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shaping tomorrow with you

Fujitsu A64FX prototype

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FUJITSU LIMITED

Nov. 19th, 2019

Outline

- TOP500 / Green500 achievements
- How Fujitsu worked
- Green500 measurement conditions and results
- Supercomputer standard and future
- Summary

Green500, Nov. 2019

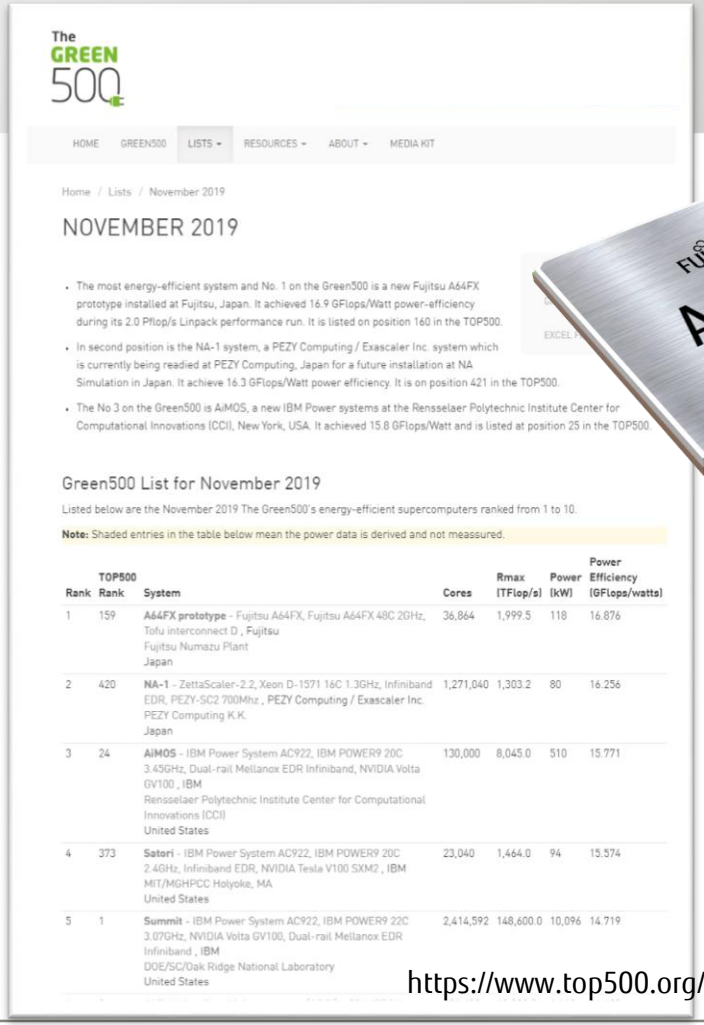
A64FX prototype –

Fujitsu A64FX 48C 2GHz

ranked #1 on the list

768x general purpose A64FX CPU w/o accelerators

- 1.9995 PFLOPS @ HPL, 84.75%
- 16.876 GF/W
- Power quality level 2



The GREEN 500

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NOVEMBER 2019

- The most energy-efficient system and No. 1 on the Green500 is a new Fujitsu A64FX prototype installed at Fujitsu, Japan. It achieved 16.9 GFlops/Watt power-efficiency during its 2.0 Pflop/s Linpack performance run. It is listed on position 160 in the TOP500.
- In second position is the NA-1 system, a PEZY Computing / Exascaler Inc. system which is currently being readied at PEZY Computing, Japan for a future installation at NA Simulation in Japan. It achieve 16.3 GFlops/Watt power efficiency. It is on position 421 in the TOP500.
- The No 3 on the Green500 is AiMOS, a new IBM Power systems at the Rensselaer Polytechnic Institute Center for Computational Innovations (CCI), New York, USA. It achieved 15.8 GFlops/Watt and is listed at position 25 in the TOP500.

Green500 List for November 2019

Listed below are the November 2019 The Green500's energy-efficient supercomputers ranked from 1 to 10.

Note: Shaded entries in the table below mean the power data is derived and not meassured.

