

Overview of Reedbush-U

How to Login

Information Technology Center
The University of Tokyo

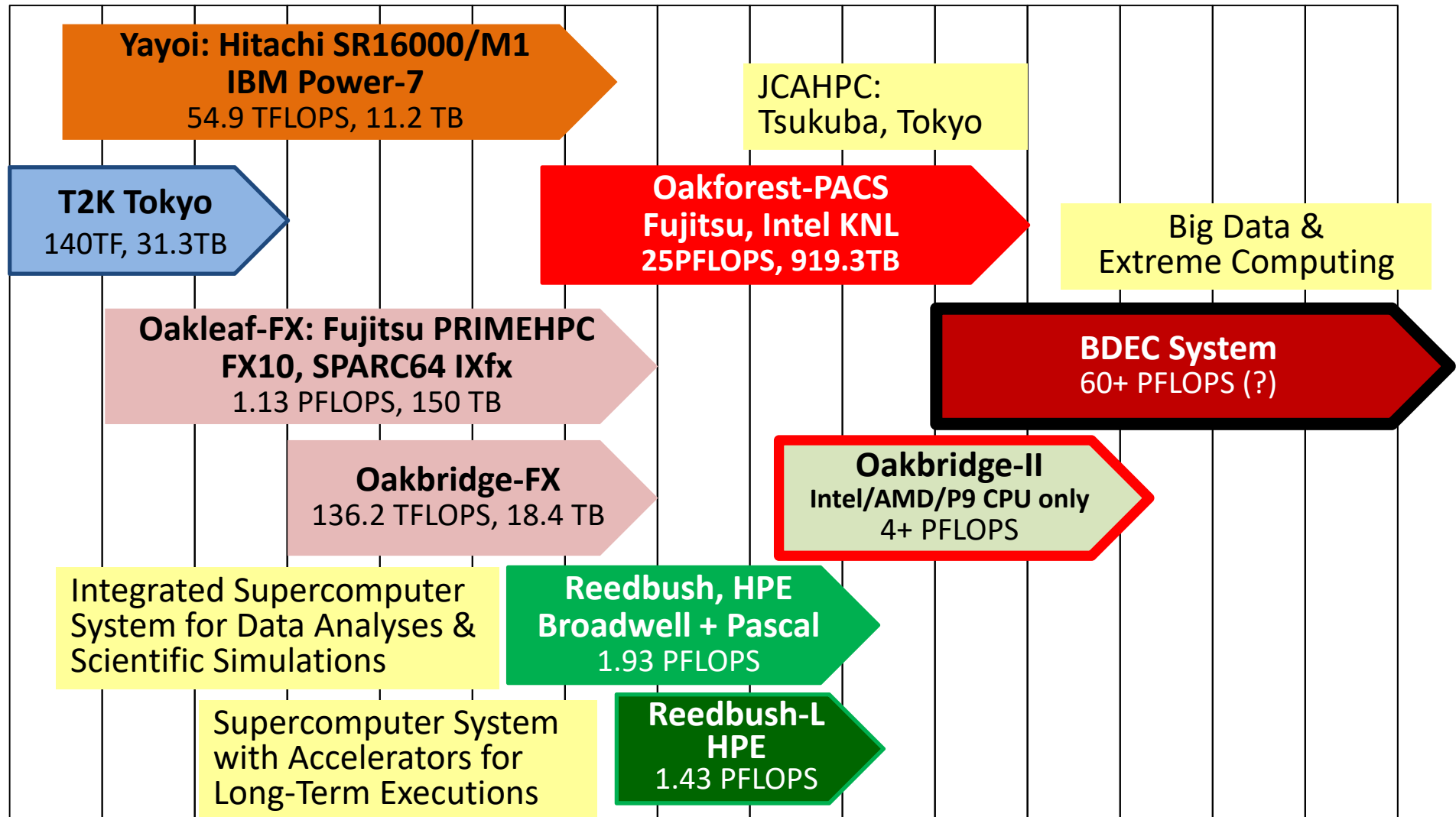
<http://www.cc.u-tokyo.ac.jp/>

Supercomputers in ITC/U.Tokyo

2 big systems, 6 yr. cycle

FY

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25



Now operating 2 (or 4)systems !!

- Oakleaf-FX (Fujitsu PRIMEHPC FX10)
 - 1.135 PF, Commercial Version of K, Apr.2012 – Mar.2018
- Oakbridge-FX (Fujitsu PRIMEHPC FX10)
 - 136.2 TF, for long-time use (up to 168 hr), Apr.2014 – Mar.2018
- Reedbush (HPE, Intel BDW + NVIDIA P100 (Pascal))
 - Integrated Supercomputer System for Data Analyses & Scientific Simulations
 - Jul.2016-Jun.2020
 - Our first GPU System, DDN IME (Burst Buffer)
 - Reedbush-U: CPU only, 420 nodes, 508 TF (Jul.2016)
 - Reedbush-H: 120 nodes, 2 GPUs/node: 1.42 PF (Mar.2017)
 - Reedbush-L: 64 nodes, 4 GPUs/node: 1.43 PF (Oct.2017)
- Oakforest-PACS (OFP) (Fujitsu, Intel Xeon Phi (KNL))
 - JCAHPC (U.Tsukuba & U.Tokyo)
 - 25 PF, #12 in 51st TOP 500 (June.2018) (#2 in Japan)
 - Omni-Path Architecture, DDN IME (Burst Buffer)

