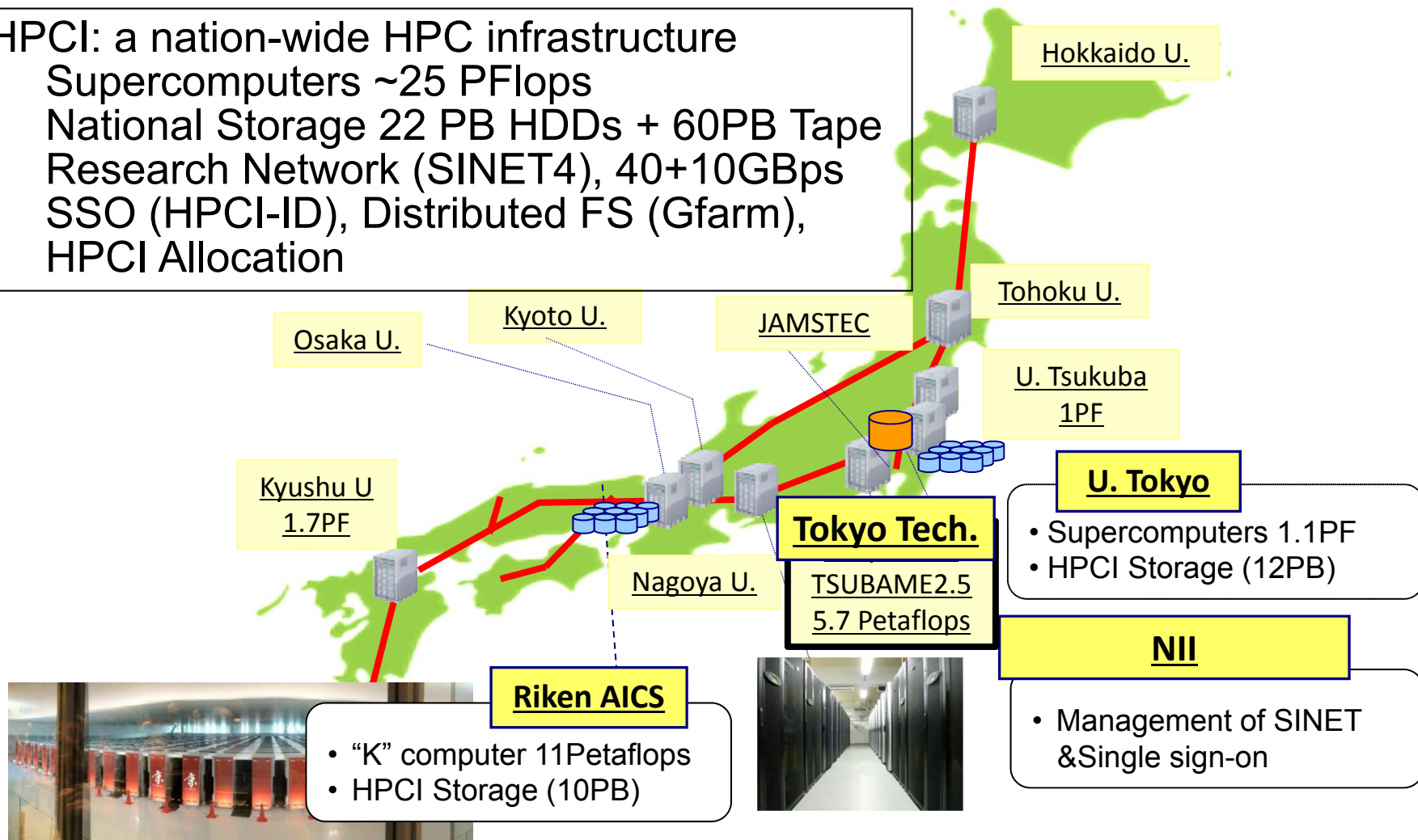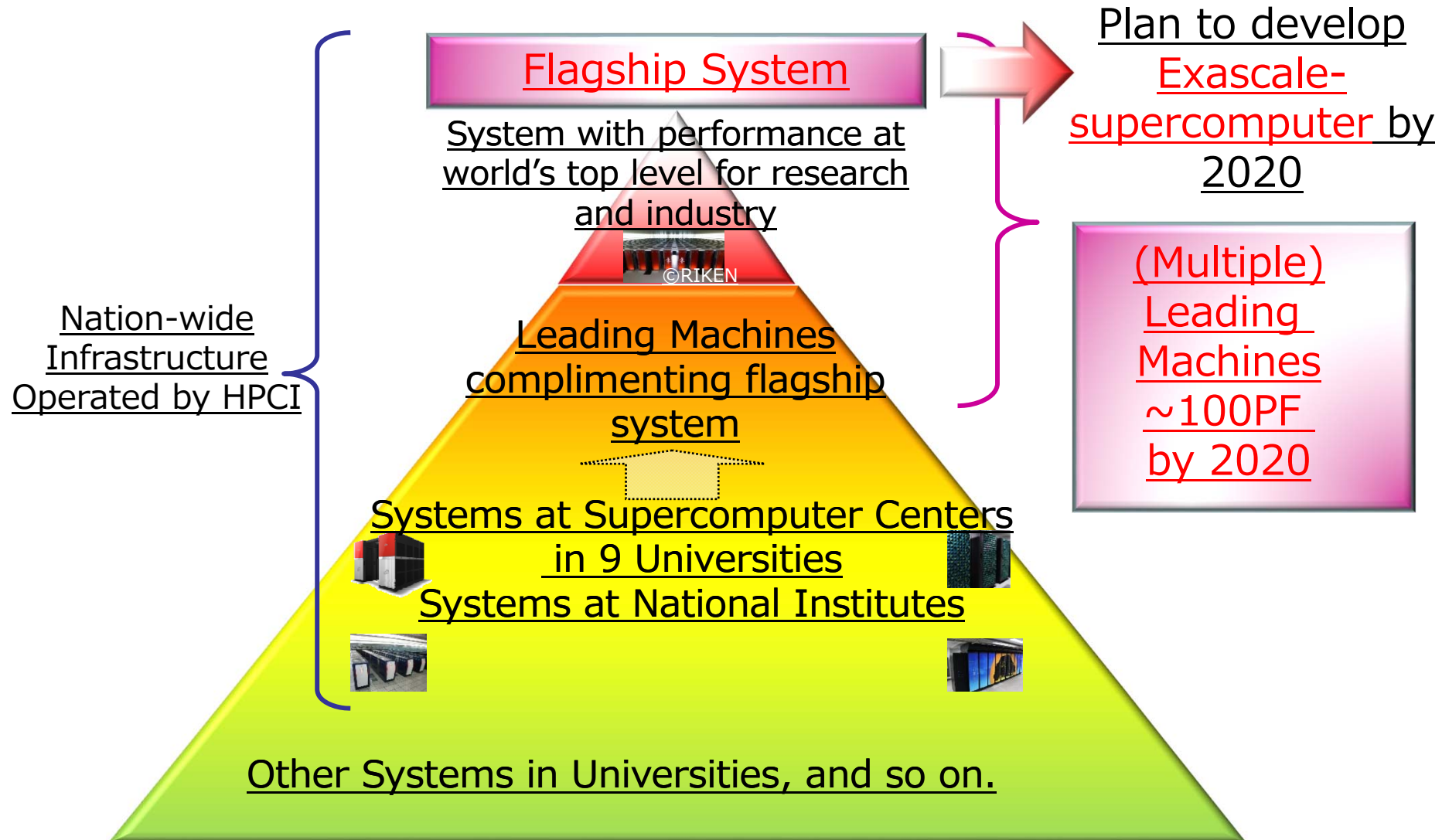# Japan's High Performance Computing Infrastructure (HPCI)

