



Operation Start of the 2nd generation **SX-Aurora TSUBASA**

Cyberscience Center, Tohoku University

Hiroyuki Takizawa

<takizawa@tohoku.ac.jp>

History and Missions

■ History

Computer Center	
1969	Foundation 
1985	NEC SX-1 
1989	NEC SX-2 
1994	NEC SX-3 
1998	NEC SX-4 
2001	Reorganization
2003	NEC SX-7 
2008	Reorganization NEC SX-9 
2015	NEC SX-ACE 

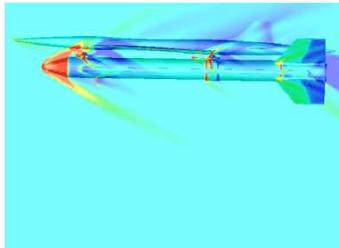
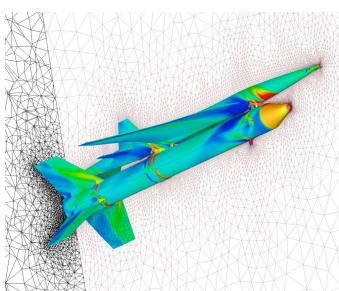
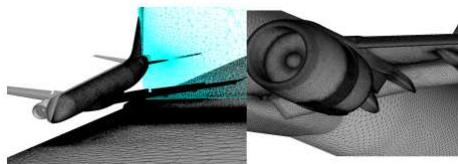
■ Missions of Cyberscience Center

- Offering leading-edge computing environments to academic users nationwide in Japan
 - 24/7 service of **NEC SX-ACE** (until July 2020)
 - **1,556 users** (as of March 2020)
 - User supports
 - Benchmarking, analyzing, and tuning users' programs
 - Presenting seminars and lectures on supercomputing
- **R&D on supercomputing**
 - Joint research projects with users and NEC on HPC
 - Designing next-generation high-performance computing systems and their applications for **highly-productive supercomputing**
- **Education**
 - Teaching and supervising BS, MS and Ph.D. Students



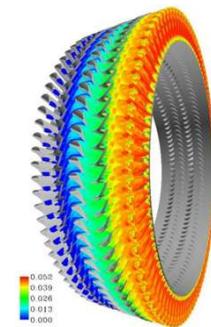
Various Scientific Simulations

Next-Generation SuperSonic Transport

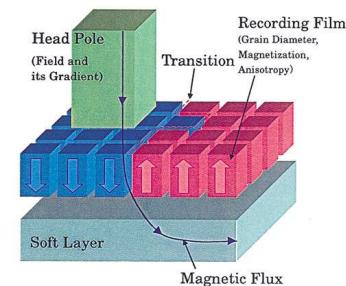


MRJ

Turbine Design



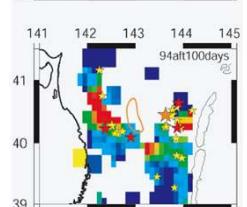
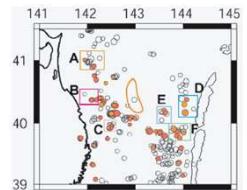
Perpendicular Magnetic Recording Medium Design