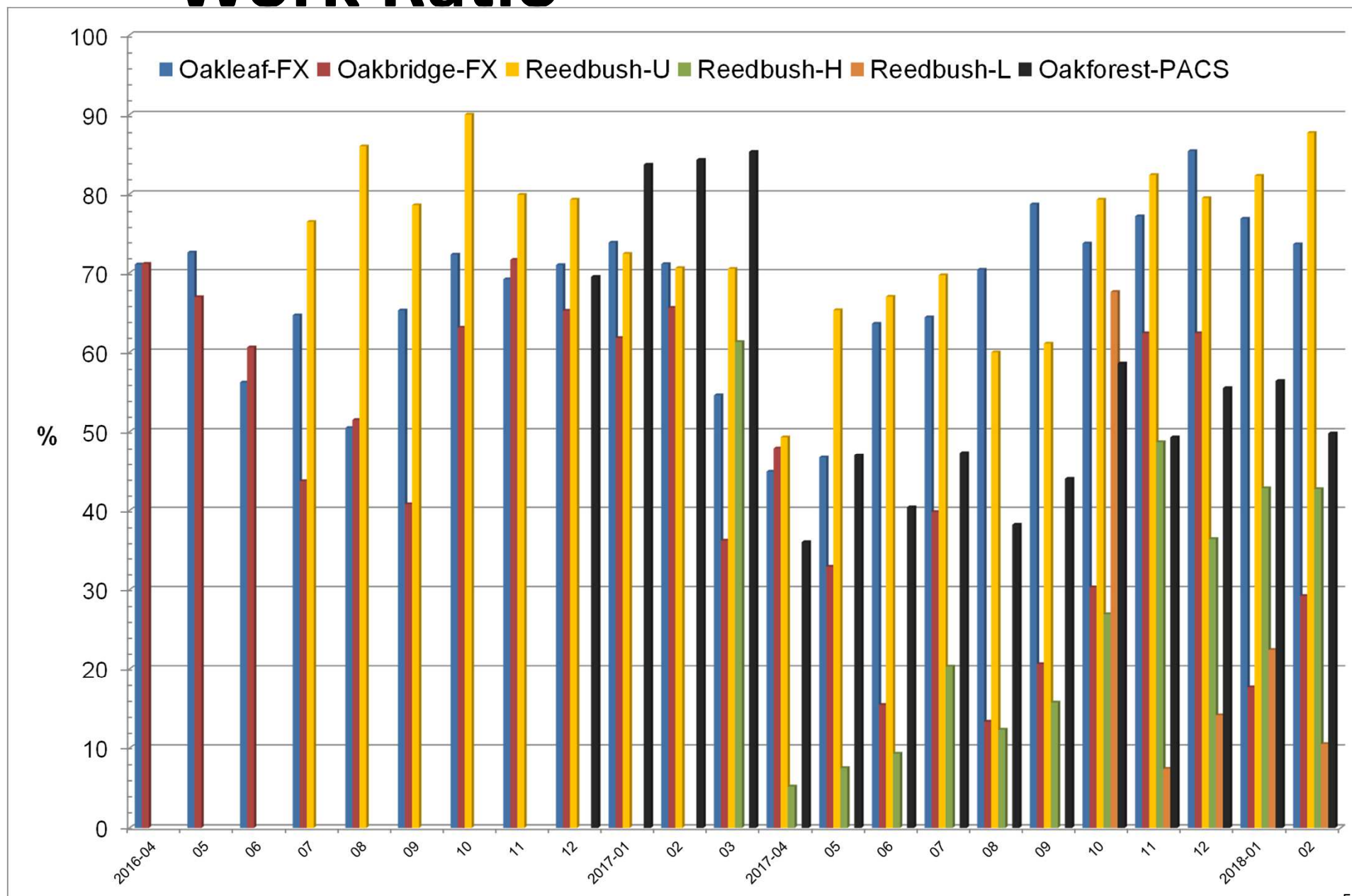


JPY (=Watt)/GFLOPS Rate

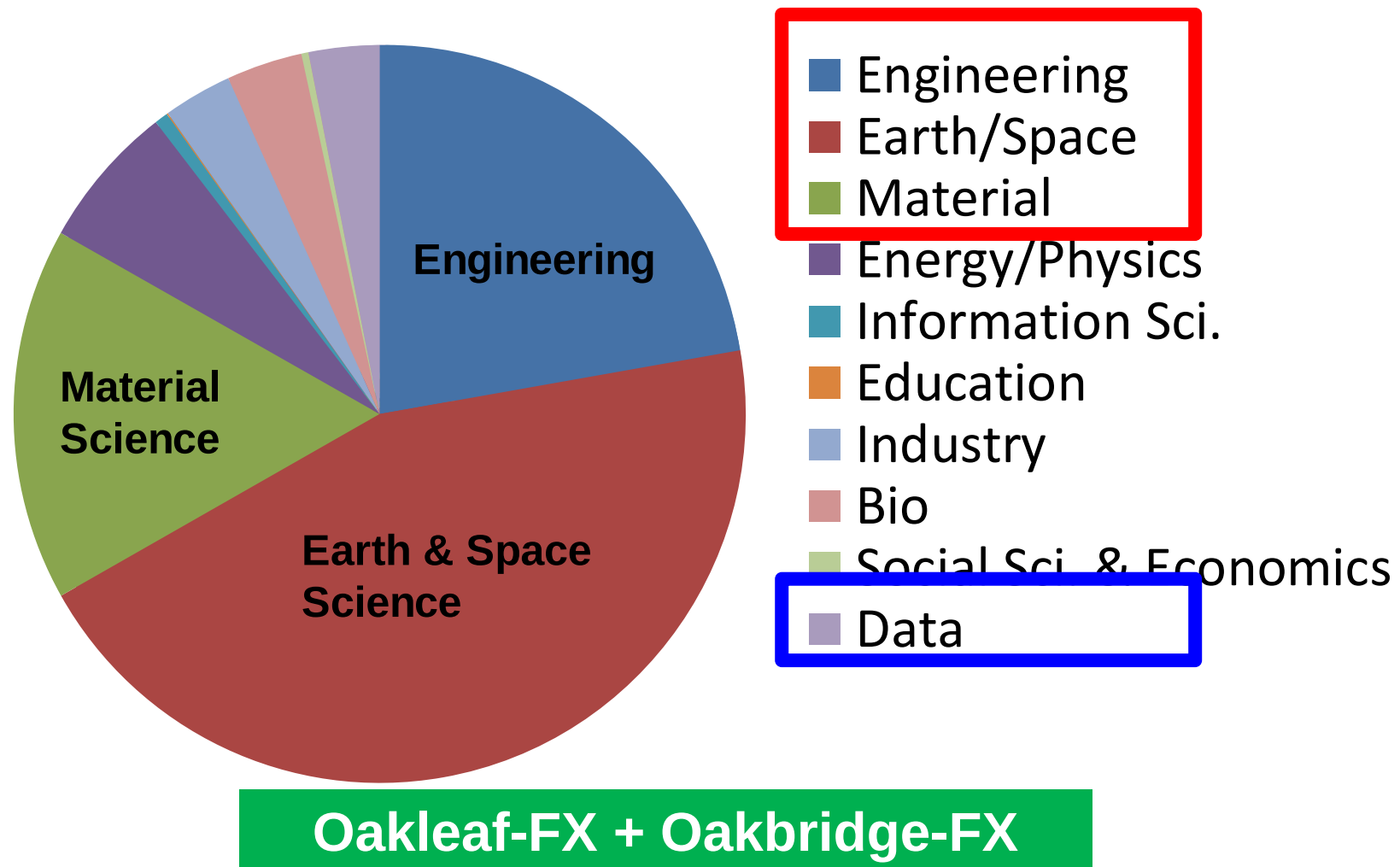
Smaller is better (efficient)

System	JPY/GFLOPS
Oakleaf/Oakbridge-FX (Fujitsu) (Fujitsu PRIMEHPC FX10)	125
Reedbush-U (SGI) (Intel BDW)	62.0
Reedbush-H (SGI) (Intel BDW+NVIDIA P100)	17.1
Oakforest-PACS (Fujitsu) (Intel Xeon Phi/Knights Landing)	16.5

