Japan׳s Policy toward Exascale Computing

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MEXT

MINISTRY OF EDUCATION,
CULTURE, SPORTS,
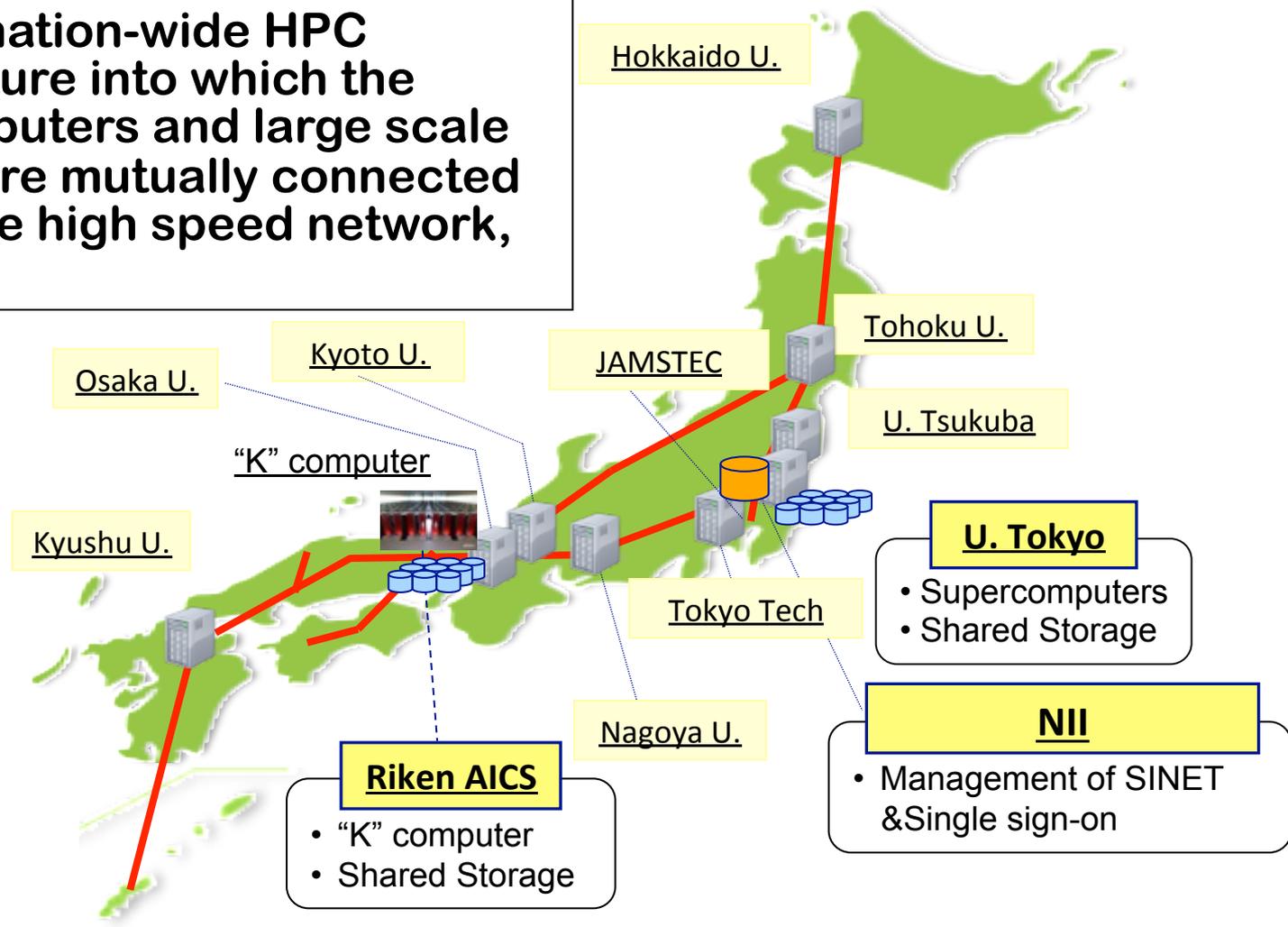SCIENCE AND TECHNOLOGY-JAPAN

Today's Topics

1. Current HPC Status in Japan

2. Japanese Policy for Development of HPC Systems

Current HPC Status in Japan

High Performance Computing Infrastructure (HPCI)

HPCI is a nation-wide HPC infrastructure into which the supercomputers and large scale storages are mutually connected through the high speed network, SINET4.

Hokkaido U.

Tohoku U.

Kyoto U.

JAMSTEC

Osaka U.