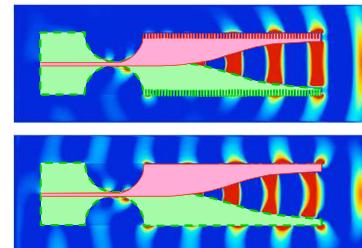
Nano Material Design



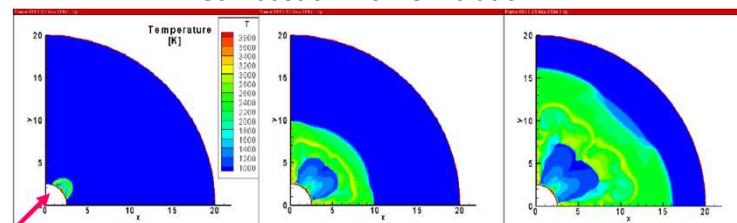
Earthquake Analysis



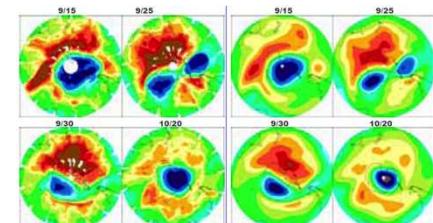
Antenna Analysis



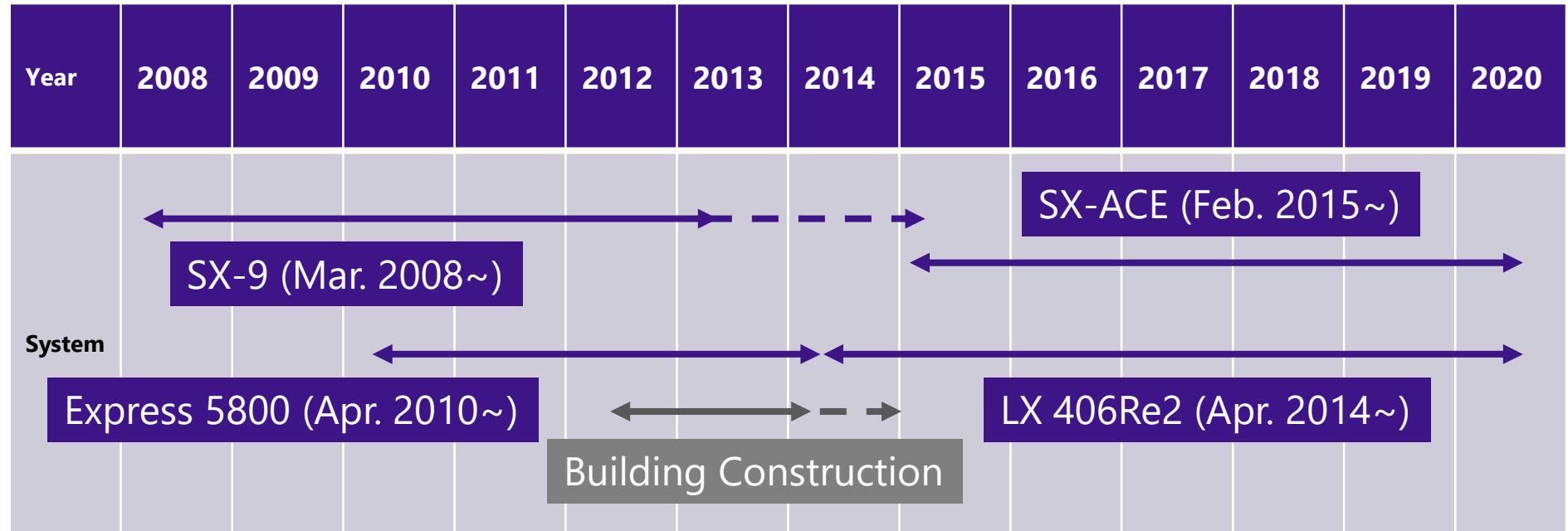
Combustion Flow Simulation



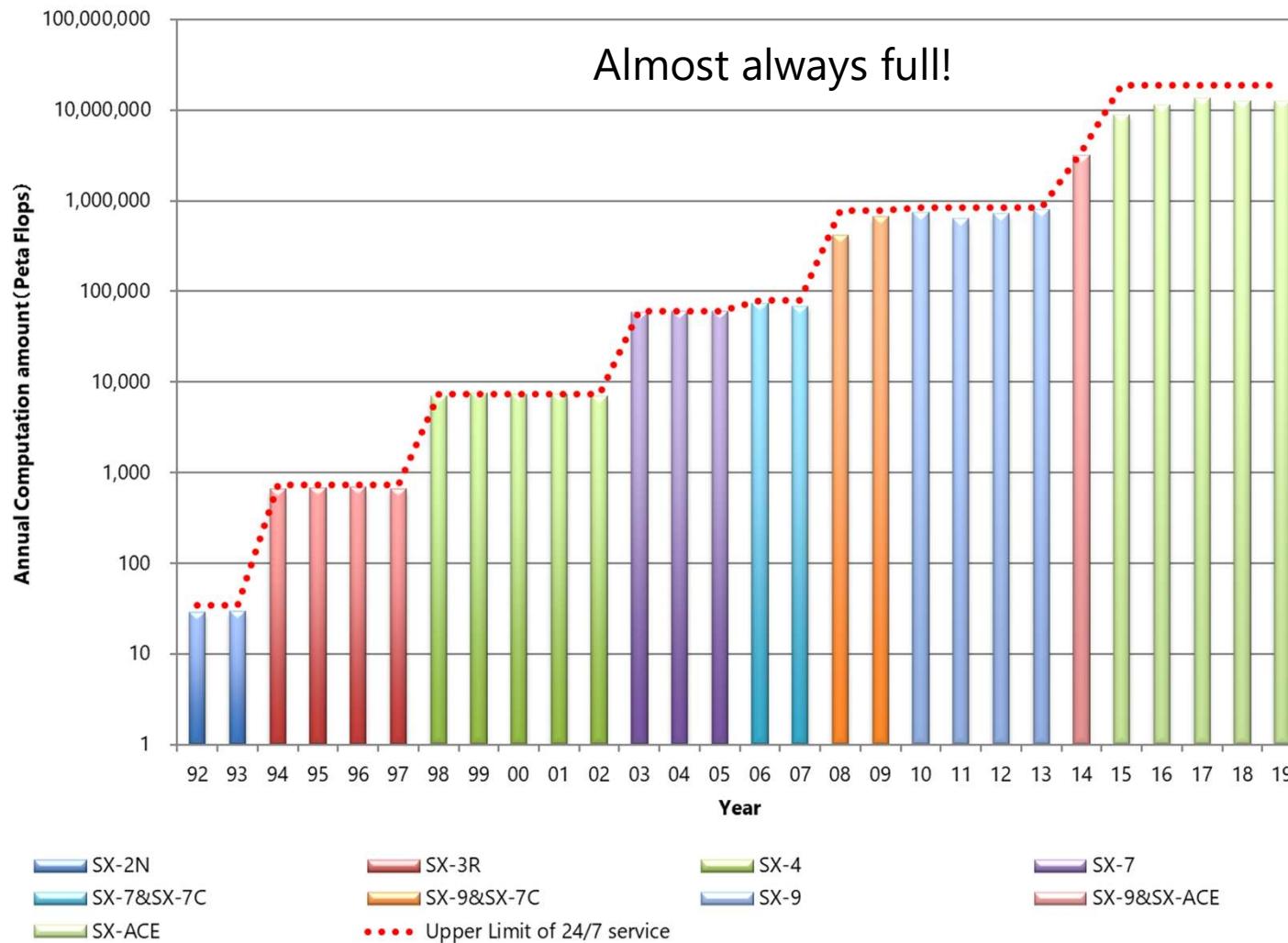
Ozone-hole Analysis



History of Our Supercomputers



Heavily Used Even Today





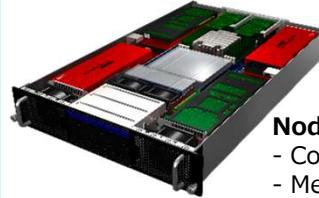
NEC Aurora Forum@SC20

System Configuration

Subsystem AOBA-A



NEC SX-Aurora TSUBASA B401-8 x 72



Node Performance

- Comp. : **20.7 TF**
- Mem size : 640 GB
- Mem BW : **12.4 TB/s**

2nd generation

AMD EPYC 7402P x 1
NEC Vector Engine Type 20B x 8



Vector Engine Core x 8
HBM2 Module x 6



Subsystem AOBA-B



NEC LX 406Rz-2 x 68



Node Performance

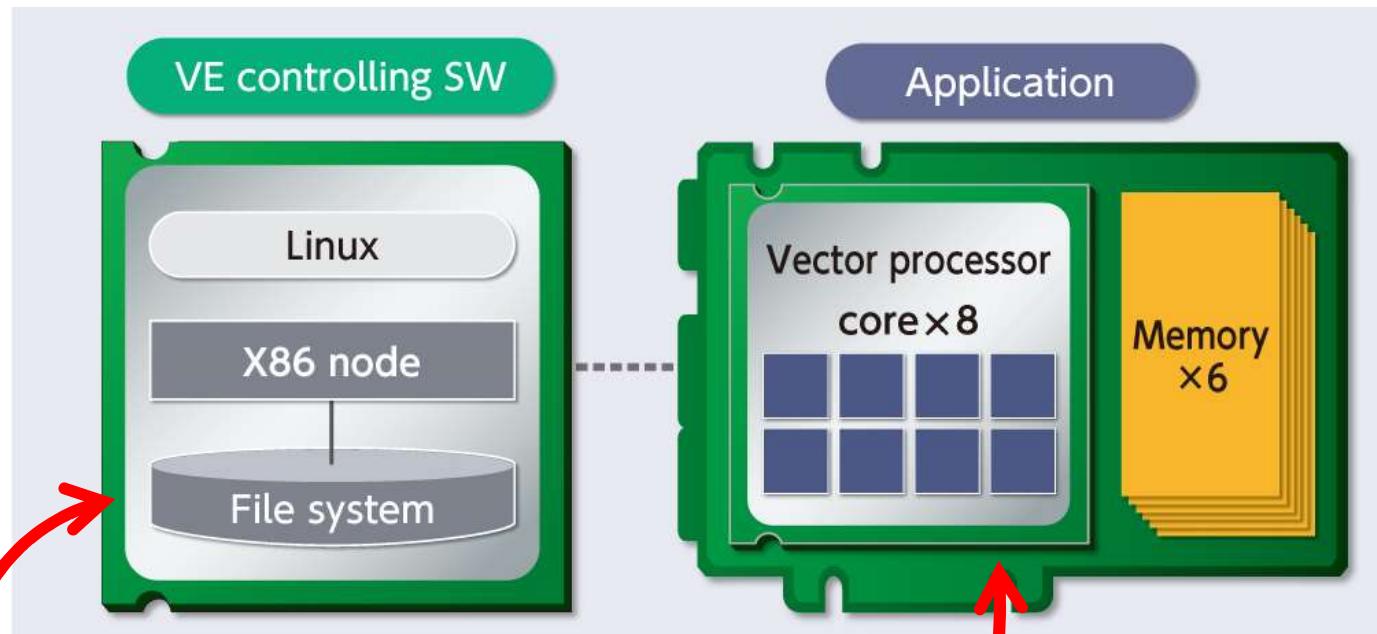
- Comp. : **4.1 TF**
- Mem size : 256 GB
- Mem BW : **0.41 TB/s**