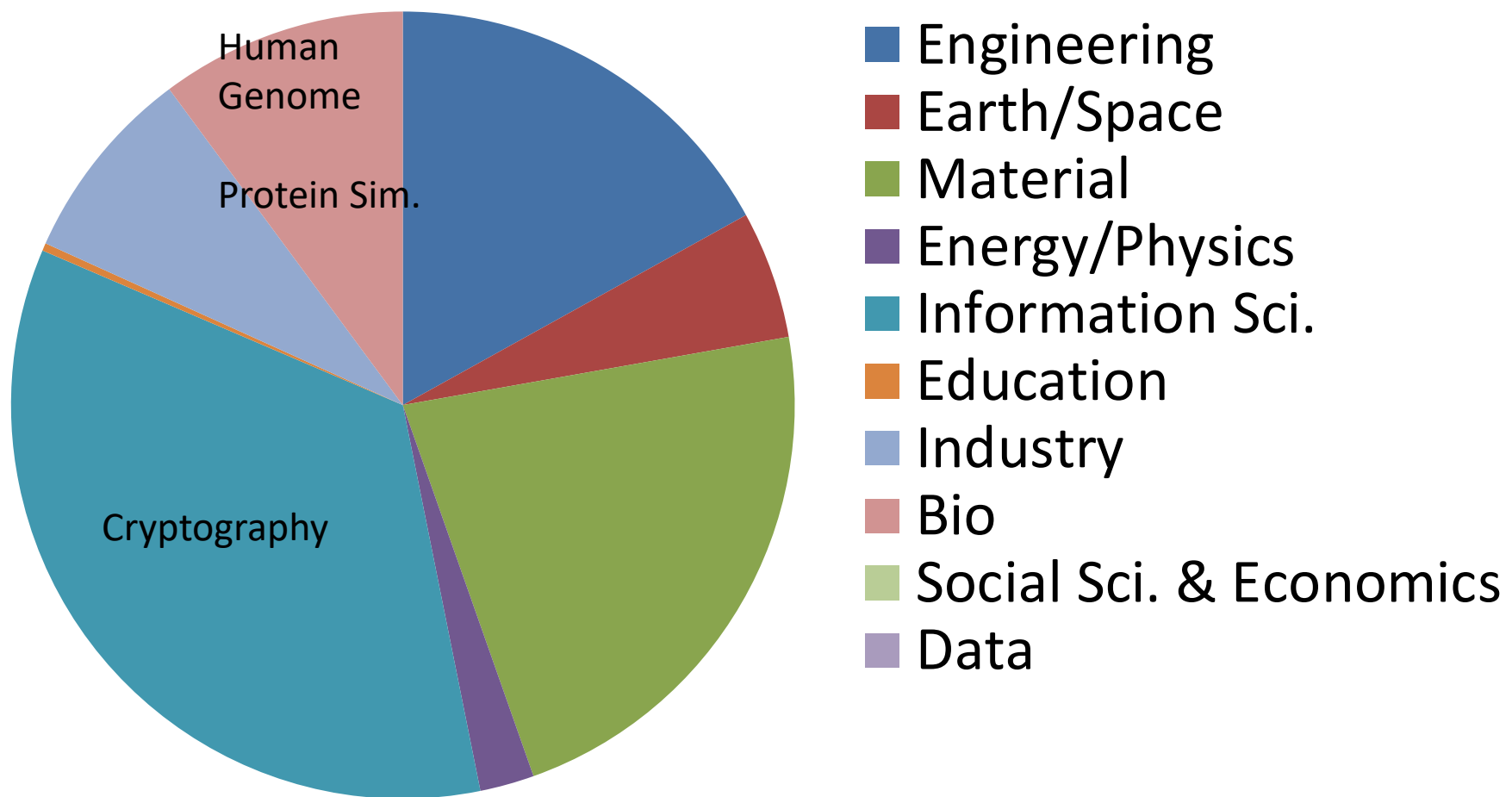
Work Ratio



Research Area based on CPU Hours FX10 in FY.2017 (2017.4~2018.3E)



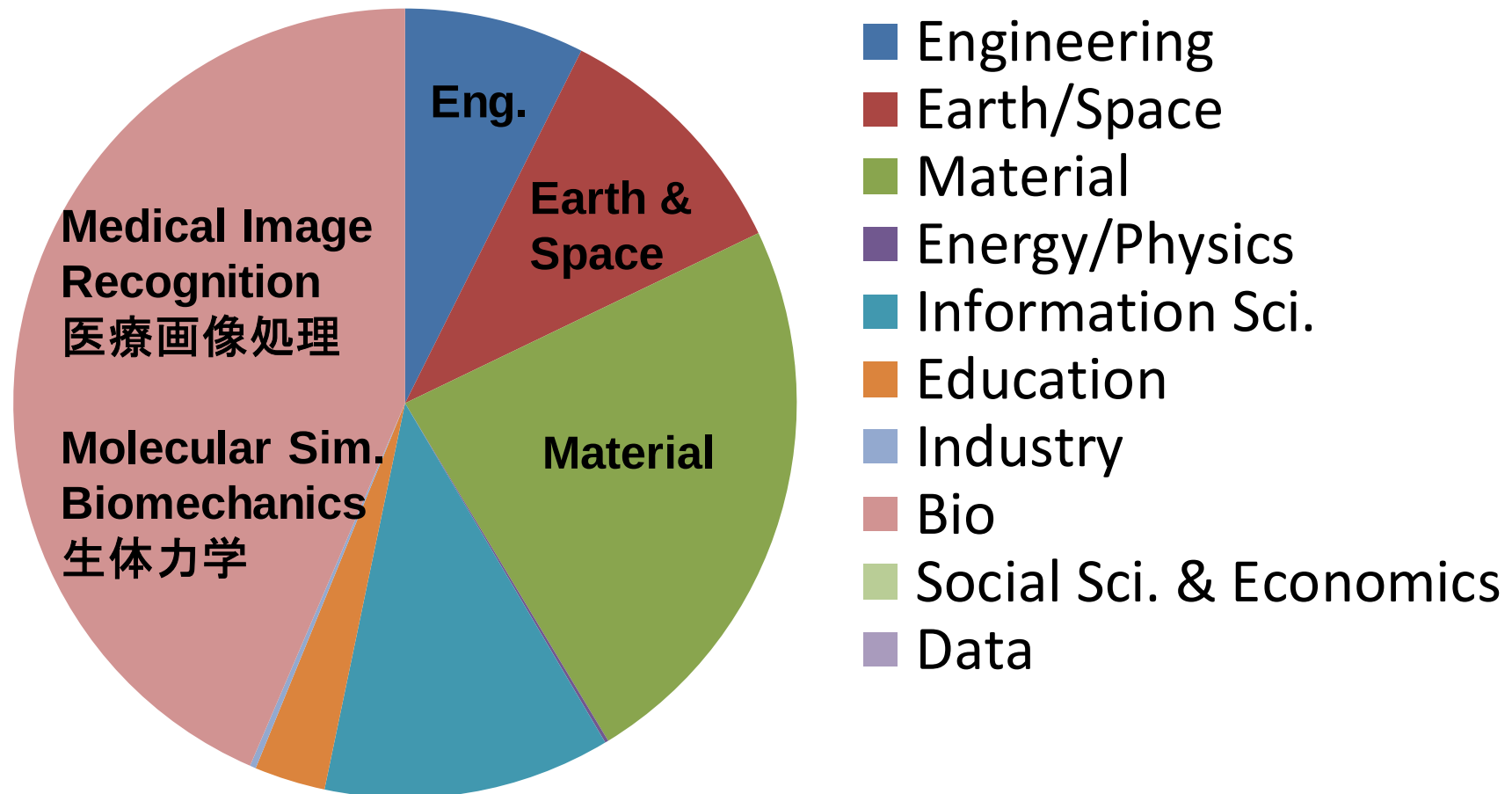
Research Area based on CPU Hours Reedbush-U in FY.2017 (2017.4~2018.2E) CPU Only