U. Tsukuba

"K" computer

Kyushu U.

U. Tokyo
- Supercomputers
- Shared Storage

Tokyo Tech

Nagoya U.

NII
- Management of SINET &Single sign-on

Riken AICS
- "K" computer
- Shared Storage

General Use Category of the K Computer

Rack

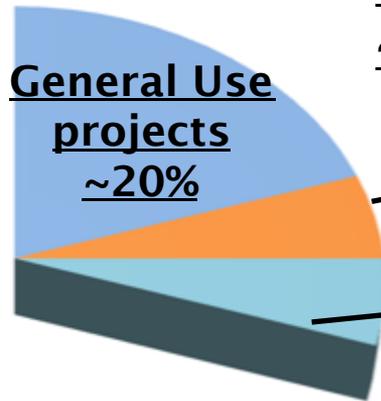"K computer (on July. 2012)

The building of "K" and AICS

General Use Category
~30% （To be called for proposals）

General Use projects ~20%

Industrial Use Projects ~ 5%

Junior Researcher Promotion Projects ~ 5%

Computing Resources Allocated for System Enhancement ~15%

Strategic Program Category ~50%

Additional Allocation for acceleration of achievements ~5%

Number of K users
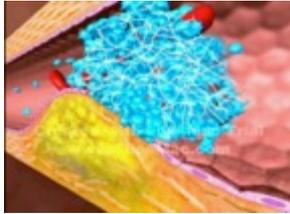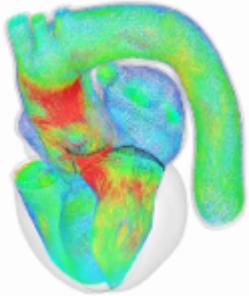**1,431**
Number of projects on K Computer
136

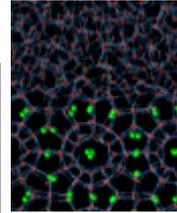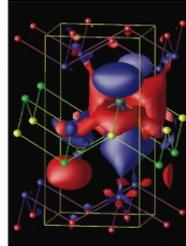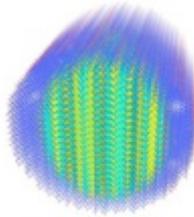MEXT MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY-JAPAN

Strategic Application Areas
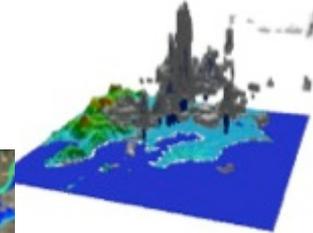
Life science/Drug design

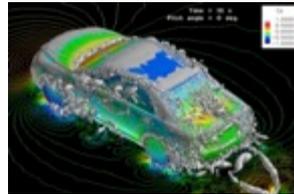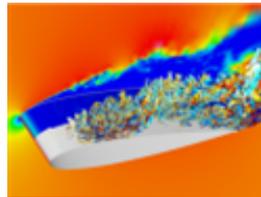Toshio YANAGIDA
RIKEN

New materials/New energy creation

Shinji TSUNEYUKI
University of Tokyo

Global climate change prediction for disaster prevention/mitigation

Shiro IMAWAKI
JAMSTEC

MONODUKURI
(Manufacturing technologies)