AMD EPYC 7702P x 2



Overall System Performance: **1.78 Pflop/s, 924 TB/s**

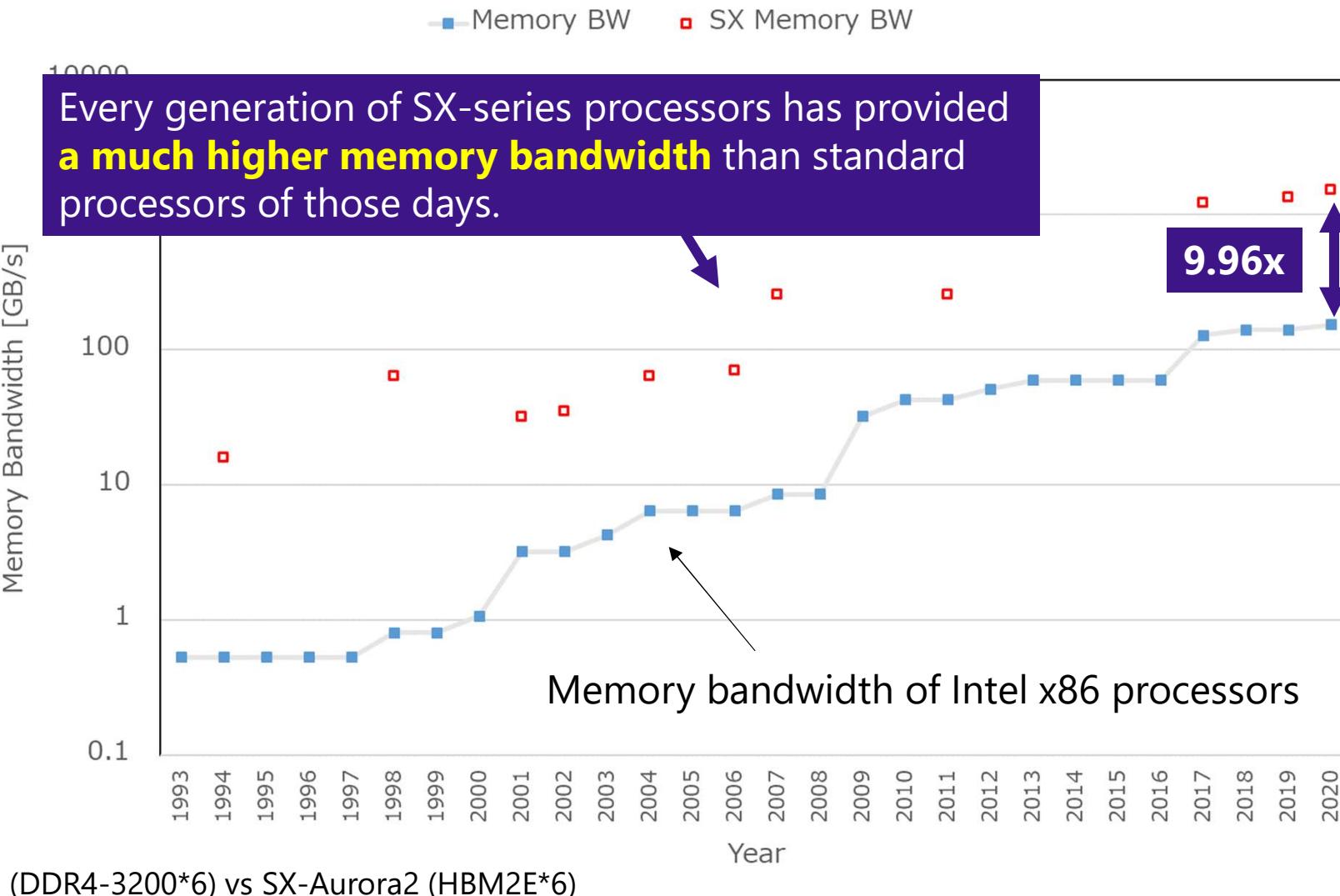
Standard SW + Special HW



```
$ gcc matmul.c -o matmul  
$ ./matmul
```

```
$ ncc matmul.c -o matmul  
$ ./matmul
```