Research Area based on CPU Hours

Reedbush-H in FY.2017

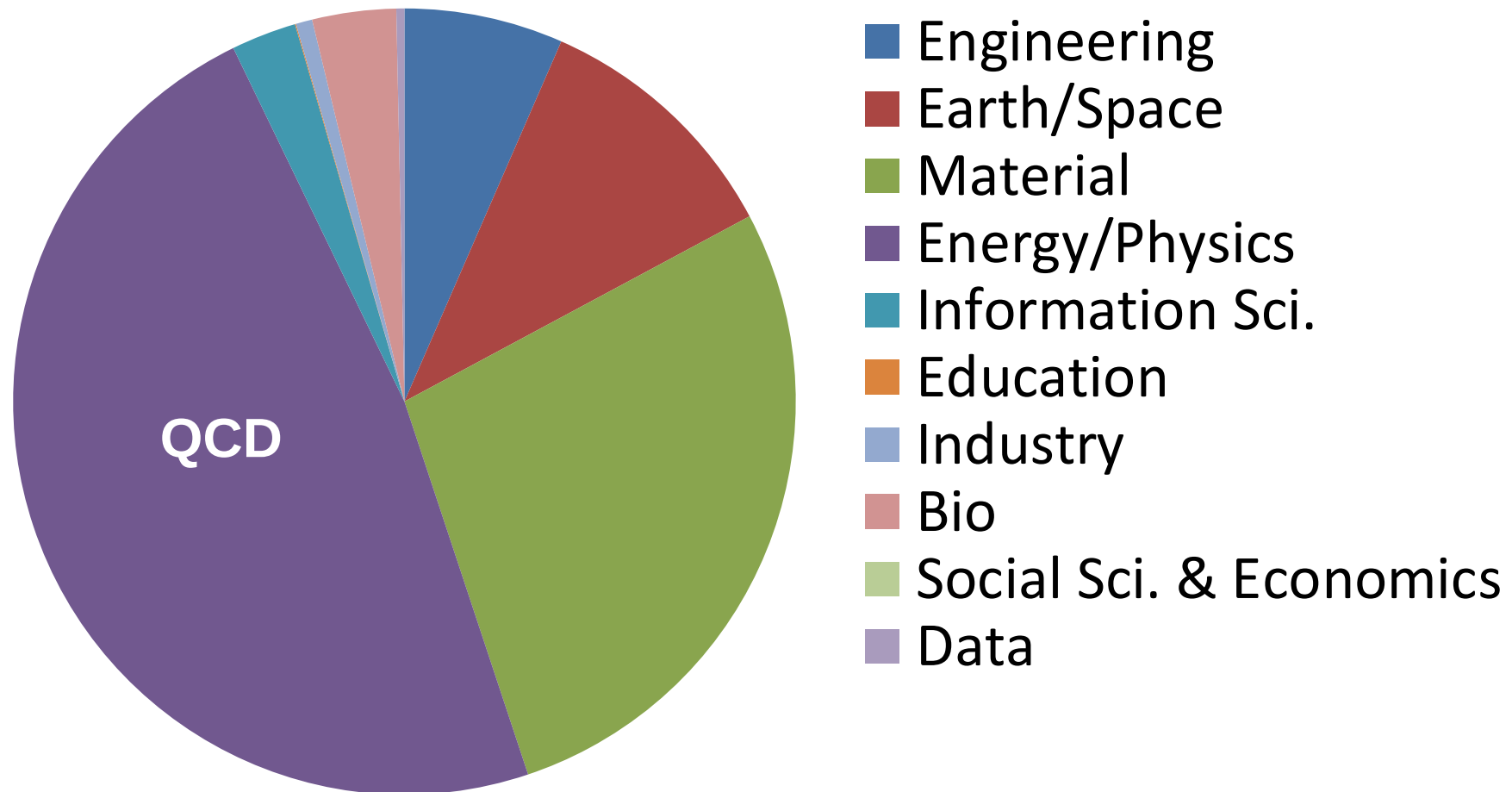
(2017.4~2018.3E) 2-GPU's/Node



Research Area based on CPU Hours

Oakforest-PACS in FY.2017

(2017.4~2018.3E)



Benchmarks

- TOP 500 (Linpack, HPL(High Performance Linpack))
 - Direct Linear Solvers, FLOPS rate
 - Regular Dense Matrices, Continuous Memory Access
 - Computing Performance
- HPCG
 - Preconditioned Iterative Solvers, FLOPS rate
 - Irregular Sparse Matrices derived from FEM Applications with Many “0” Components
 - Irregular/Random Memory Access,
 - Closer to “Real” Applications than HPL
 - Performance of Memory, Communications
- Green 500
 - FLOPS/W rate for HPL (TOP500)

51th TOP500 List (June, 2018)

$R_{\max}$: Performance of Linpack (TFLOPS)
 R_{peak} : Peak Performance (TFLOPS),
 Power: kW

<http://www.top500.org/>

	Site	Computer/Year Vendor	Cores	$R_{\max}$ (TFLOPS)	R_{peak} (TFLOPS)	Power (kW)
1	<u>Summit, 2018, USA</u> DOE/SC/Oak Ridge National Laboratory	IBM Power System AC922, IBM POWER9 22C 3.07GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband	2,282,544	122,300 (= 122.3 PF)	187,659	8,806
2	<u>Sunway TaihuLight, 2016, China</u> National Supercomputing Center in Wuxi	Sunway MPP, Sunway SW26010 260C 1.45GHz, Sunway	10,649,600	93,015	125,436	15,371
3	<u>Sieera, 2018, USA</u> DOE/NNSA/LLNL	IBM Power System S922LC, IBM POWER9 22C 3.1GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband	1,572,480	71,610	119,194	
4	<u>Tianhe-2A, 2018, China</u> National Super Computer Center in Guangzhou	TH-IVB-FEP Cluster, Intel Xeon E5-2692v2 12C 2.2GHz, TH Express-2, Matrix-2000	4,981,760	61,445	100,679	18,482
5	<u>ABCI (AI Bridging Cloud Infrastructure), 2018, Japan</u> National Institute of Advanced Industrial Science and Technology (AIST)	PRIMERGY CX2550 M4, Xeon Gold 6148 20C 2.4GHz, NVIDIA Tesla V100 SXM2, Infiniband EDR	391,680	19,880	32,577	1,649
6	<u>Piz Daint, 2017, Switzerland</u> Swiss National Supercomputing Centre (CSCS)	Cray XC50, Xeon E5-2690v3 12C 2.6GHz, Aries interconnect, NVIDIA Tesla P100	361,760	19,590	25,326	2,272
7	<u>Titan, 2012, USA</u> DOE/SC/Oak Ridge National Laboratory	Cray XK7, Opteron 6274 16C 2.200GHz, Cray Gemini interconnect, NVIDIA K20x	560,640	17,590	27,113	8,209
8	<u>Sequoia, 2011, USA</u> DOE/NNSA/LLNL	BlueGene/Q, Power BQC 16C 1.60 GHz, Custom	1,572,864	17,173	20,133	7,890
9	<u>Trinity, 2017, USA</u> DOE/NNSA/LANL/SNL	Cray XC40, Intel Xeon Phi 7250 68C 1.4GHz, Aries interconnect	979,968	14,137	43,903	3,844
10	<u>Cori, 2016, Japan</u> DOE/SC/LBNL/NERSC	Cray XC40, Intel Xeon Phi 7250 68C 1.4GHz, Aries interconnect	622,336	14,016	27,881	3,939
12	<u>Oakforest-PACS, 2016, Japan</u> Joint Center for Advanced High Performance Computing	PRIMERGY CX1640 M1, Intel Xeon Phi 7250 68C 1.4GHz, Intel Omni-Path	556,104	13,556	24,913	2,719

HPCG Ranking (June, 2018)

	Computer	Cores	HPL Rmax (Pflop/s)	TOP500 Rank	HPCG (Pflop/s)	Peak
1	Summit	2,392,000	122.300	1	2.926	1.5%
2	Sierra	835,584	71.610	3	1.796	1.5%
3	K computer	705,024	10.510	16	0.603	5.3%
4	Trinity	979,072	14.137	9	0.546	1.8%
5	Piz Daint	361,760	19.590	6	0.486	1.9%
6	Sunway TaihuLight	10,649,600	93.015	2	0.481	0.4%
7	Oakforest-PACS	557,056	13.555	12	0.385	1.5%
8	Cori	632,400	13.832	10	0.355	1.3%
9	Tera-1000-2	522,240	11.965	14	0.334	1.4%
10	Sequoia	1,572,864	17.173	8	0.330	1.6%

Green 500 Ranking (June, 2018)