Chisachi KATO
University of Tokyo
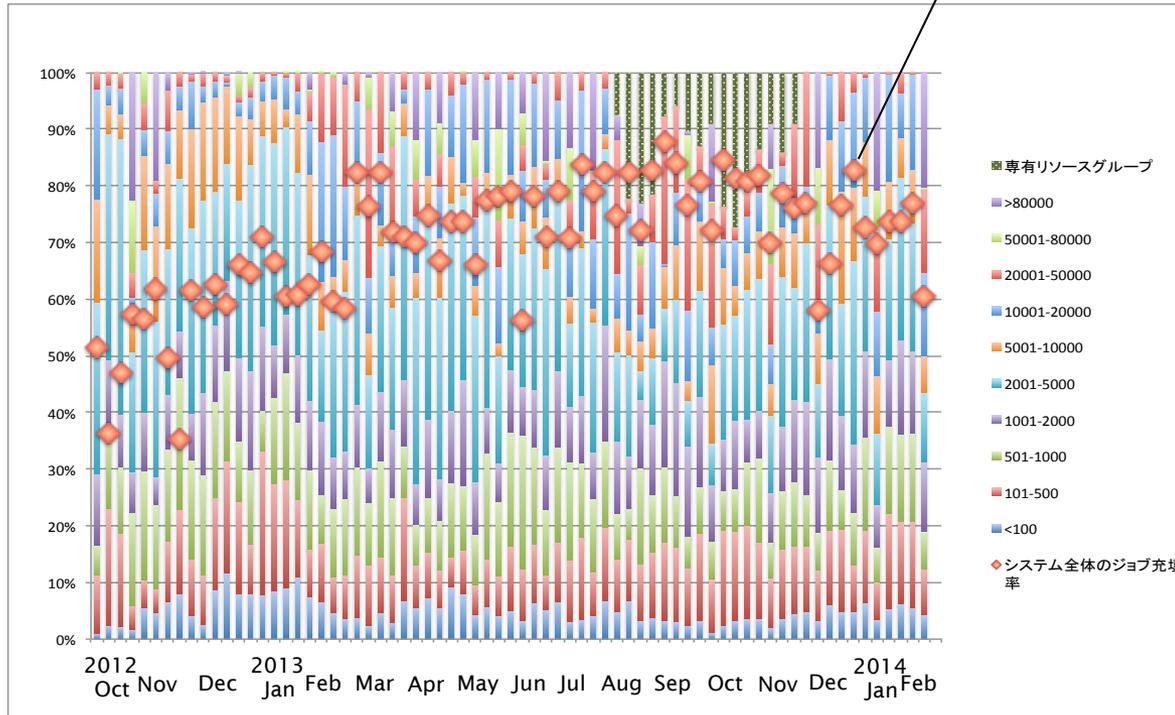
The origin of matters and the universe

Shinya AOKI
University of Tsukuba

Strategic organizaions

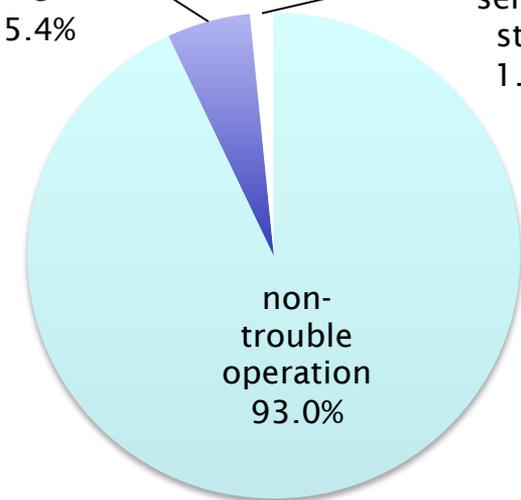# Operation of K Computer

CPU resources which are occupied to run applications

scheduled maintenance 5.4%

irregular service stop 1.6%

non-trouble operation 93.0%

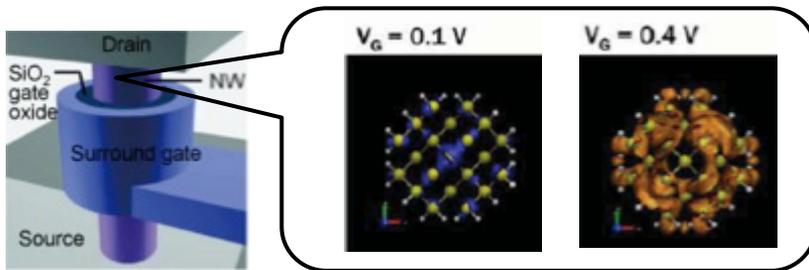**About 80% of CPU resources are used for jobs**

The rate of operation is about 93%

The researchers who conducted simulation researches in K received Gordon Bell Prizes in two consecutive years (2011&2012).

Real space DFT calculations of Silicon nanowires
(Gordon Bell Prize 2011)

The world's first nano-level high precision simulation with the actual material size.

The gravitational trillion-body problem
(Gordon Bell Prize 2012)

The world's largest number of dark matter simulation performed on the K computer.
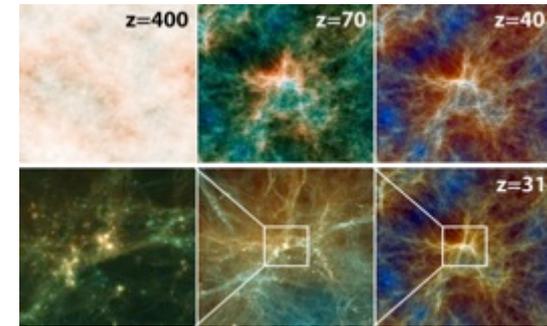
Applications by Industry for Using K Computer

Docking simulation between protein and compound

Estimating about 19 billion docking pairs through high speed calculations by the organized 11 Japanese pharmaceutical companies.
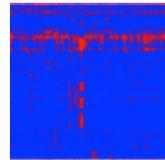
Nanometer level simulation of rubber for tire

Contribution to the development of the new rubber material for tires which realizes low fuel consumption and high grip performance.