SX's DNA



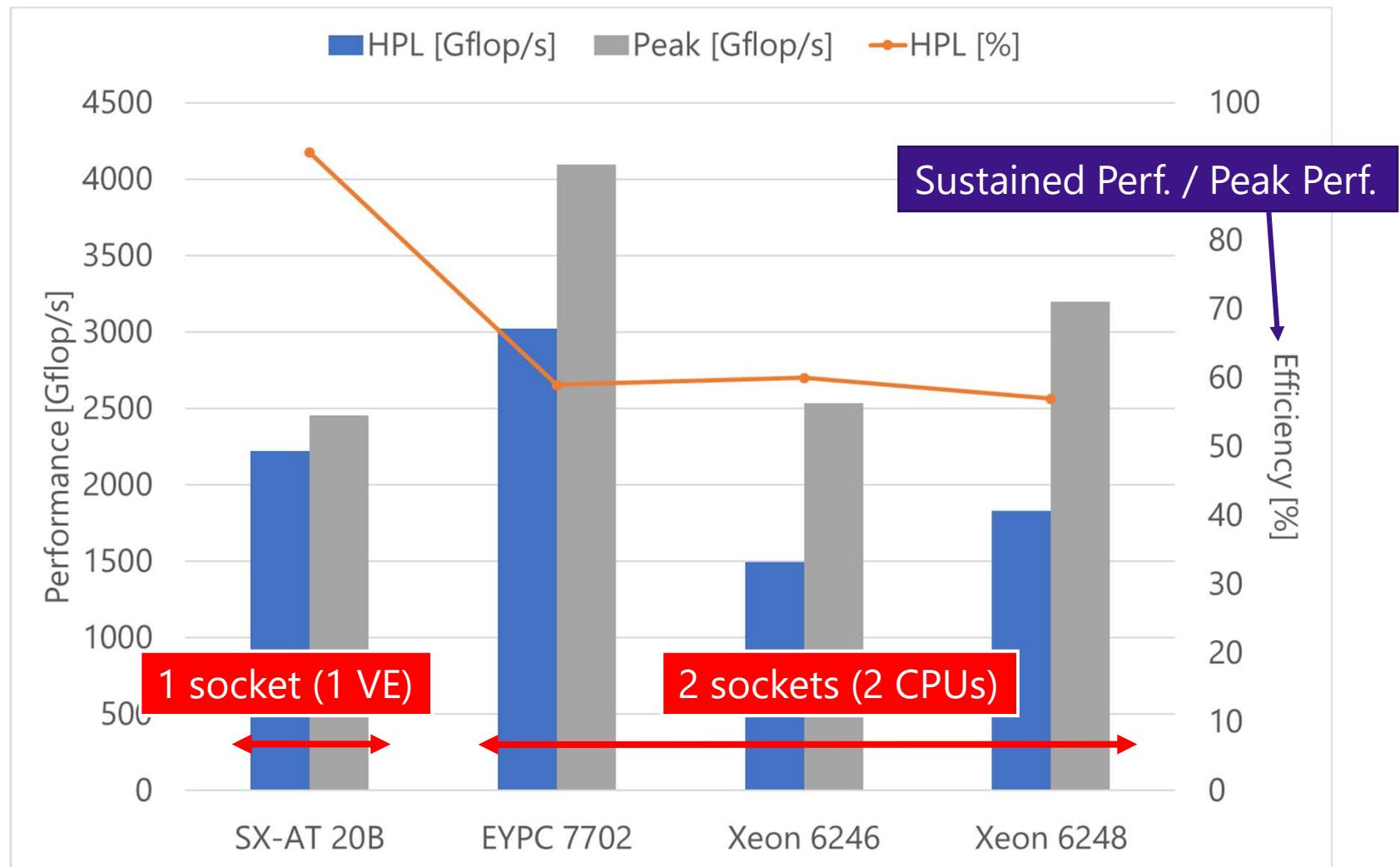
Evaluation Setup

		SX-ACE	SX-AT 10B	SX-AT 10AE	SX-AT 20B	EPYC 7702	Xeon 6246	Xeon 6248
Core	Clock Freq. [GHz]	1	1.4	1.58	1.6	2	3.3	2.5
	Peak Perf. [Gflop/s]	64	268	304	307	32	105	80
Socket	No. of Cores	4	8	8	8	64	12	20
	Peak Perf. [Gflop/s]	256	2150	2433	2457	2048	1267	1600
	Mem BW [GB/s]	256	1228	1352	1536	204	140	140
Node	No. of Sockets	1	1	1	1	2	2	2
	Peak Perf. [Gflop/s]	256	2150	2433	2457	4096	2534	3200
	System B/F	1	0.56	0.56	0.62	0.1	0.11	0.09

