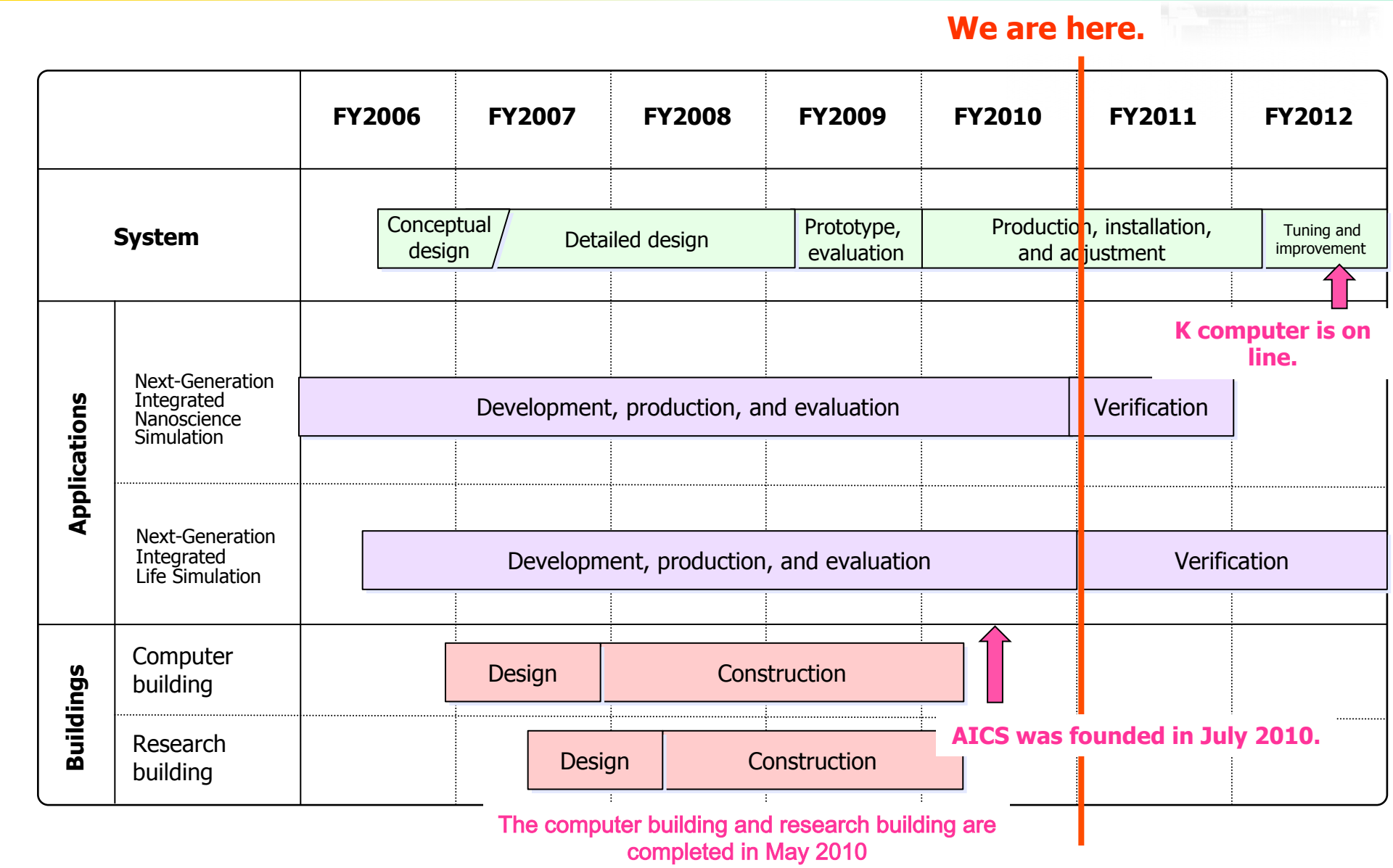


Photo of First delivery, Sep 28, 2010

Schedule of development

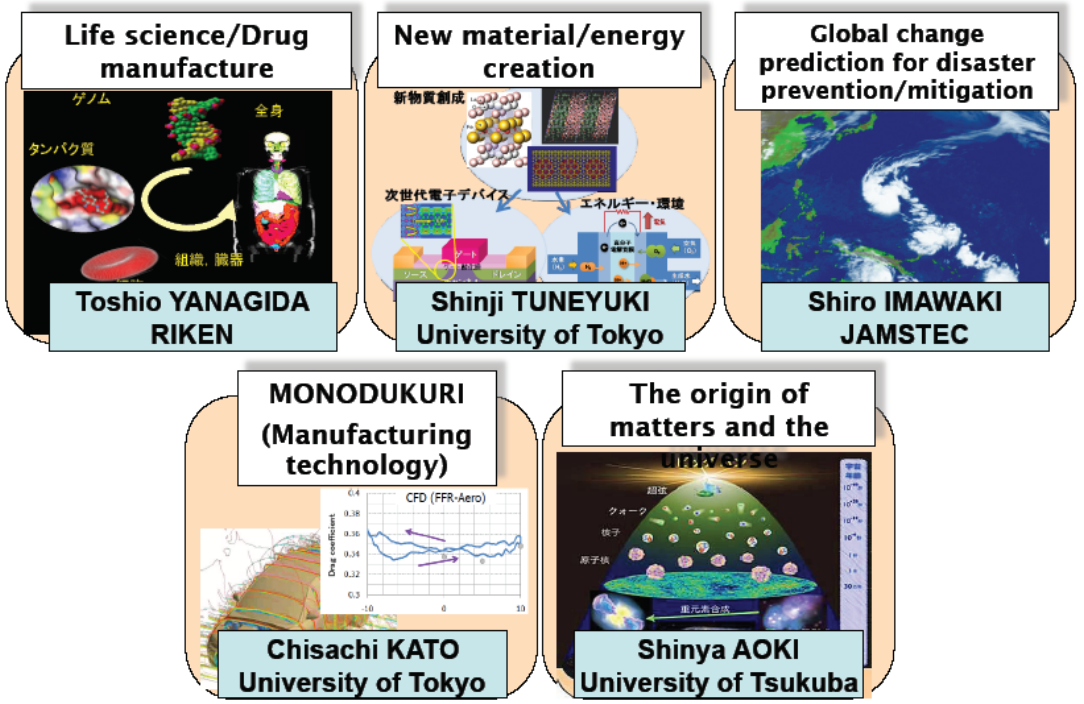


How to organize users of the K computer

- The strategic computational science program committee of MEXT has identified five application areas that are expected to create breakthroughs using the K computer from national viewpoint.
  - Field 1: Life science/Drug manufacture
  - Field 2: New material/energy creation
  - Field 3: Global change prediction for disaster prevention/mitigation
  - Field 4: *Mono-zukuri* (Manufacturing technology)
  - Field 5: The origin of matters and the universe

- MEXT funds five core organizations that lead research activities in these five strategic areas

- General Users
  -> will be orangaized
  in the context of HPCI



RIKEN Advanced Institute for Computational Science (AICS)

- The institute have been established at the NGS in Kobe (started in October 2010)
- Missions:
  - Take responsibility to run the NGS (K computer)
  - Carry out the leading edge of computational science technologies and contribute for COE of computational science in Japan
  - Propose the future directions of HPC in Japan and conduct it.
- Agenda:
  - Promoting strong collaborations between computational and computer scientists, working with core-organizations of each fields together.
  - Fostering young scientists who exploit both computational and computer science
  - Research for new concepts for HPC in the future beyond the NGS (this is, exascale?)
- 8 research teams started (3 for computer science, 5 for computational

Research teams in AICS (1/2)

- Computer science research teams
  - Basic research and development of computer science of petascale computing, and researches for post-petascale computing
  - System software research team (leader: Yutaka Ishikawa)