Rank	TOP500 Rank	System	Cores	Rmax (TFlop/s)	Power (kW)	Power Efficiency (GFlops/watts)
1	159	**A64FX prototype** - Fujitsu A64FX, Fujitsu A64FX 48C 2GHz, Tofu interconnect D , **Fujitsu** Fujitsu Numazu Plant Japan	36,864	1,999.5	118	16.876
2	420	**NA-1** - ZettaScaler-2.2, Xeon D-1571 16C 1.3GHz, Infiniband EDR, PEZY-SC2 700Mhz , **PEZY Computing / Exascaler Inc.** PEZY Computing K.K. Japan	1,271,040	1,303.2	80	16.256
3	24	**AiMOS** - IBM Power System AC922, IBM POWER9 20C 3.45GHz, Dual-rail Mellanox EDR Infiniband, NVIDIA Volta GV100 , **IBM** Rensselaer Polytechnic Institute Center for Computational Innovations (CCI) United States	130,000	8,045.0	510	15.771
4	373	**Satori** - IBM Power System AC922, IBM POWER9 20C 2.4GHz, Infiniband EDR, NVIDIA Tesla V100 SXM2 , **IBM** MIT/MGHPCC Holyoke, MA United States	23,040	1,464.0	94	15.574
5	1	**Summit** - IBM Power System AC922, IBM POWER9 22C 3.07GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband , **IBM** DOE/SC/Oak Ridge National Laboratory United States	2,414,592	148,600.0	10,096	14.719

https://www.top500.org/green500/lists/2019/11/

SC19 Green500 ranking and 1st appeared TOP500 edition

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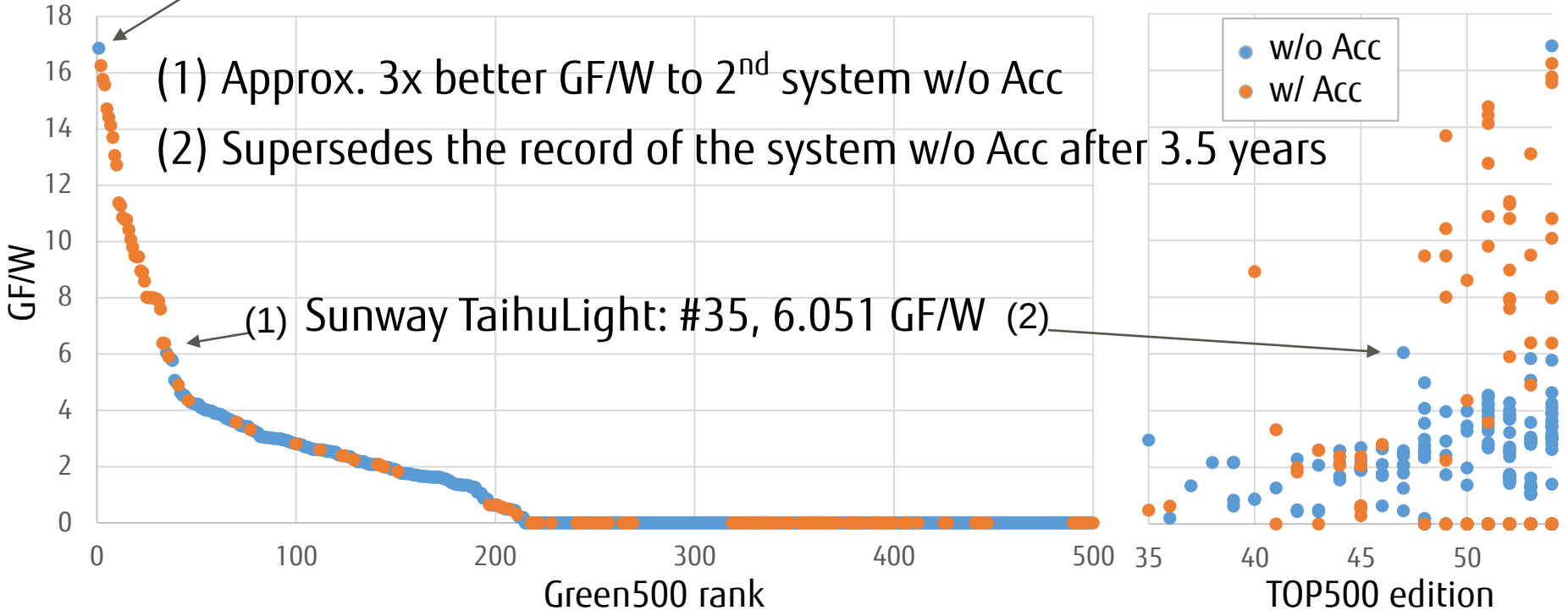