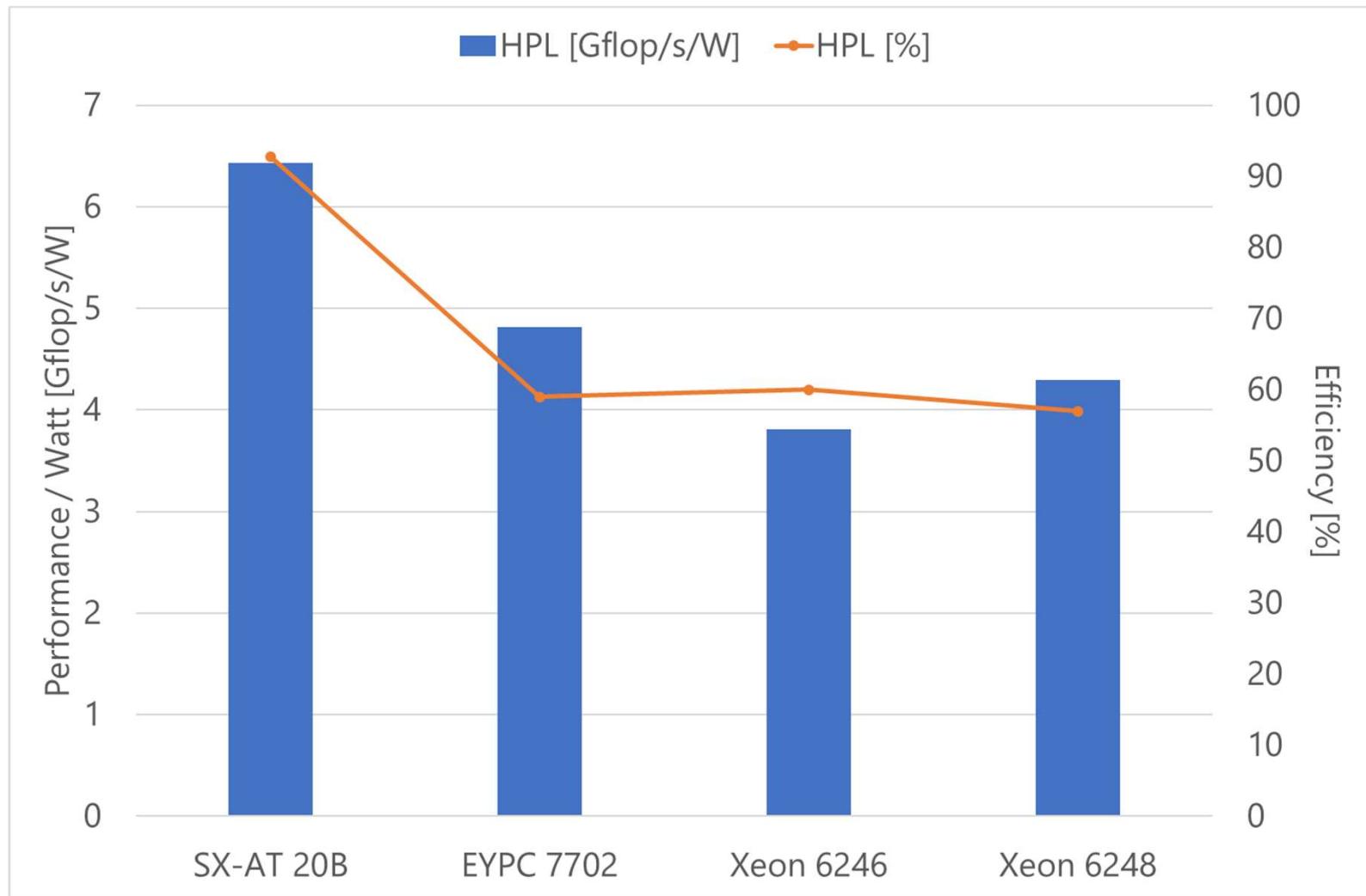


AOBA

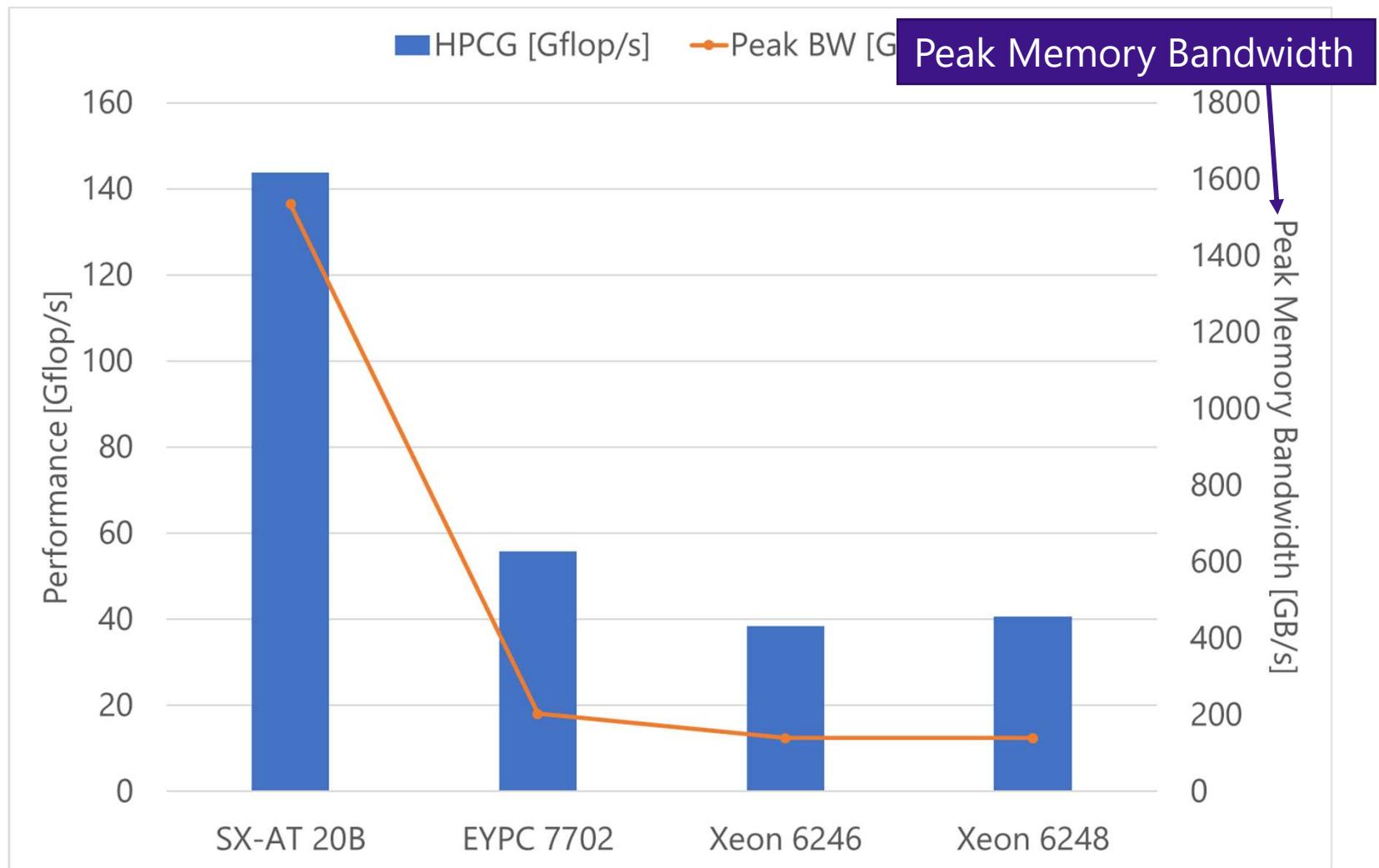
HPL Performance



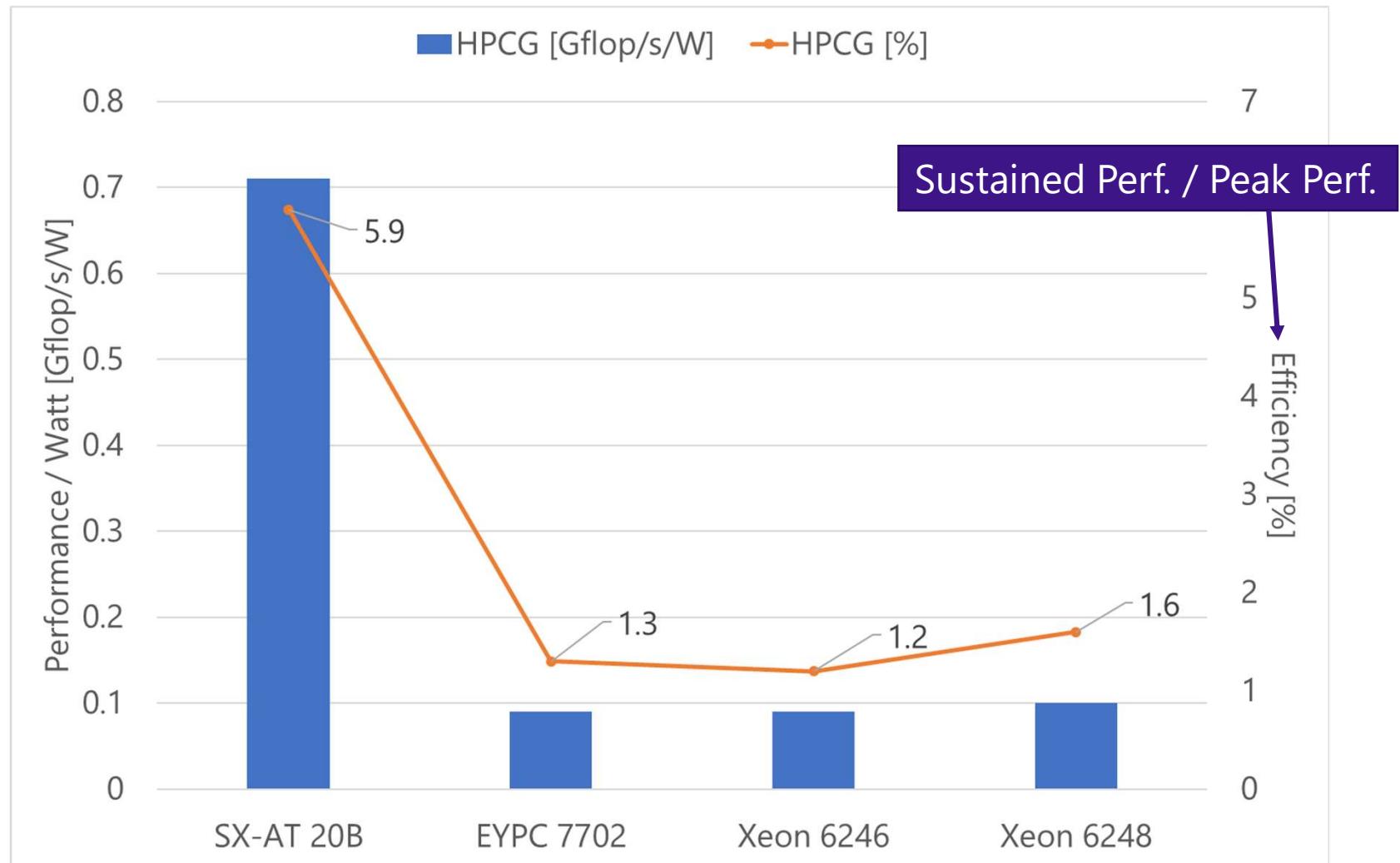
HPL Power Efficiency



HPCG Performance



HPCG Power Efficiency

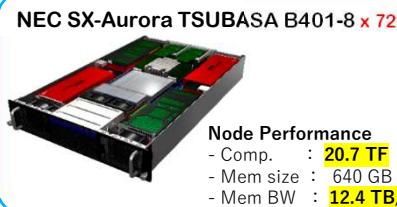


HPCG & HPL on AOBA

Egawa et al.@PMBS20



Subsystem AOBA-A



[SX-Aurora]
72VH(576VE) Peak 1415.6TF

Subsystem AOBA-B



NEC LX 406Rz-2 x 68

Node Performance
- Comp. : **4.1 TF**
- Mem size : 256 GB
- Mem BW : **0.41 TB/s**