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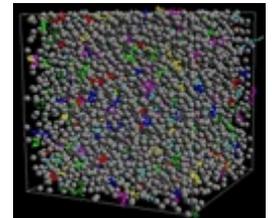
Japanese Policy
for Development of HPC Systems

Comprehensive Strategy on Science,Technology and Inovation (June,2013）

○ **Comprehensive Strategy on Science, Technology and Innovation (Cabinet Decision)**

• **Promotion of development, establishment, and wide utilization of world-class R&D infrastructure (e.g., utilization of supercomputers)**; establishment of an environment where skilled talents from the industry, academia, and government can attempt to conduct innovative groundbreaking research projects beyond the field or organizational boundaries.

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Continuous Development of HPCI (High Performance Computing Infrastructure)

Direction for Development of Next Gen. Supercomputers

＜Picture of Infrastructure for Computational Science and Technology in Japan＞

Flagship System

Aim to develop Exascale-supercomputer by 2020

System with performance at world's top level for wide-area applications

©RIKEN

Leading Machines

Nation-wide Infrastructure Operated by HPCI

Characterized systems supporting Flagship system

Systems at Supercomputer Centers in 9 Universities

Systems at National Institutes

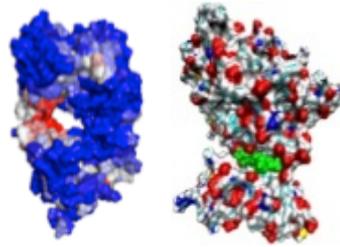Other Systems in Universities, and so on.

Major Social and Science Challenges to Be Solved Using Exascale Supercomputer
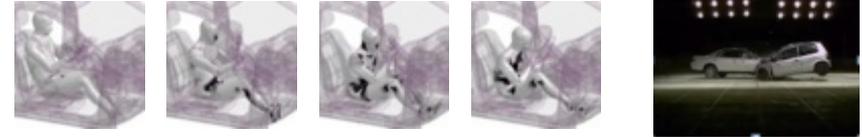
Development of new medicine with little side effect

Computing simulation that could take the possibility of side effects into account

Development of higher safety car

Evaluating damages of not only car itself but human body (injury of bones, entrails, etc) of driver.

* Black shows injured body parts.

Prevention and mitigation against wide-ranging complex disaster

Damage prediction and mitigation of the wide-ranging complex disaster including earthquake, tsunami, refuge, people's movement and so on.

Propagation
Earthquake Tsunami Refuge People's movement Restoration & Reconstruction
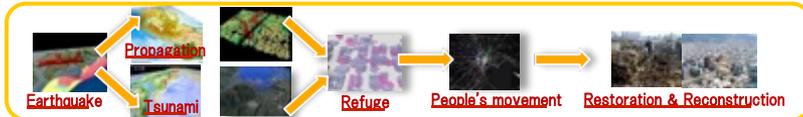
Development of an epoch-making battery

The combination of the optimal electrode material and an electrolyte is realized and it contributes to the development of the advanced battery which has high safety and tolerance.
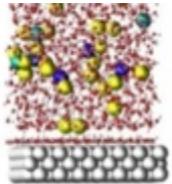
Next-generation device science

Predicting the unique physical properties of a composite material in one million atomic levels.
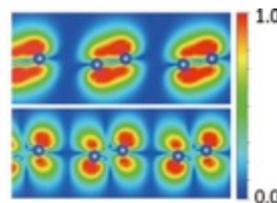
Explorer of the origin and evolution of the universe

Clarifying the large variety of galaxies and planets by integrated simulations of the overall universe ranging from planets formation to large scale structure formation in the universe.