SC19 TOP500 ranking and GF/W

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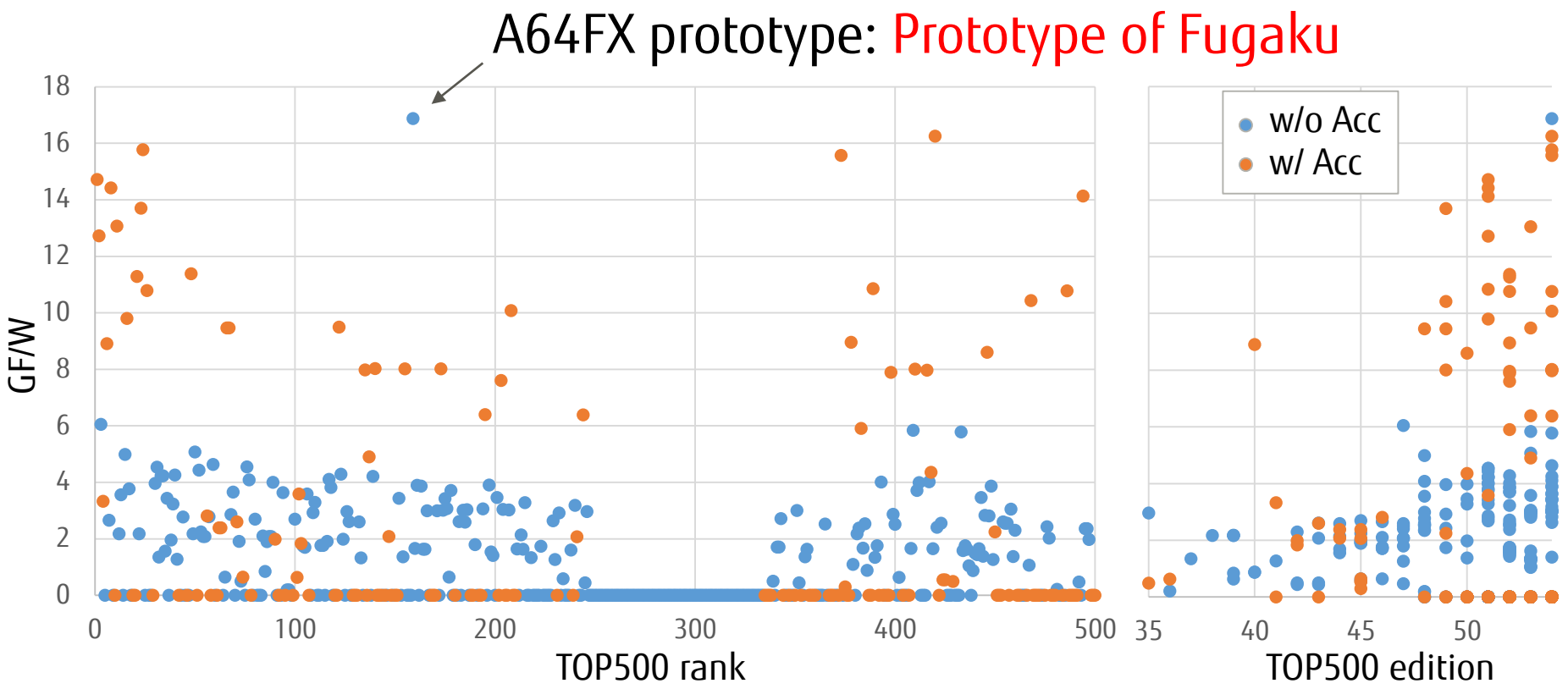