[AMD Rome 7702]
68node Peak 278.5TF

HPL : 1140.1TF (Efficiency 80.5%)

HPCG : 75.3TF (Efficiency 5.32%)

HPL : 161.7TF (Efficiency 58.08%)

HPCG : 2.55TF (Efficiency 0.92%)

Key Applications

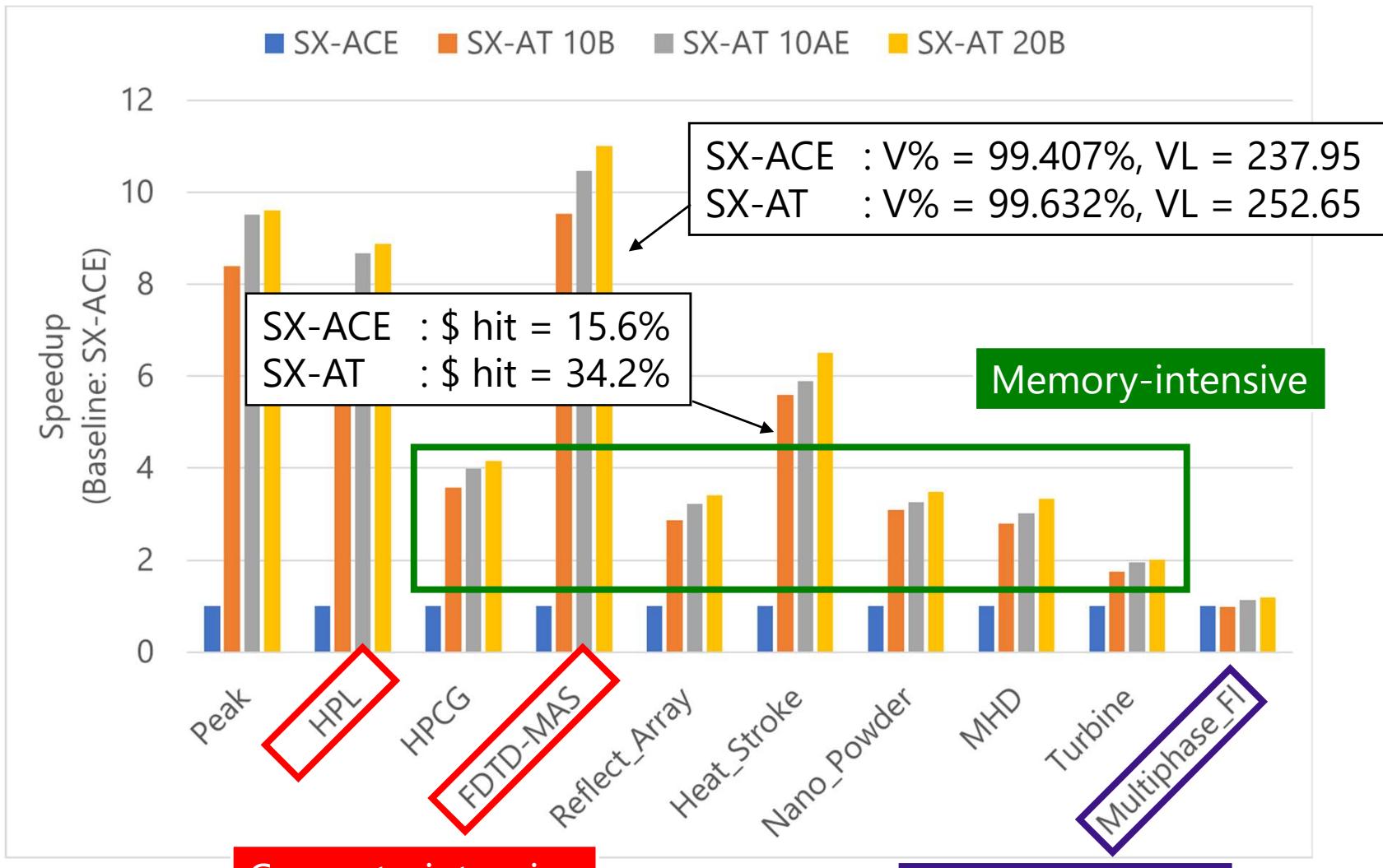
- **FDTD-MAS (Konno et al. 2016)**
 - Analysis of noises on a PCB board
- **Reflext_Array (Kasuga et al. 2005)**
 - Simulation of a reflect array
- **Heat_Stroke (Kojima et al. 2018)**
 - Evaluation of the heat stroke risk
- **Nano_Powder (Shigera et al. 2018)**
 - Simulation of generating silicon nanoparticles
- **MHD (Fukazawa et al. 2016)**
 - Simulation of radiation band electrons around Jupiter
- **Turbine (Yamamoto et al. 2011)**
 - Design of steam and gas turbines
- **Multiphase_Fl (Yoshida 2020)**
 - Simulation of dust explosion phenomena

Application Summary

	Vectorization [%]	Ave Vec Len	No. of Processes	No. of VEs	B/F
HPL	99.3	254.4	256	32	0.31
HPCG	99.0	237.5	Compute-intensive	32	11.08
FDTD-MAS	99.6	252.7	1	1	0.29
Reflect_Array	98.8	216.1	8	1	3.74
Heat_Stroke	99.3	214.2	160	20	1.87
Nano_Powder	98.9	255.1	32	32	2.40
MHD	99.6	249.6	Memory-intensive	32	1.33
Turbine	92.0	175.5	159	20	2.52
Multiphase_Fl	29.1	18.0	1	1	12.88
Vector-unfriendly					