※ Matthew Baw (University of Exeter)

Large scale structure formation galaxy formation star formation * planet formation

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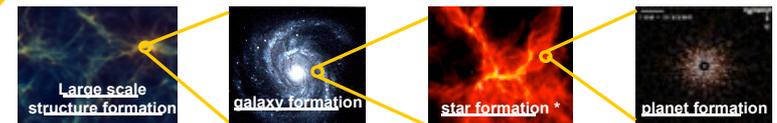
Japan Exascale System Development

Outline:

- Double-digits (higher)performance by 2020
- Push state of the art in power efficiency, scalability & reliability
- Enable unprecedented application capability
- AICS RIKEN in charge of exascale systems development
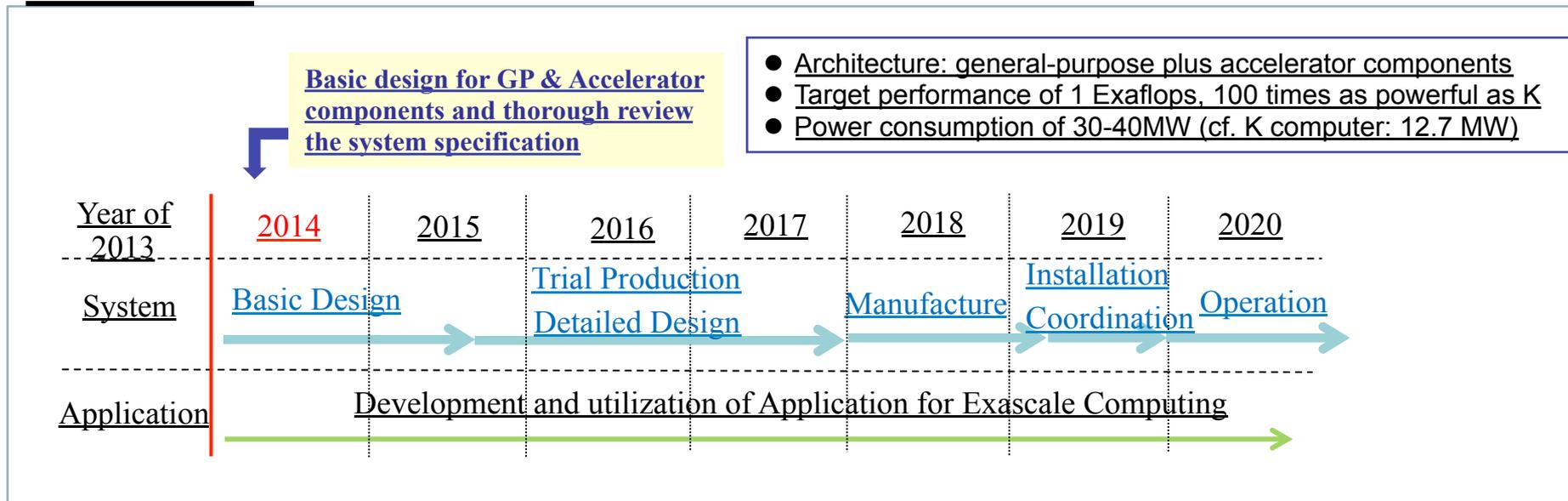- Total project cost ca. JPY140 billion with about JPY 110 billion from the government's budget (JPY 1.2 billion for 2014)

Schedule:

Basic design for GP & Accelerator components and thorough review the system specification

- Architecture: general-purpose plus accelerator components
- Target performance of 1 Exaflops, 100 times as powerful as K
- Power consumption of 30-40MW (cf. K computer: 12.7 MW)

Year of 2013	2014	2015	2016	2017	2018	2019	2020
System	Basic Design		Trial Production Detailed Design		Manufacture	Installation Coordination	Operation
Application		Development and utilization of Application for Exascale Computing					

Project Arrangement between US and Japan on R&D Collaboration for HPC System Software Development

Agreement between US and Japan on Cooperation in R&D in Sci. and Tech. (1988)

The Implementing Arrangement Concerning Cooperation in R&D in Energy and Related Fields
MEXT, Japan ⇔ DOE, US
<April 30, 2013>

※Cooperative area described in this arrangement:
(Nuclear Fusion Science, High Energy Physics, Nuclear Physics, Computer Science, etc)

※At Joint High Level Committee Meeting on Science and Technology cooperation (April 30, 2013)

TBC (As One of cooperative area)

Project Arrangement to the Implementing Arrangement between US and Japan Concerning Computer Science and Software Related to HPC for Open Scientific Research

- Participating Organizations:
    National Lab. (DOE, US), RIKEN (Japan)
- Cooperative Area:
    System Software
- Major Contents
    Description for Forms of Cooperation and Management of Project etc

Summary

○HPCI（High Performance Computing Infrastructure)
　　・Started in September 2012
　　・K Computer, other supercomputers, large storage,
　　network
　　・Great success

○Development of Exascale Supercomputer
　　・Starting point of long and hard way
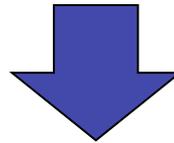
MEXT continuously promotes both projects