HPCI: a nation-wide HPC infrastructure
- Supercomputers ~25 PFlops
- National Storage 22 PB HDDs + 60PB Tape
- Research Network (SINET4), 40+10GBps
- SSO (HPCI-ID), Distributed FS (Gfarm), HPCI Allocation

Hokkaido U.

Tohoku U.

Kyoto U.

Osaka U.

JAMSTEC

U. Tsukuba 1PF

Kyushu U 1.7PF

Tokyo Tech.

Nagoya U.

TSUBAME2.5 5.7 Petaflops

U. Tokyo
- Supercomputers 1.1PF
- HPCI Storage (12PB)

NII
- Management of SINET &Single sign-on

Riken AICS
- "K" computer 11Petaflops
- HPCI Storage (10PB)

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

Direction for Development of Next Gen. Supercomputers towards EXASCALE

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

Flagship System

System with performance at world's top level for research and industry

©RIKEN

Leading Machines complimenting flagship system

Systems at Supercomputer Centers in 9 Universities
Systems at National Institutes

Other Systems in Universities, and so on.

Nation-wide Infrastructure Operated by HPCI

Plan to develop Exascale-supercomputer by 2020

(Multiple) Leading Machines ~100PF by 2020

Japanese "Leading Machine" Candidates
Roadmap of the 9 Centers

Fiscal Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Hokkaido	Hitachi SR16000/M1 (172 TF, 22TB) Cloud System Hitachi BS2000 (44TF, 14TB)					10+ PF					50+ PF	
Tohoku	NEC SX-9 + Exp5800 (31TF)		~1PFlop/s						30+Pflop/s			
Tsukuba	HA-PACS (800 TF)		(Manycore system) (700+ TF)		PostT2K (20+ PF, (100+ TiB, 600TiB, 4.0+ PB/s, 0.68+ PB/s))					100+ PF		
Tokyo	T2K Todai (140 TF) / Fujitsu FX10 (1PFlops, 150TiB, 408 TB/s), Hitachi SR16000/M1 (54.9 TF, 10.9 TiB, 5.376 TB/s)							50+ PF				
Tokyo Tech.	Tsubame 2.0 (2.4PF, 97TB, 744 TB/s)1.8MW	Tsubame 2.5 (5.7 PF, 110+ TB, 1160 TB/s), 1.8MW		Tsubame 3.0 (20~30 PF, 2~6PB/s) 1.8MW (Max 3MW)					Tsubame 4.0 (100~200 PF, 20~40PB/s), 2.3~1.8MW			
Nagoya	Fujitsu M9000(3.8TF, 1TB/s) HX600(25.6TF, 6.6TB/s) FX1(30.7TF, 30 TB/s)	Fujitsu FX10 (90.8TF, 31.8 TB/s), CX400(470.6TF, 55 TB/s) Upgrade (3.6PF)							50+ PFlops			
Kyoto	Cray XE6 (300TF, 92.6TB/s), GreenBlade 8000 (243TF, 61.5 TB/s)		Cray XC30 (400TF) 600TF		10+ PF					50+ PF		
Osaka	SX-8 + SX-9 (21.7 TF, 3.3 TB, 50.4 TB/s)		(500+ TiB/s)						(5+ PiB/s)			
Kyushu	Hitachi SR1600(25TF) / Fujitsu FX10 (270TF, 65.28 TB/s), CX400(510TF, 152.5 TiB, 151.14 TB/s), GPGPU(256TF, 30 TiB, 53.92 TB/s)	Hitachi HA8000tc/HT210(500TF, 215 TiB, 98.82TB/s), Xeon Phi (212TF, 26.25 TiB, 67.2 TB/s), SR16000(8.2TF, 6 TiB, 4.4 TB/s)		10+ PF						50+ PF		