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How Fujitsu worked

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- Key for GF/W is {energy efficient HW} x {parallel/exec efficiency}
- A64FX is designed for energy efficient
  - Fujitsu's proven CPU microarchitecture & 7nm FinFET
  - SoC design: Tofu interconnect D integrated
  - CoWoS: 4x HBM2 for main memory integrated
- Superior parallel/exec efficiency
  - Math. libraries are tuned for application efficiency
  - Comm. libs are also tuned utilizing long experience of Tofu @ K computer
  - Performance tuning is efficiently done utilizing rich performance analyzer/monitor

SC19 TOP500 calculation efficiency

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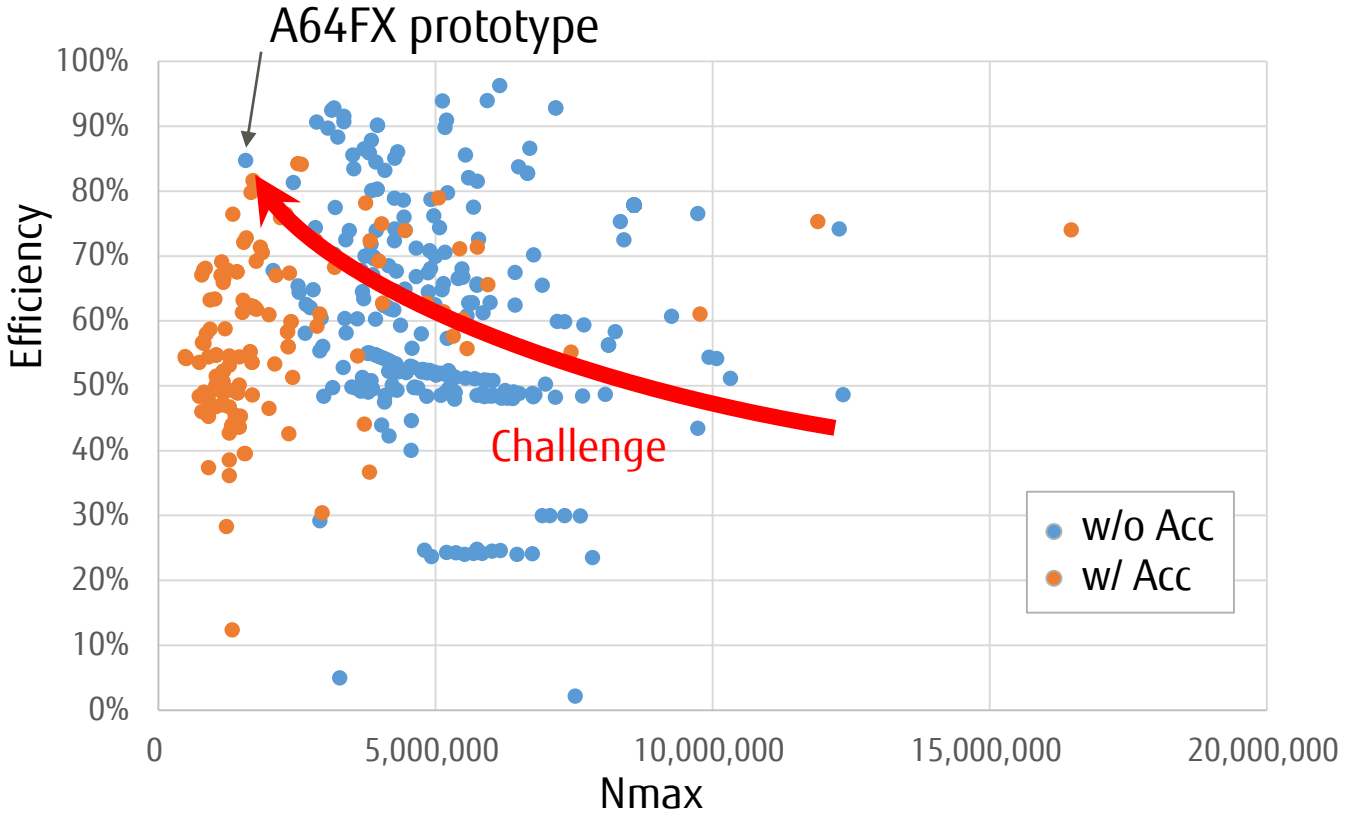
- Superior efficiency 84.75% with small Nmax
- Results of:
  - Optimized communication and math. libs
  - Optimization of overlapped communication