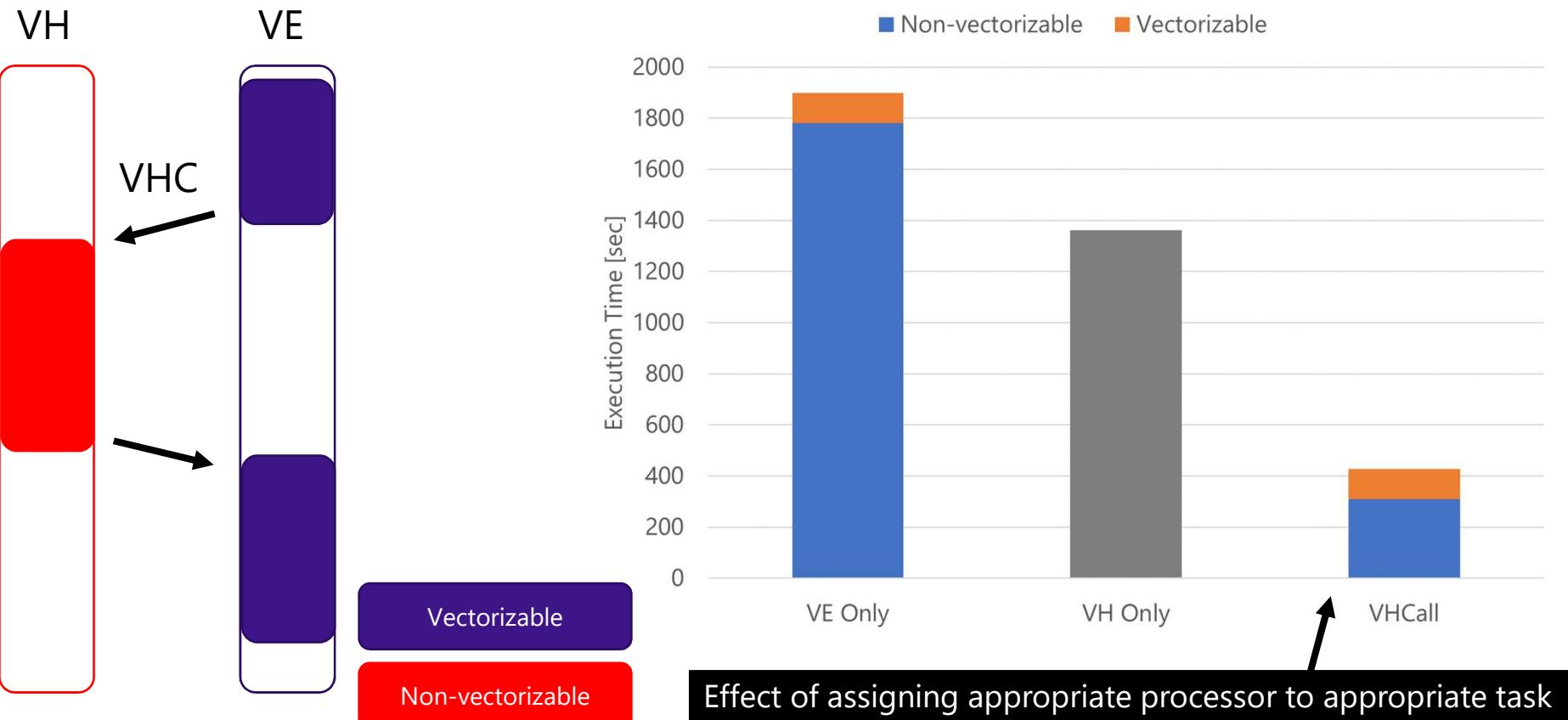
Performance Evaluation Results



VH-VE Collaboration

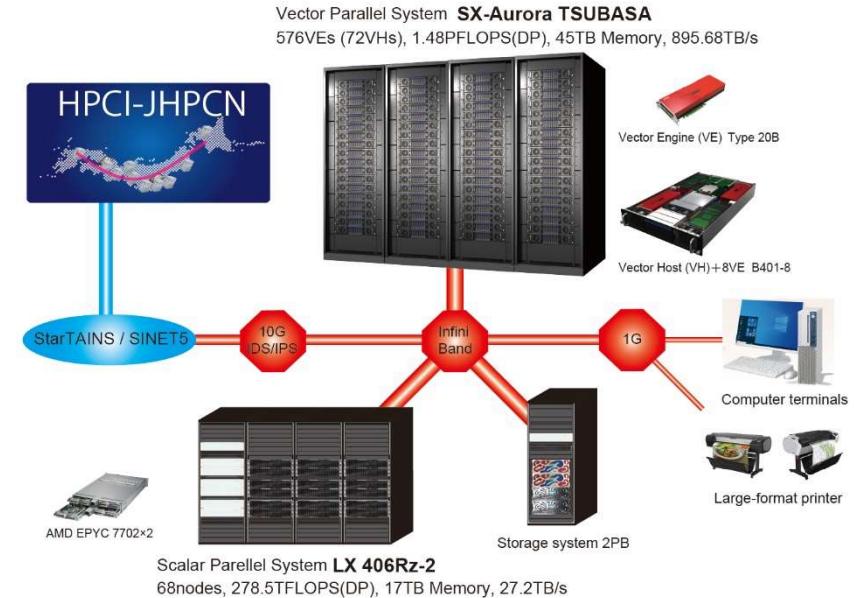
■ Vector Host Call (VHC)