<http://www.top500.org/>

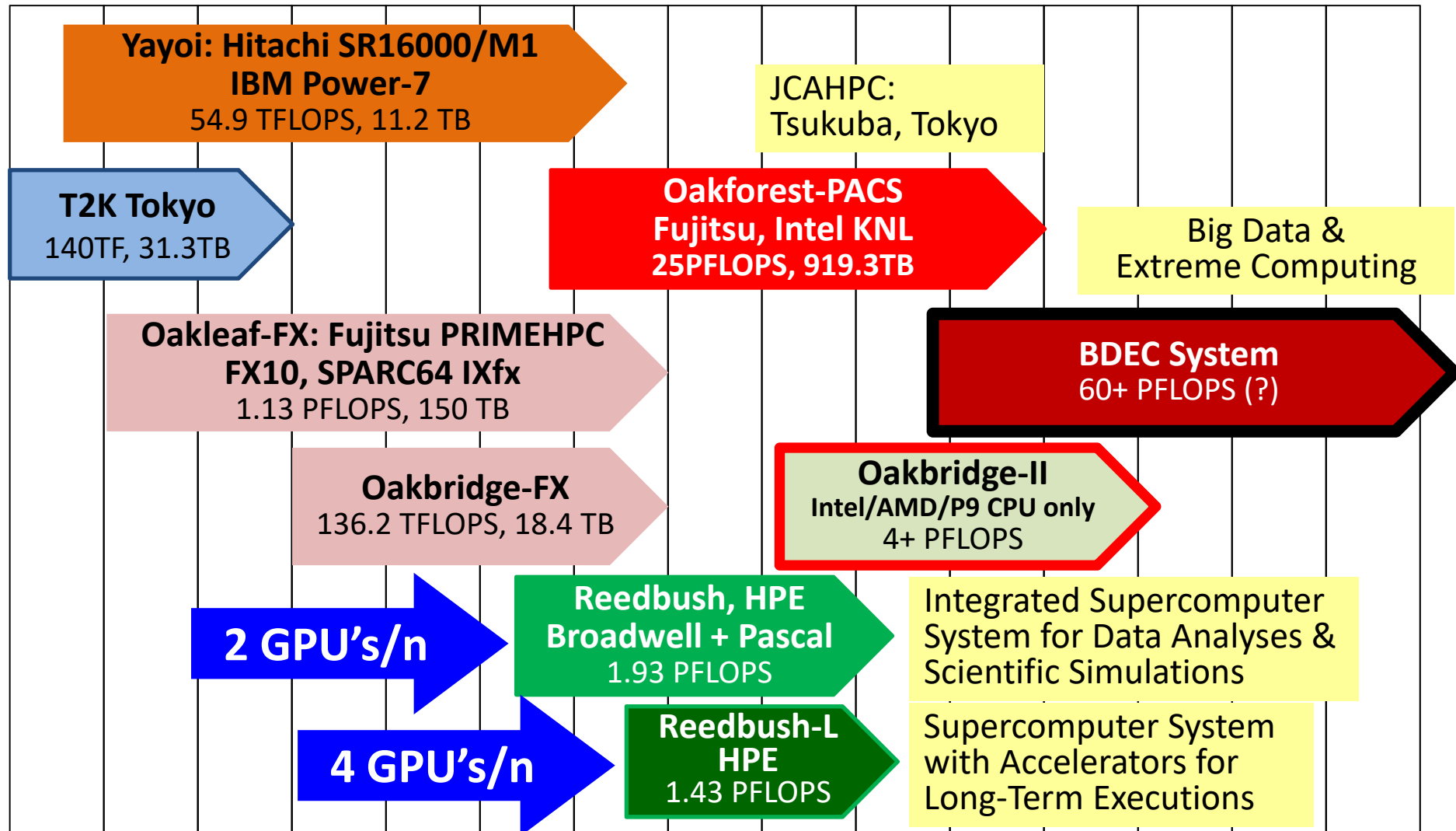
	TOP 500 Rank	System	Cores	HPL Rmax (Pflop/s)	Power (MW)	GFLOPS/W
1	359	Shoubu system B, Japan	794,400	858.	47	18.404
2	419	Suiren2, Japan	762,624	798.	47	16.835
3	385	Sakura, Japan	794,400	825.	50	16.657
4	227	DGX SaturnV Volta, USA	22,440	1,070.	97	15.113
5	1	Summit, USA	2,282,544	122,300.	8,806	13.889
6	19	TSUBAME3.0, Japan	135,828	8,125.	792	13.704
7	287	AIST AI Cloud, Japan	23,400	961.	76	12.681
8	5	ABCI, Japan	391,680	19,880.	1,649	12.054
9	255	MareNostrum P9 CTE, Spain	19,440	1,018.	86	11.865
10	171	RAIDEN GPU, Japan	35,360	1,213.	107	11.363
13	411	Reedbush-L, U.Tokyo, Japan	16,640	806.	79	10.167
19	414	Reedbush-H, U.Tokyo, Japan	17,760	802.	94	8.575

Supercomputers in ITC/U.Tokyo

2 big systems, 6 yr. cycle

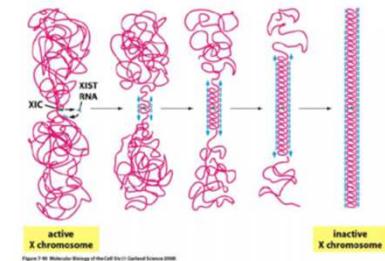
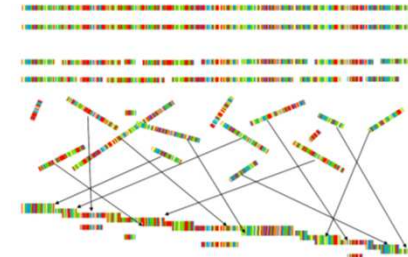
FY

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25



Reedbush: Our First System with GPU's

- Before 2015
 - CUDA
 - We have 2,000+ users
- Reasons of Changing Policy
 - Recent Improvement of OpenACC
 - Similar Interface as OpenMP
 - Research Collaboration with NVIDIA Engineers
 - Data Science, Deep Learning
 - New types of users other than traditional CSE (Computational Science & Engineering) are needed
 - Research Organization for Genome Medical Science, U. Tokyo
 - U. Tokyo Hospital: Processing of Medical Images by Deep Learning



Reedbush-U/H (1/2)

Integrated Supercomputer System for Data Analyses & Scientific Simulations

- SGI was awarded (Mar. 22, 2016)
- Compute Nodes (CPU only): Reedbush-U
 - Intel Xeon E5-2695v4 (Broadwell-EP, 2.1GHz 18core) x 2socket (1.210 TF), 256 GiB (153.6GB/sec)
 - InfiniBand EDR, Full bisection Fat-tree
 - Total System: 420 nodes, 508.0 TF
- Compute Nodes (with Accelerators): Reedbush-H
 - Intel Xeon E5-2695v4 (Broadwell-EP, 2.1GHz 18core) x 2socket, 256 GiB (153.6GB/sec)
 - NVIDIA Pascal GPU (Tesla P100)
 - (5.3TF, 720GB/sec, 16GiB) x 2 / node
 - InfiniBand FDR x 2ch (for ea. GPU), Full bisection Fat-tree
 - 120 nodes, 145.2 TF(CPU)+ 1.27 PF(GPU)= 1.42 PF

Why “Reedbush” ?



Blaise Pascal
(1623-1662)