    - operating system, communication libraries, runtime
  - Programming environment research team (leader: Mitsuhisa Sato)
    - programming languages and compiler, runtime, performance tuning tools
  - Processor research team (leader: Makoto Taiji)
    - many-core processor architectures. development of heterogeneous accelerators for exascale computing
  - Planned research teams
    - Numerical algorithms design：numerical parallel algorithms , numerical analysis
    - System architectures ：Processor architecture and interconnection technologies
    - Data-intensive computating and visualization

Research teams in AICS (2/2)

- Computational science research teams
  - Field theory research team (leader: Yoshinobu Kuramashi)
    - Research on non-perturbative properties of elementary particles and nuclei through numerical simulations with the use of lattice QCD (Quantum ChromoDynamics).
  - Computational climate science research team (leader: Hirofiumi Tomita)
    - Climate research through the construction of a state-of-the-art climate model that is based on more fundamental physical laws.
  - Computational materials science research team (leader: Seiji Yunoki)
    - Research to understand quantum states of matter in a wide range of quantum many-body systems, including solid state materials, nano-sized matters, and cold atoms
  - Computational molecular science research team (leader: Takahito Nakajima)
    - Research for computational molecular theory to perform first-principle calculations on large-size and complicated molecular systems including nano- and bio-materials.
  - Computational biophysics research team (leader: Yuji Sugita)
    - Development for efficient and accurate methodologies for free-energy calculations in biological systems.
  - Planned research teams
    - Simulation for disaster prevention by earthquake, tsunami.
    - Engineering for complex system