Exascale Deployment vs. ~500PF aggregate

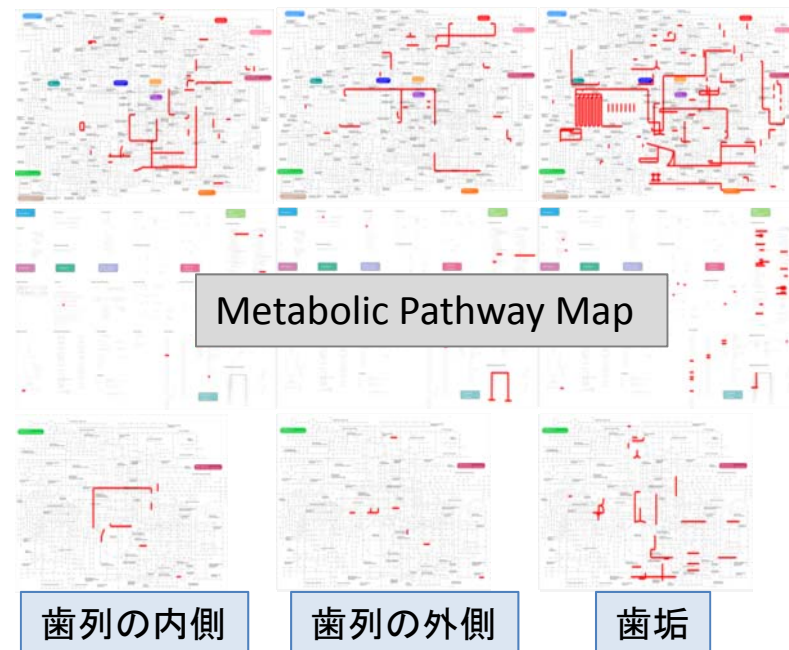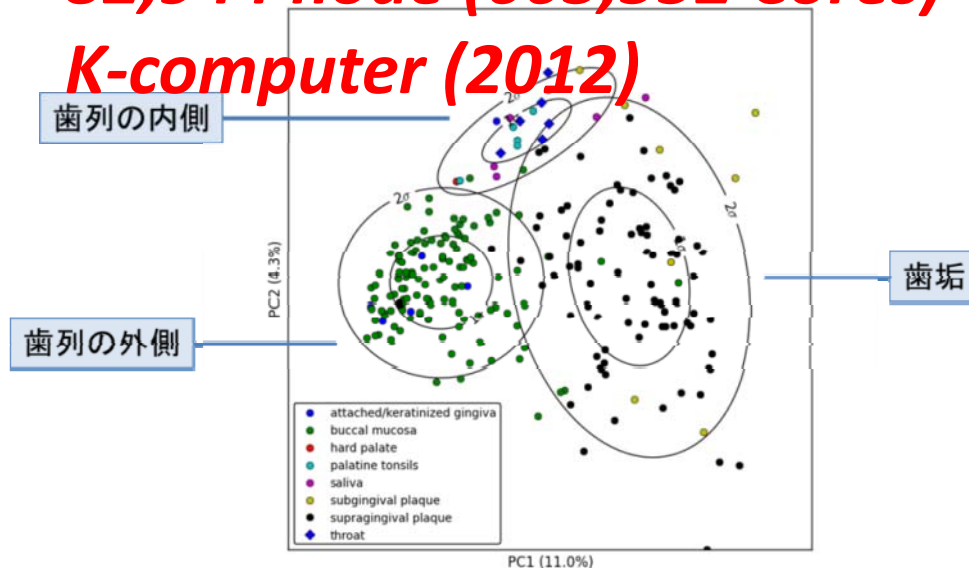# Future Big Data Application Akiyama group@Tokyo Tech

Ultra high-sensitive "big data" metagenome sequence analysis of human oral microbiome

- Required > **1 million node*hour product** on K-computer
- World's most sensitive sequence analysis (based on amino acid similarity)
- Discovered at least three microbiome clusters with <u>functional</u> differences.
   (Integrated 422 experiment samples taken from 9 different oral parts)

572.8 M Reads / hour

82,944 node (663,552 Cores)

K-computer (2012)

歯列の内側

歯列の外側

歯垢

PC2 (4.3%)

- ● attached/keratinized gingiva
- ● buccal mucosa
- ● hard palate
- ● palatine tonsils
- ● saliva
- ● subgingival plaque
- ● supragingival plaque
- ◆ throat

PC1 (11.0%)