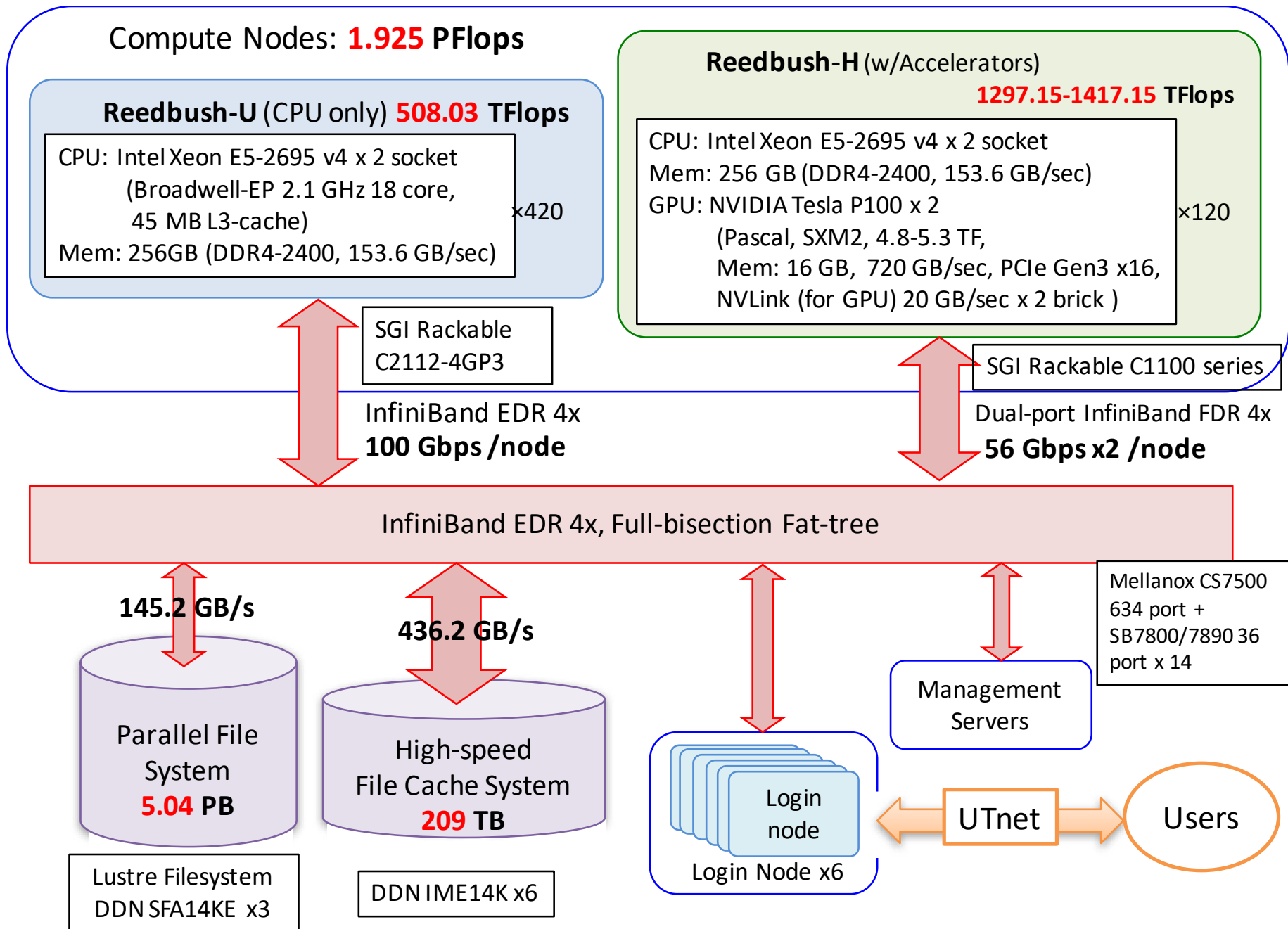
- L'homme est un roseau pensant.
 - Man is a thinking reed.
 - 人間は考える葦である
- Pensées (Blaise Pascal)



Reedbush-U/H (2/2)

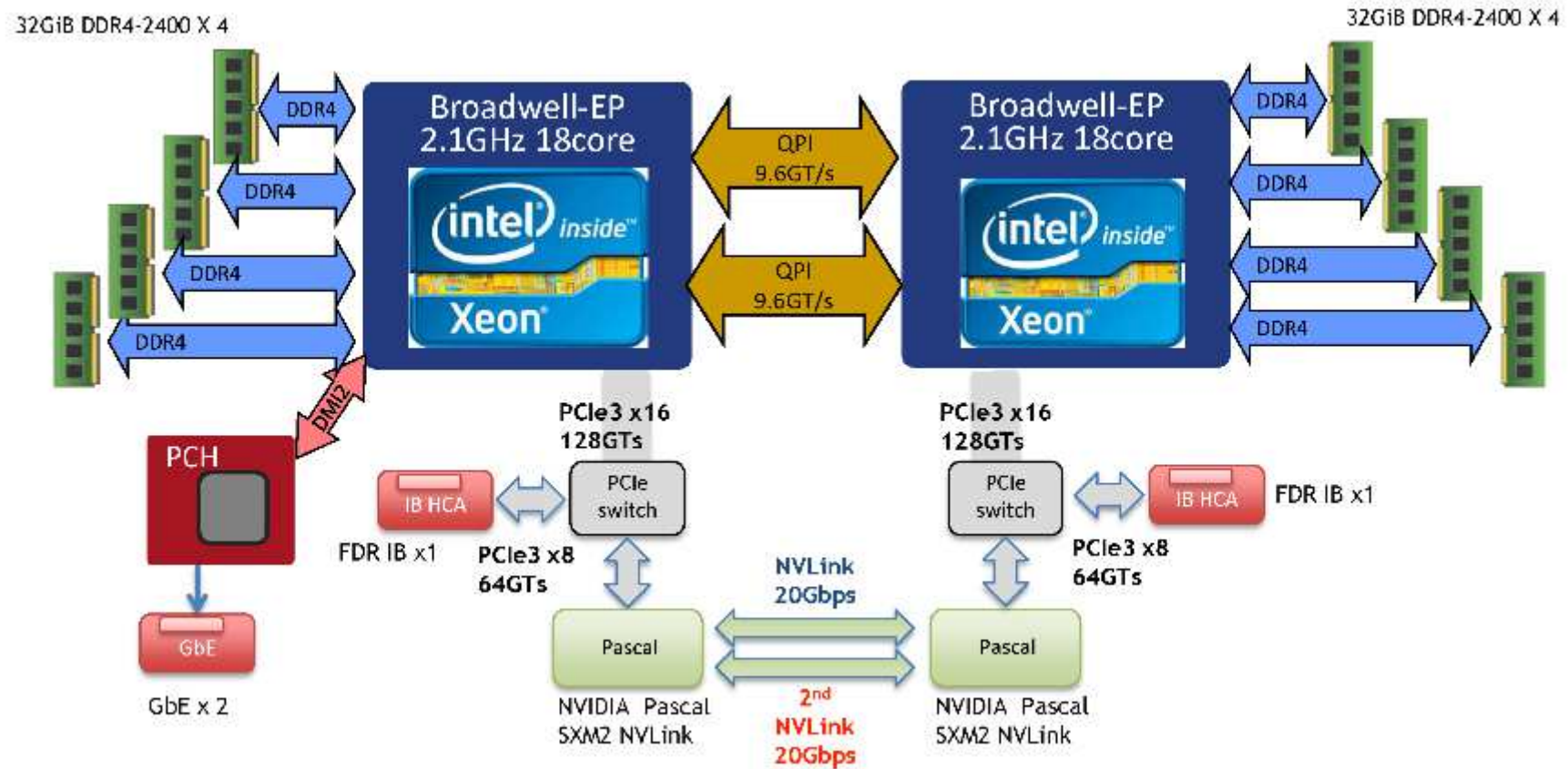
Integrated Supercomputer System for Data Analyses & Scientific Simulations

- Storage/File Systems
 - Shared Parallel File-system (Lustre)
 - 5.04 PB, 145.2 GB/sec
 - Fast File Cache System: Burst Buffer (DDN IME (Infinite Memory Engine))
 - SSD: 209.5 TB, 450 GB/sec
- Power, Cooling, Space
 - Air cooling only, < 500 kVA (without A/C): 378 kVA
 - < 90 m²
- Software & Toolkit for Data Analysis, Deep Learning ...
 - OpenCV, Theano, Anaconda, ROOT, TensorFlow
 - Torch, Caffe, Chainer, GEANT4