- Offloading a non-vectorizable part from VE to VH



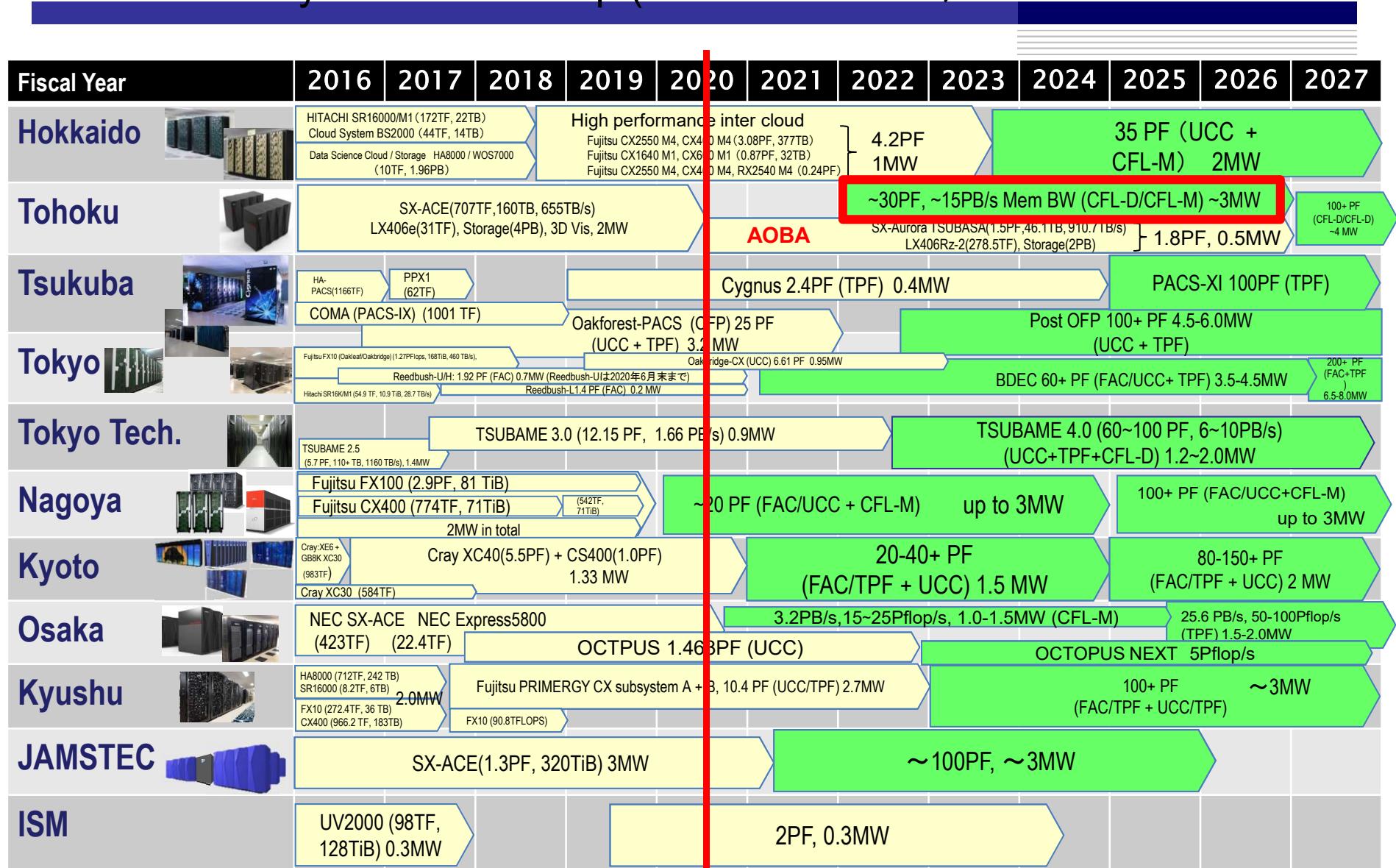
Summary

■ Supercomputer AOBA

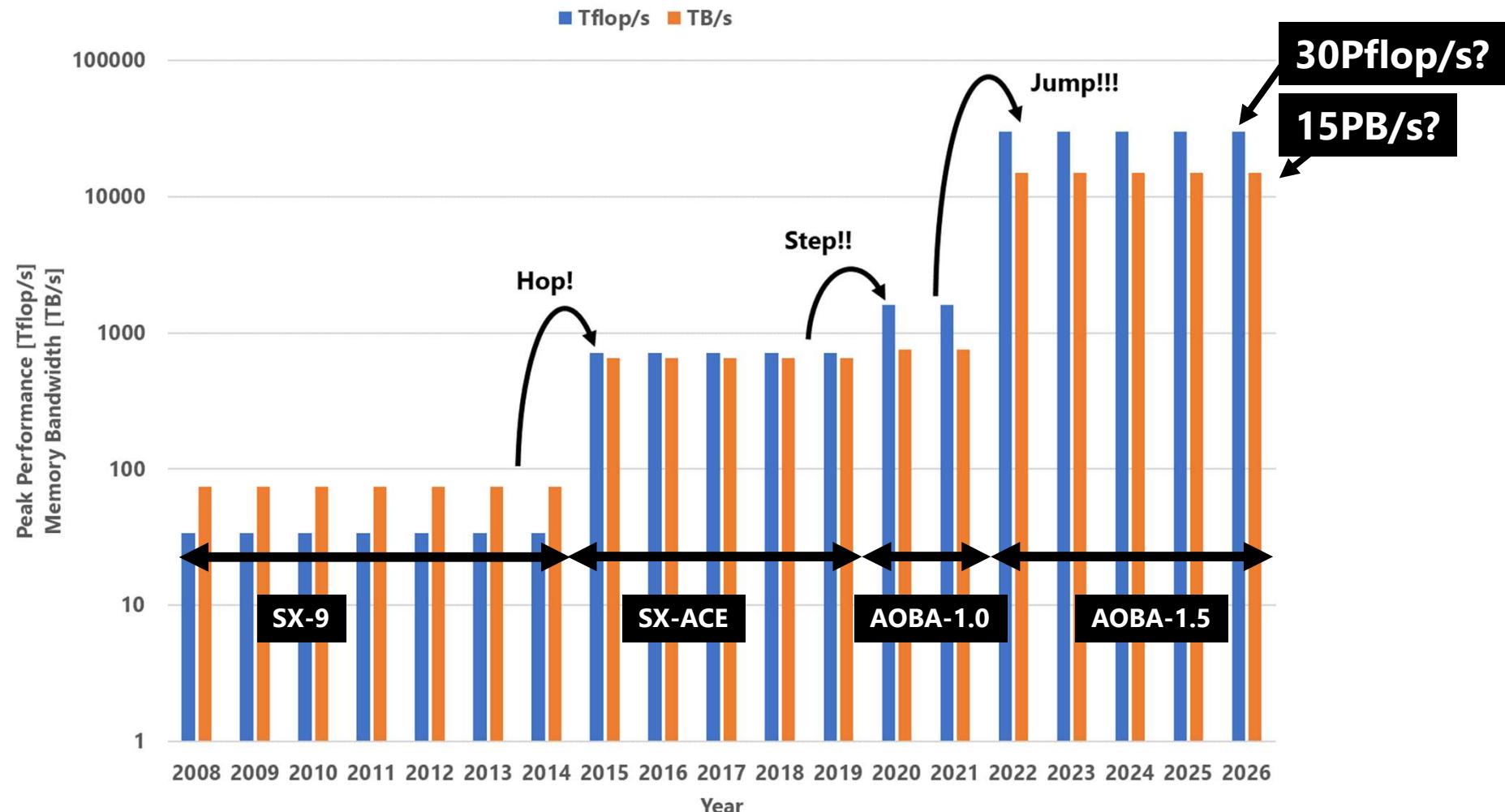


- Start operation on **October 1, 2020**.
- **The world's first system** of **2nd Generation** SX-Aurora TSUBASA
 - Standard Software + Special Hardware
 - High Memory Bandwidth
 - Vector Engine Type 20B
→ Higher B/F Rate = **Higher Comp.&Power Efficiencies**

HPCI Tier 2 Systems Roadmap (As of June 2020)



Outlook for System Updates



Acknowledgments

■ Many thanks to the collaborators.

- Ryusuke Egawa (Tokyo Denki University)
- Souya Fujimoto (NEC)
- Yoko Isobe (NEC)
- Yoichi Shimomura (NEC)
- Tsuyoshi Yamashita (CC, Tohoku University)
- Daisuke Sasaki (CC, Tohoku University)
- Joint-Research Division of High Performance Computing (NEC), CC, Tohoku University

This work is partially supported by MEXT Next-Generation High-Performance Computing Infrastructures and Applications R&D Program “R&D of a Quantum-Annealing-Assisted Next Generation HPC Infrastructure and its Applications,” and Grant-in-Aid for Scientific Research(A) #20H00593.