Metabolic Pathway Map

歯列の内側　　歯列の外側　　歯垢

Top Supercomputers vs. Cloud IDC

K Computer (#1 2011-12) Riken-AICS
Fujitsu Sparc VIII-fx Venus CPU
88,000 nodes, 800,000CPU cores
~11 Petaflops (10^{16})
1.4 Petabyte memory, 13 MW Power
864 racks、3000m^2
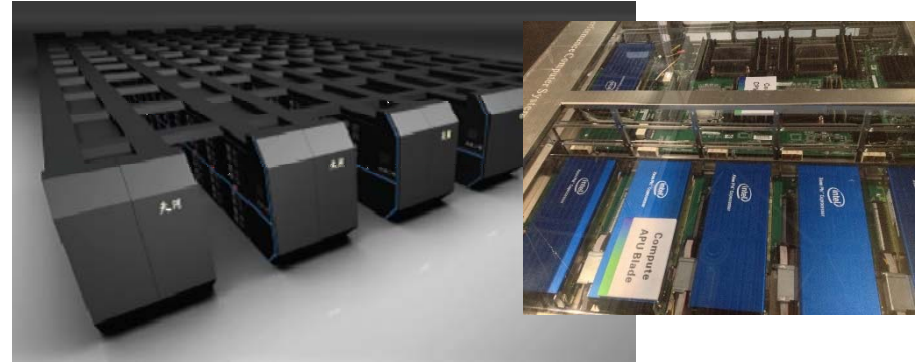
Tianhe2 (#1 2013) China Gwanjou
48,000 KNC Xeon Phi + 36,000 Ivy
Bridge Xeon
18,000 nodes, >3 Million CPU cores
54 Petaflops (10^{16})
0.8 Petabyte memory, 20 MW Power
??? racks、???m^2

C.f. Amazon ~= 450,000 Nodes, ~3 million Cores
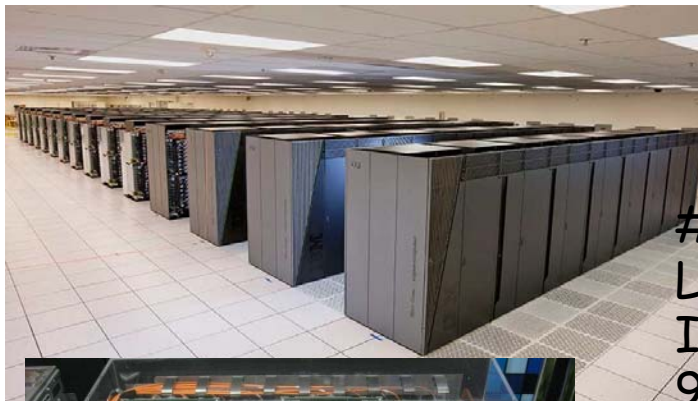
#1 2012 IBM BlueGene/Q "Sequoia"
Lawrence Livermore National Lab
IBM PowerPC System-On-Chip
98,000 nodes, 1.57million Cores
~20 Petaflops
1.6 Petabytes, 8MW, 96 racks

DARPA study
2020 Exaflop (10^{18})
100 million~
1 Billion Cores

Supercomputer Tokyo Tech. Tsubame 2.0 #4 Top500 (2010)

Advanced Silicon Photonics 40G single CMOS Die 1490nm DFB 100km Fiber
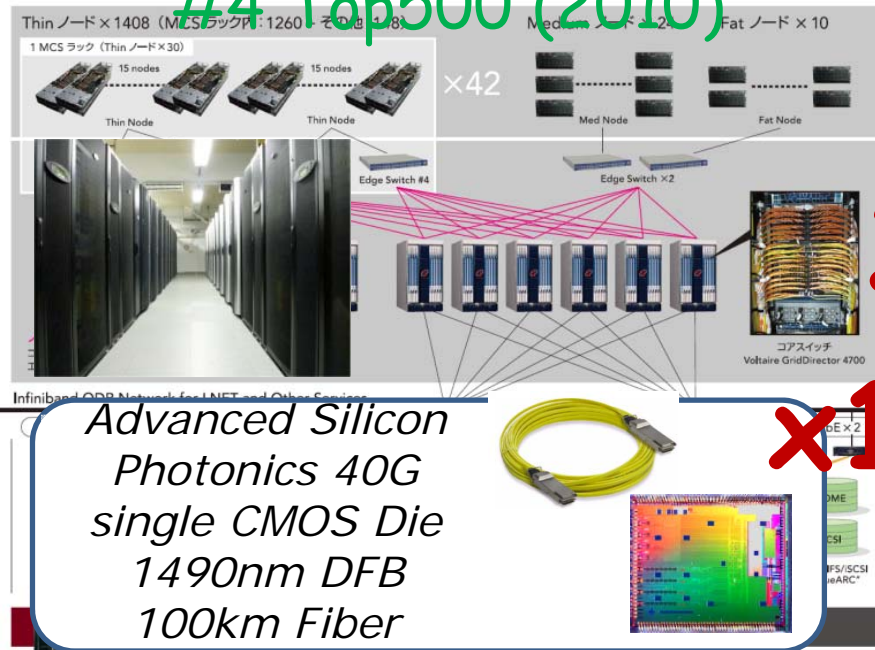
~1500 nodes compute & storage
Full Bisection Multi-Rail
Optical Network
Injection 80GBps/Node
Bisection 220Terabps