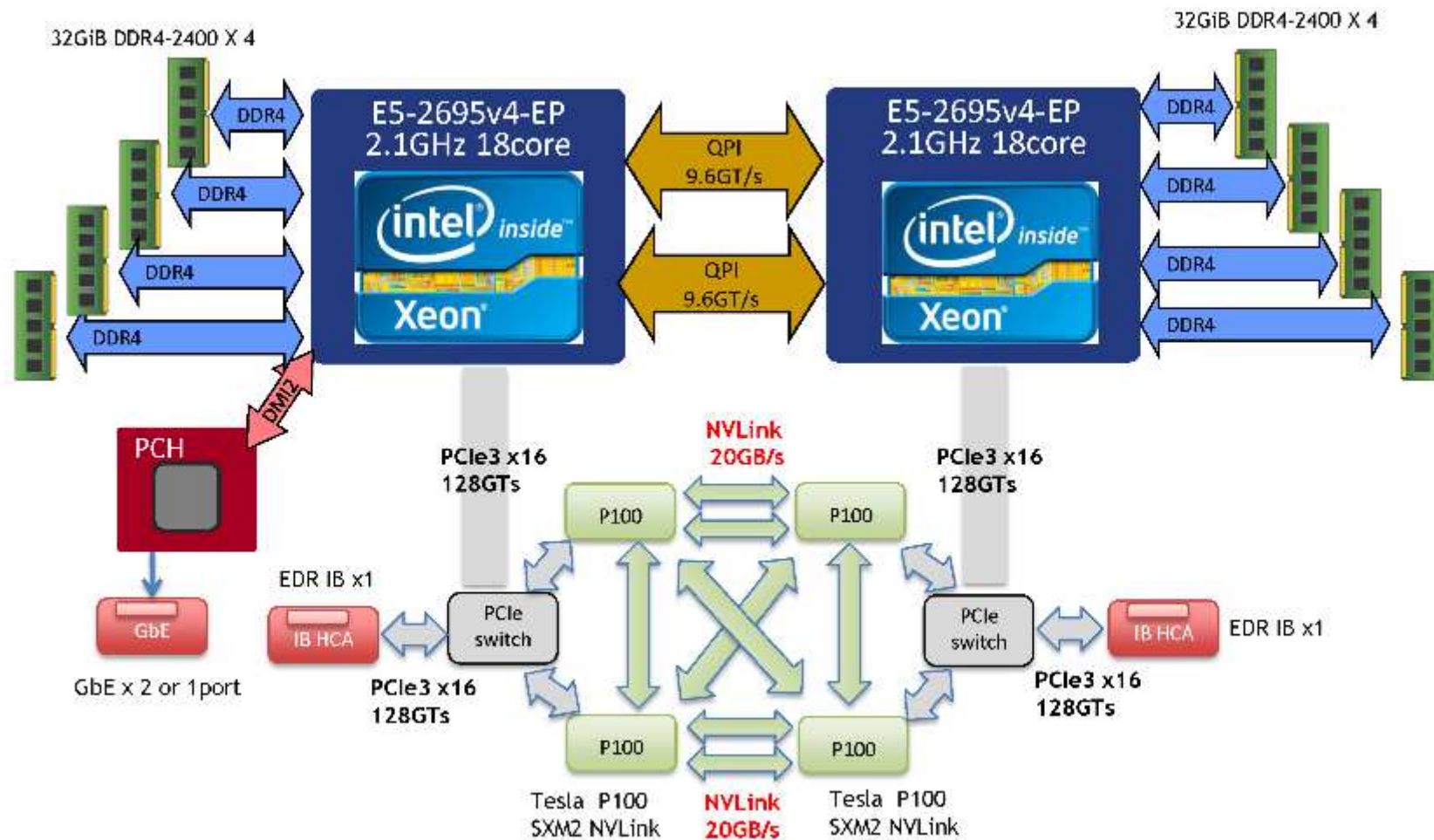


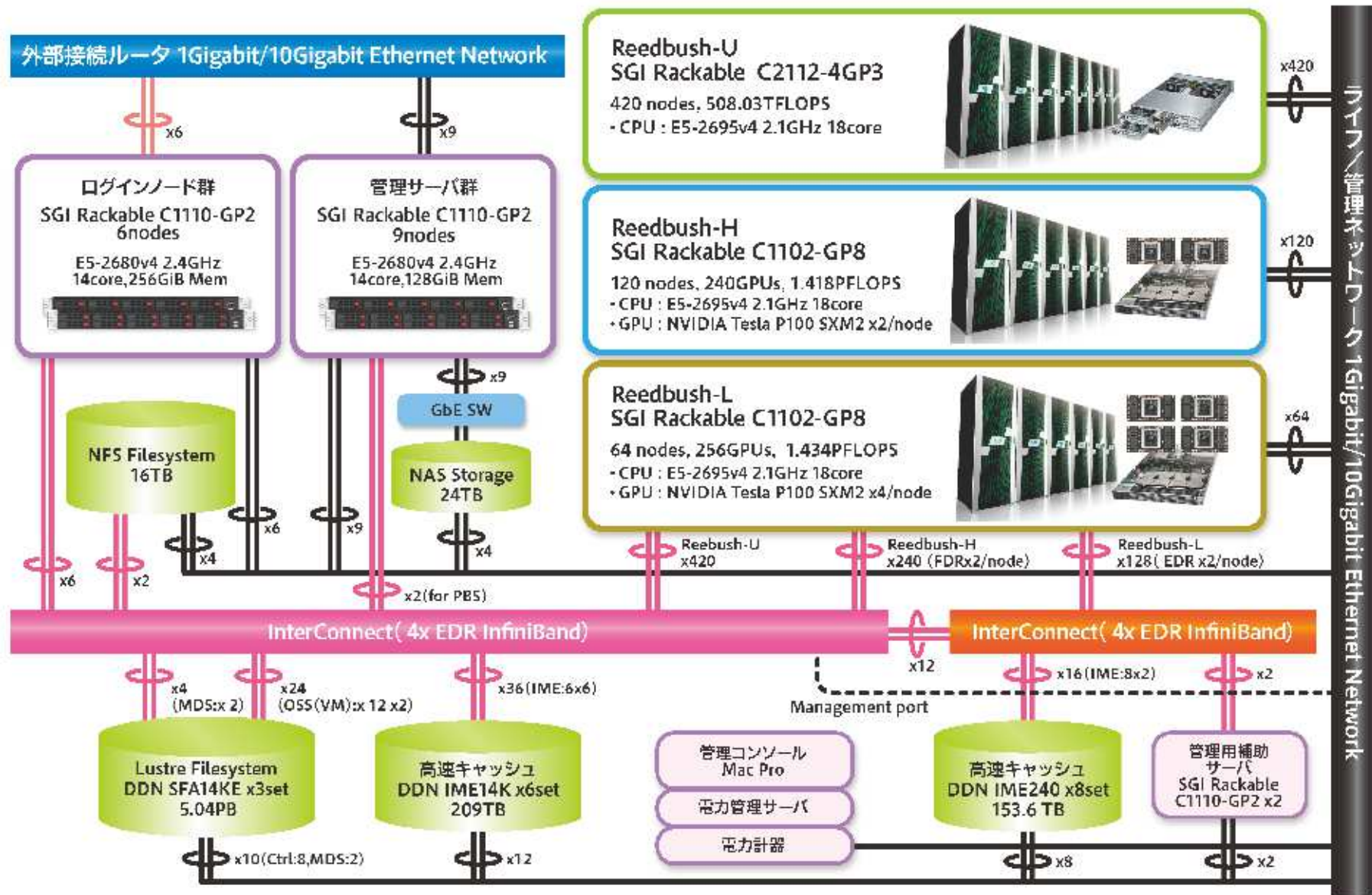
	Reedbush-U	Reedbush-H	Reedbush-L
	Integrated Supercomputer System for Data Analyses & Scientific Simulations		Supercomputer System with Accelerators for Long-Term Executions
CPU/node	Intel Xeon E5-2695v4 (Broadwell-EP, 2.1GHz, 18core) x 2 sockets (1.210 TF), 256 GiB (153.6GB/sec)		
GPU	-	NVIDIA Tesla P100 (Pascal, 5.3TF, 720GB/sec, 16GiB)	
Infiniband	EDR	FDR × 2ch	EDR × 2ch
Nodes #	420	120	64
GPU #	-	240 (=120 × 2)	256 (=64 × 4)
Peak Performance (TFLOPS)	509	1,417 (145 + 1,272)	1,433 (76.8 + 1,358)
Total Memory Bandwidth (TB/sec)	64.5	191.2 (18.4+172.8)	194.2 (9.83+184.3)
since	2016.07	2017.03	2017.10