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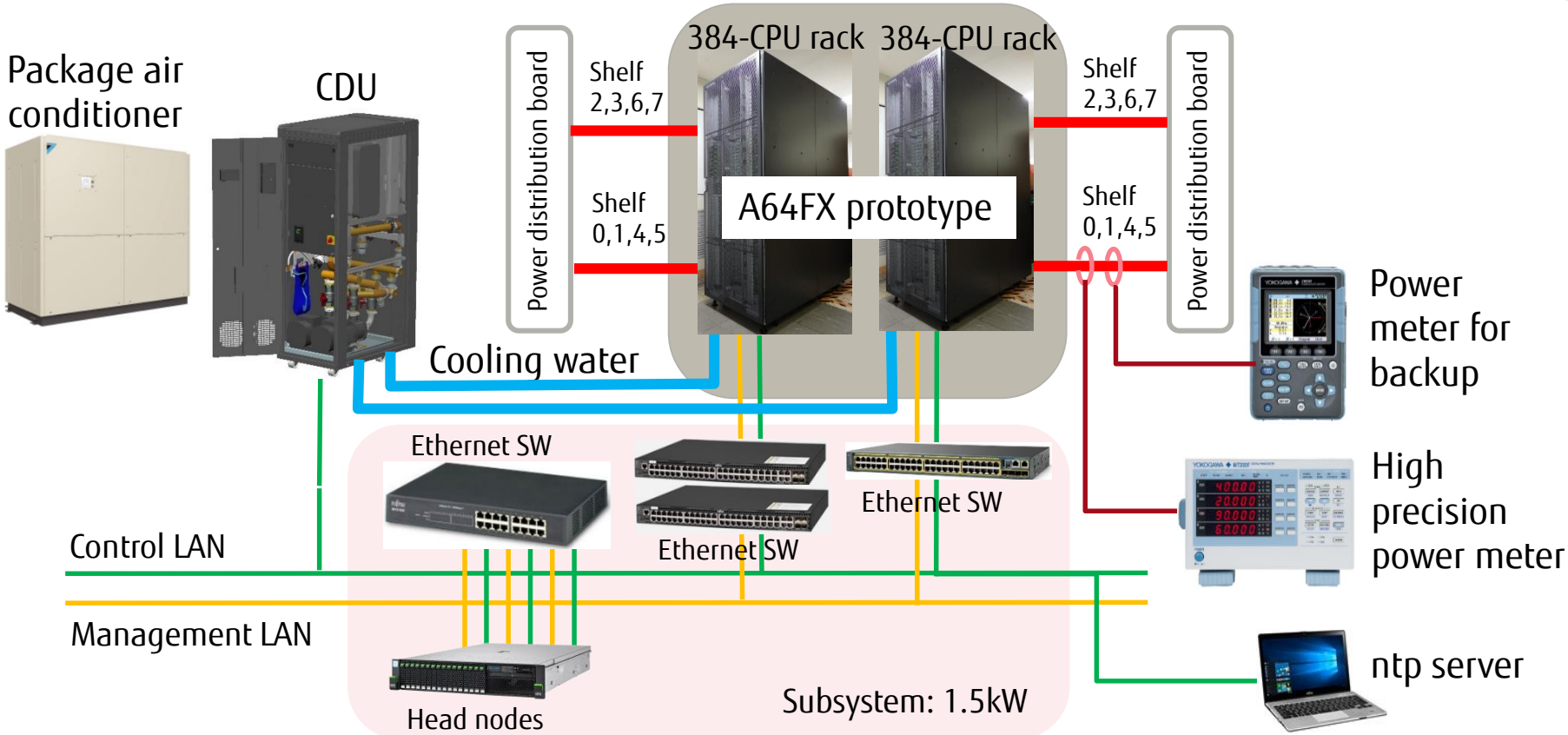
Fujitsu Numazu Plant: A64FX prototype system