A Major Northern Japanese Cloud Datacenter (2013)

>> ×1000!
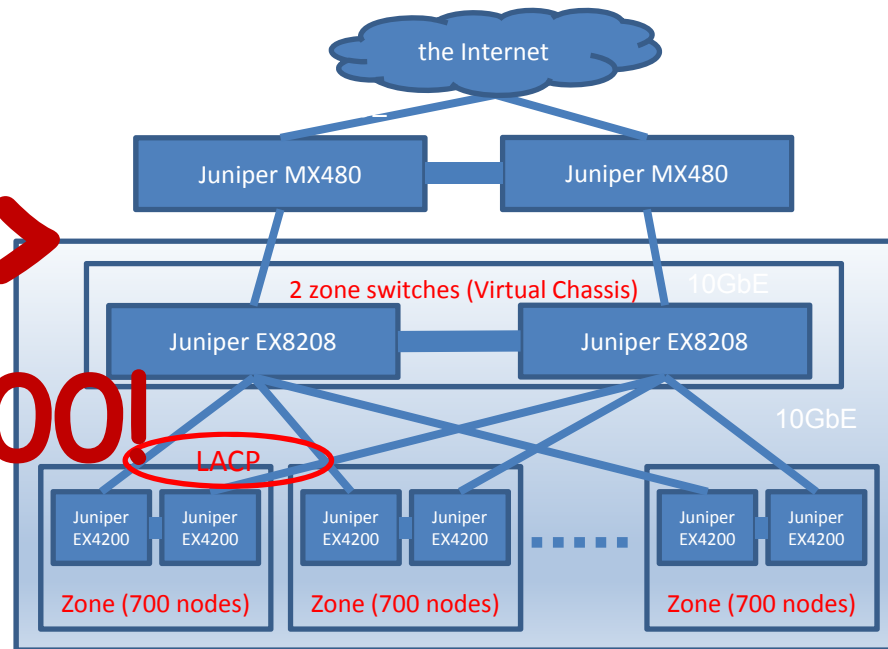
8 zones, Total 5600 nodes,
Injection 1GBps/Node
Bisection 160Gigabps

*C.f. Entire Global Internet BW average:
213 Tbps (source: CISCO)*

Extreme Big Data:
Convergence of Big Data and HPC

Large Scale
Metagenomics

Ultra Large Scale
Graphs and Social
Infrastructures

Massive Sensors and
Data Assimilation in
Weather Prediction

Co-Design **Co-Design** **Co-Design**

EBD Bag

Graph Store

**EBD System Software
incl. EBD Object System**

Cartesian Plane

KV

KV KV

EBD KVS

NVM/Fla 2Tbps HBM NVM/Flas
4~6HBM Channe
1.5TB/s DRAM

Exascale Big Data HPC

PCB

**Convergent Architecture (Phases 1~4)
Large Capacity NVM, High-Bisection NW**

**Cloud IDC
Very low BW & Efficiencty**

**Supercomputers
Compute&Batch-Oriented**

Project Arrangement between US and Japan on R&D Collaboration for HPC System Software Development
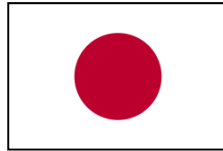
Agreement between US and Japan on Cooperation in R&D in Sci. and Tech. (1988)

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), other centers and companies
- Cooperative Area:
    System Software
- Major Contents
    Description for Forms of Cooperation and Management of Project   etc

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