Compute Node of Reedbush-H



Compute Node of Reedbush-L





How to Login (1 / 3)

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- Public Key Certificate

- Public Key Certificate

- Password provided by ITC
with 8 characters is not used
for “login”

How to Login (2/3)

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- Password with 8 characters by ITC
 - ▣ for registration of keys
 - ▣ browsing manuals
 - Only users can access manuals
 - SSH Port Forwarding is possible by keys

How to Login (3/3)

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- Procedures
 - ▣ Creating Keys
 - ▣ Registration of Public Key
 - ▣ Login

Creating Keys on Unix (1 / 2)

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- OpenSSH for UNIX/Mac/Cygwin
- Command for creating keys
\$ ssh-keygen -t rsa
- RETURN
- Passphrase
- Passphrase again

Creating Keys on Unix (2/2)

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```
>$ ssh-keygen -t rsa
```

Generating public/private rsa key pair.

Enter file in which to save the key (/home/guestx/.ssh/id_rsa):

Enter passphrase (empty for no passphrase): (your favorite passphrase)

Enter same passphrase again:

Your identification has been saved in /home/guestx/.ssh/id_rsa.

Your public key has been saved in /home/guestx/.ssh/id_rsa.pub.

The key fingerprint is:

```
>$ cd ~/.ssh
```

```
>$ ls -l
```

total 12

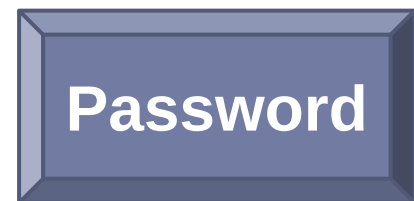
-rw-----	1	guestx	guestx	1743	Aug 23 15:14	id_rsa
-rw-r--r--	1	guestx	guestx	413	Aug 23 15:14	id_rsa.pub

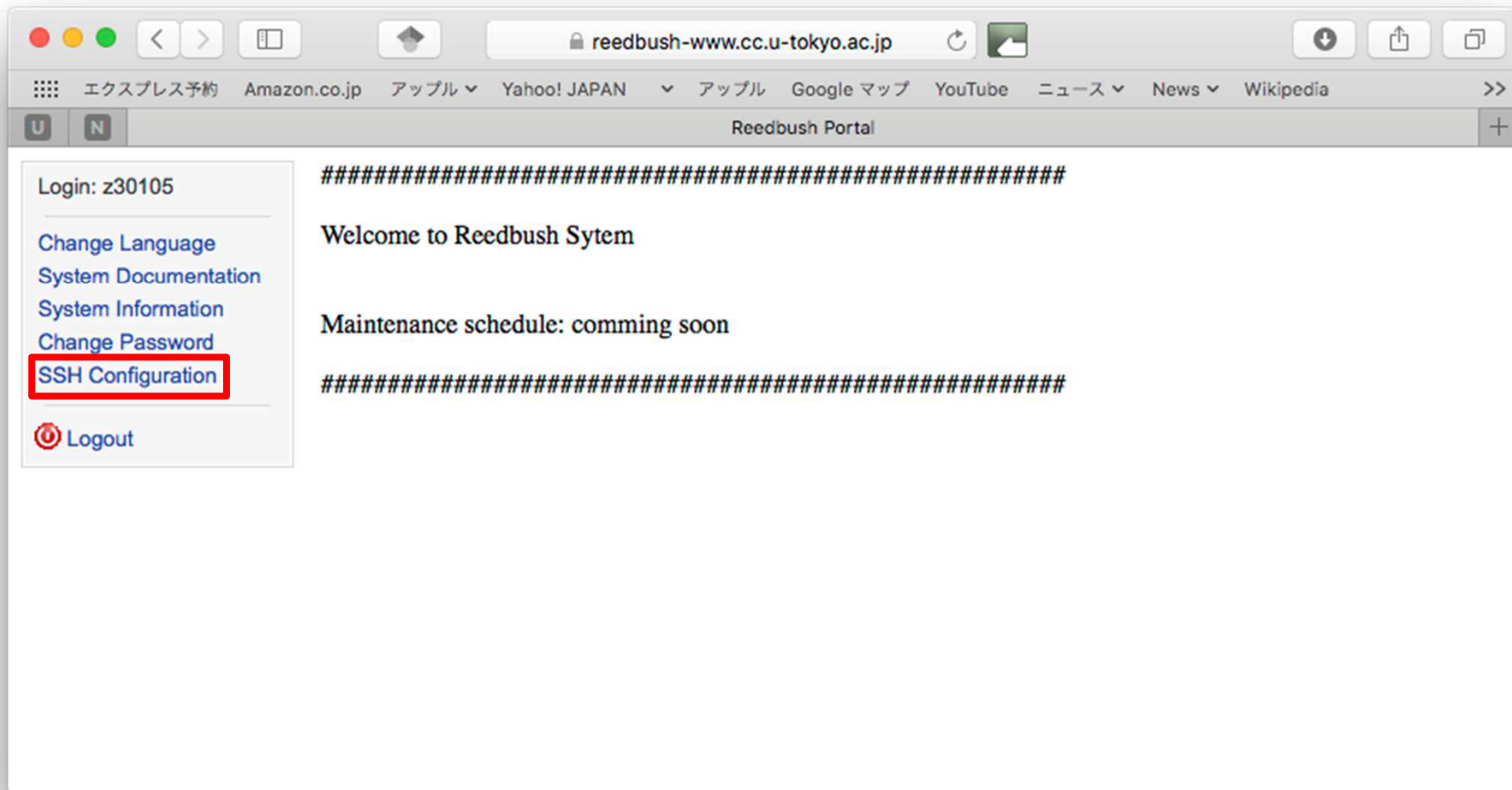
```
>$ cat id_rsa.pub
```

(cut & paste)

Registration of Public Key

- ▶ <https://reedbush-www.cc.u-tokyo.ac.jp/>
- ▶ User ID
- ▶ Password (8 characters)
- ▶ “SSH Configuration”
- ▶ Cut & Paste the Public Key





Login

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□ Login

```
$ ssh reedbush.cc.u-tokyo.ac.jp -l t180XX (or)
```

```
$ ssh t180XX@reedbush.cc.u-tokyo.ac.jp
```

□ Directory

```
$ /home/gt18/t180XX          login -> small
```

- ▣ Type “cd” for going back to /home/gt18/t180XX

```
$ cd /lustre/gt18/t180XX      please use this directory
```

- ▣ Type “cdw” for going to /lustre/gt18/t180XX

□ Copying Files

```
$ scp <file> t180**@reedbush.cc.u-tokyo.ac.jp:~/.
```

```
$ scp -r <dir> t180**@reedbush.cc.u-tokyo.ac.jp:~/.
```

□ Public/Private Keys are used

- ▣ “Passphrase”, not “Password”

Please check schedule of maintenance

- Last Friday of each month
 - other non-regular shutdown
- <http://www.cc.u-tokyo.ac.jp/>
- <http://www.cc.u-tokyo.ac.jp/system/reedbush/>

**If you have any questions,
please contact KN (Kengo
Nakajima)**

[nakajima\(at\)cc.u-tokyo.ac.jp](mailto:nakajima(at)cc.u-tokyo.ac.jp)

Do not contact ITC support directly.