A64FX prototype @ Fujitsu Numazu Plant

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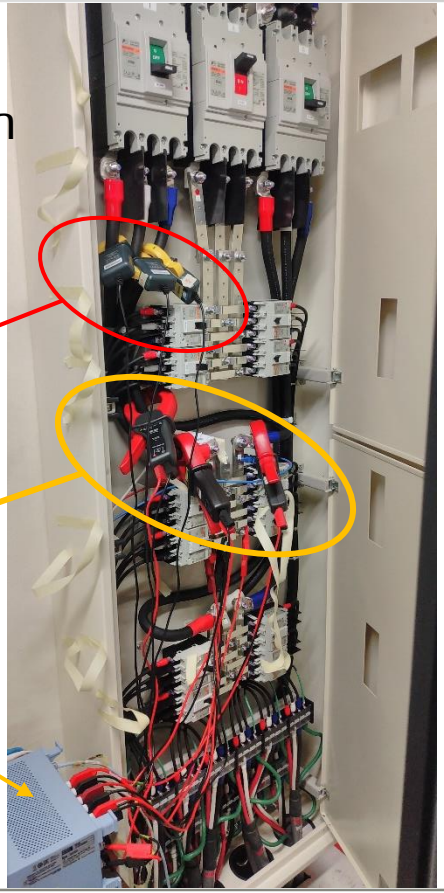
Power distribution board

Clamps for backup

Clamps for high precision power meter

High precision power meter



Power consumption of ¼ A64FX prototype system

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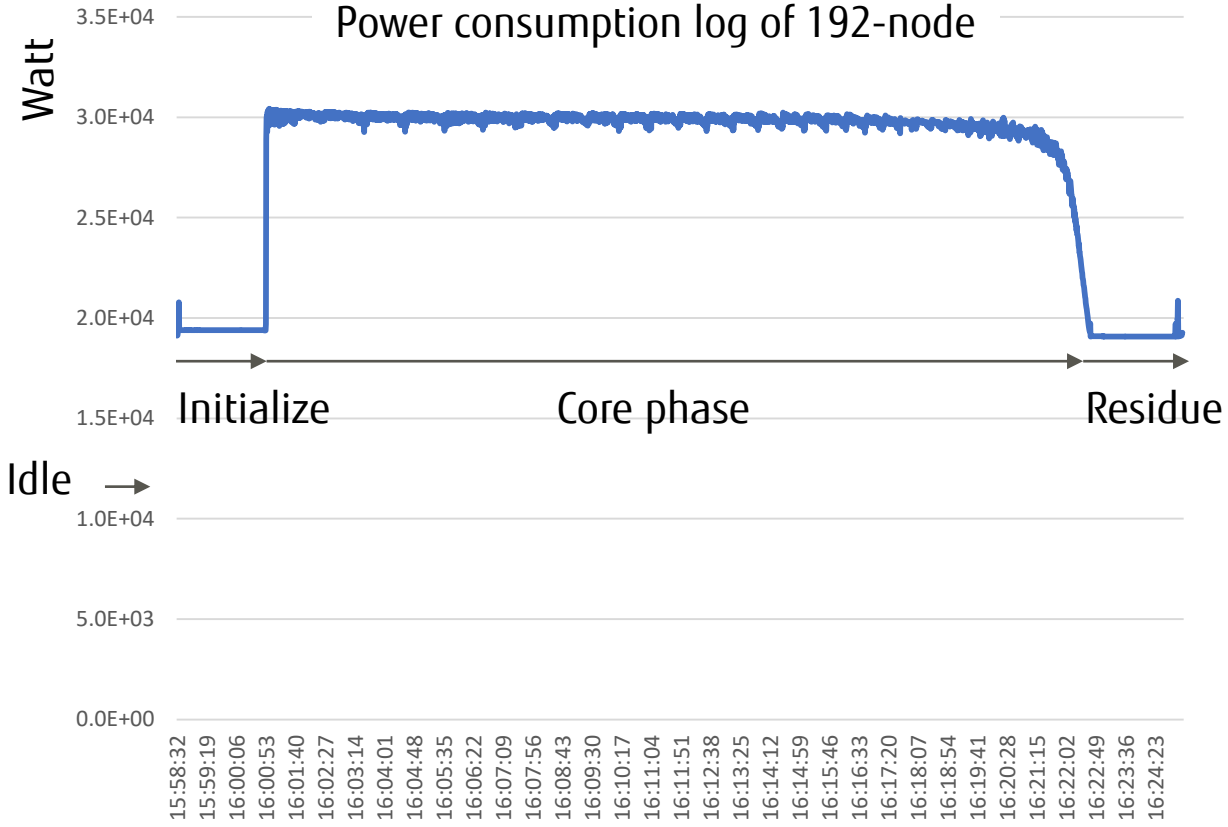
- Steady and high efficient computation are observed even from the point of power consumption
- Ave. of core phase:

  118.48 kW / system
- Idle power:

  46.92 kW / system



Supercomputer Fugaku named after Mt. Fuji

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- Highest mountain (performance)
- Very broad gradual slopes (applications and users)

Fugaku「富岳」

Focus	Approach
Application performance	Co-design w/ application developers and Fuji high memory bandwidth utilizing HBM2
Power efficiency	Leading-edge Si-technology, Fujitsu's proven performance logic design, and power-control
Usability	Arm®v8-A ISA with Scalable Vector Extension Linux

New PRIMEHPC Lineup

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PRIMEHPC FX1000

Supercomputer optimized for large scale computing

High Scalability **High Density** **Superior power efficiency**

A64FX processor
384 nodes/Rack
Tofu-D Interconnect
Water Cooling
Fujitsu Software Stack
for Supercomputing

PRIMEHPC FX700

Supercomputer based on standard technologies

Ease to use **Installation**

A64FX Processor
8 nodes/2U Rackmount
InfiniBand
Air Cooling
Utilize ISV and Open Source Software Stack

Cray to ship Fujitsu A64FX, announced Nov. 12, 2019

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INTRODUCING THE CRAY CS500 - FUJITSU A64FX ARM SERVER

- Next generation Arm® solution enabled through Cray Fujitsu Technology Agreement
- Builds on Cray and Fujitsu strong history with vector processing and supercomputing
- Supported in Cray CS500 infrastructure including Cray Programming Environment
- Leadership performance for many memory intensive HPC applications
- Provides customers with more choice and flexibility
- GA in mid'2020

Courtesy of Cray

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Towards the future

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- Energy saving is primary social issue for the future, even now
  - Greenness is not only for the environment but also for good economy
  - Power consumption or cost of electricity is a major part of TCO of supercomputer
- Be more conscious for the supercomputer power consumption
  - Green500 is the good benchmark and will be more important
  - TOP500 better to ask to submit power consumption mandatory
    - To raise the bottom and recognition, only 43% systems report the power consumption now

Summary

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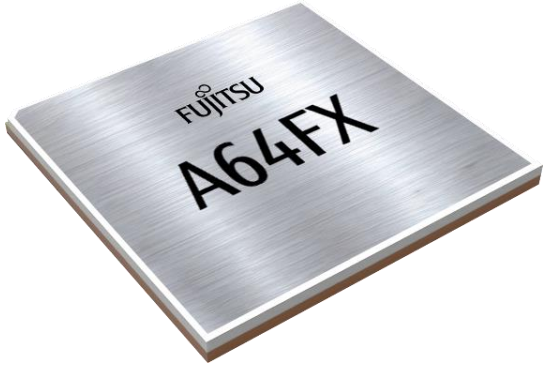
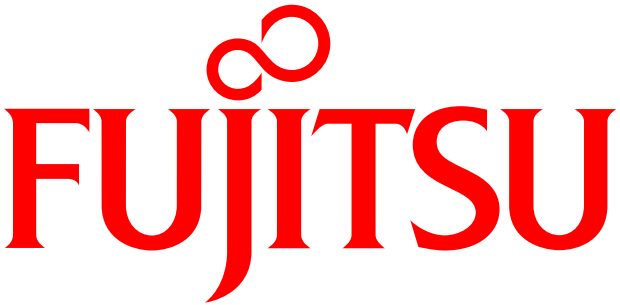
- A64FX prototype @ SC19
  - #1 @ Green500: Highest energy efficiency 16.876 GF/W, power quality level 2
  - #159 @ TOP500: High calc. efficiency 84.75% with small Nmax 1,576,960
- General purpose A64FX CPU will be widely used by many customers from Fujitsu directly and through many partners
  - Supercomputer Fugaku
  - Cray CS500
  - Fujitsu PRIMEHPC FX1000 / FX700
- Please come to Green500 BoF tomorrow





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