

The First arm-based HPC processor

A64FX

- designed by Fujitsu

Architecture
and
Achievements



Performance and Advantages from Hardware Design

Memory, NIC and PCIe are integrated into a chip.

→ High-memory BW and superior power efficiency are achieved.

Peak Memory BW	1,024 GB/s
----------------	------------

Power efficiency	16.876 GF/W (HPL, @2.0GHz)
------------------	----------------------------

Peak Performance	2.7+ TFLOPS
------------------	-------------

Hardware Specifications

Process Technology	7 nm FinFET
--------------------	-------------

# of Cores	48 + 0/2/4
------------	------------

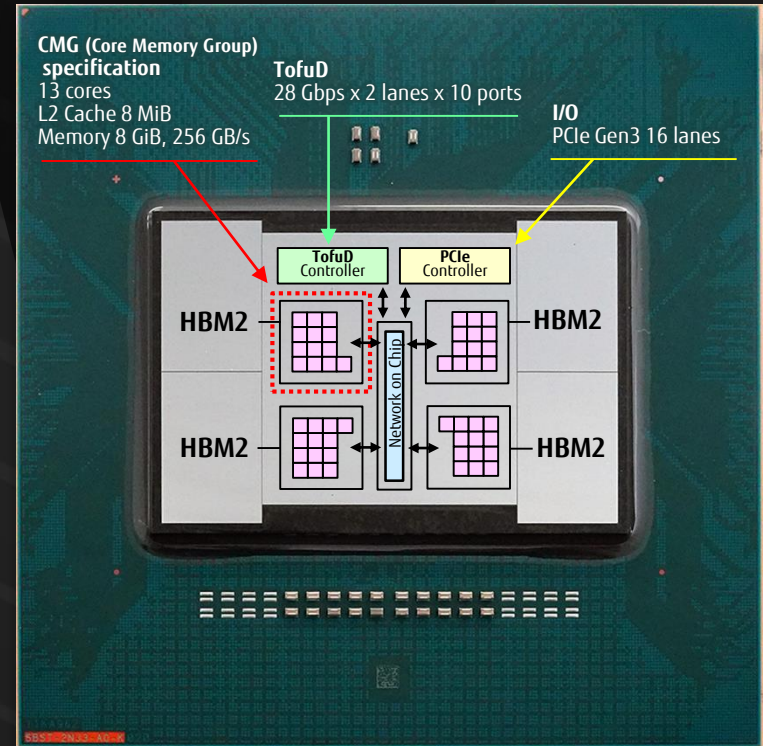
Memory / Capacity	HBM2 / 32 GiB (8 GiB × 4 stacks)
-------------------	----------------------------------

PCIe	Gen 3 / 16 lanes
------	------------------

Interconnect	Tofu Interconnect D
--------------	---------------------

	6D mesh/torus
--	---------------

	Chip-integrated NIC
--	---------------------



Performance and Advantages from Hardware Design

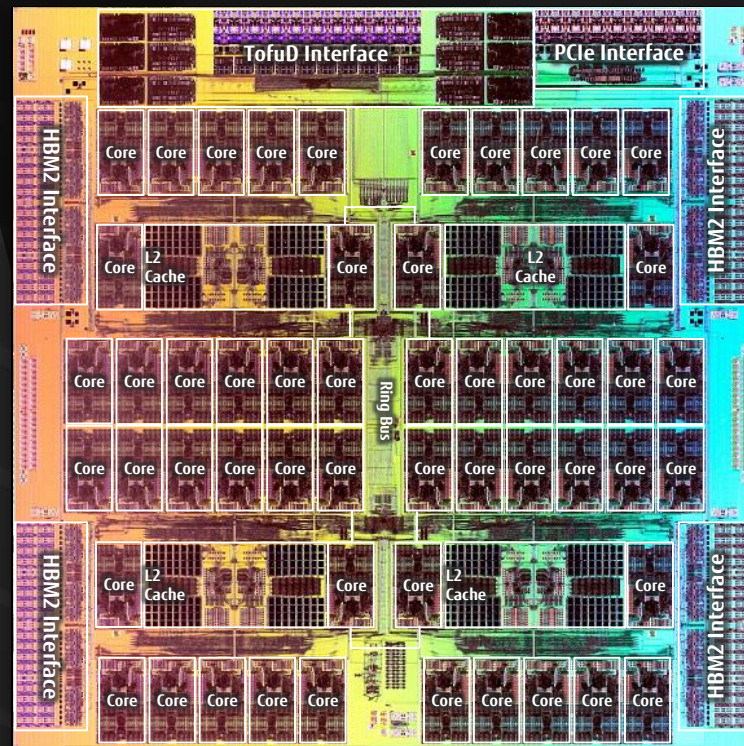
Memory, NIC and PCIe are integrated into a chip.

→ High-memory BW and superior power efficiency are achieved.

Peak Memory BW	1,024 GB/s
Power efficiency	16.876 GF/W (HPL, @2.0GHz)
Peak Performance	2.7+ TFLOPS

Hardware Specifications

Process Technology	7 nm FinFET
# of Cores	48 + 0/2/4
Memory / Capacity	HBM2 / 32 GiB (8 GiB × 4 stacks)
PCIe	Gen 3 / 16 lanes
Interconnect	Tofu Interconnect D
	6D mesh/torus
	Chip-integrated NIC




Green500 #1 on the List

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 measured.

TOP500						
Rank	Rank	System	Cores	Rmax (TFlop/s)	Power (kW)	Power Efficiency (GFlops/watt)
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 / Exascale 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

- 
- A64FX prototype - Fujitsu A64FX 48C 2GHz ranked #1 on the list
 - 768x general purpose A64FX CPUs w/o accelerators
 - 1.9995 PFLOPS @ HPL, 84.75%
 - 16.876 GF/W
 - Power quality level 2

A64FX: High Performance also in the AI Area.



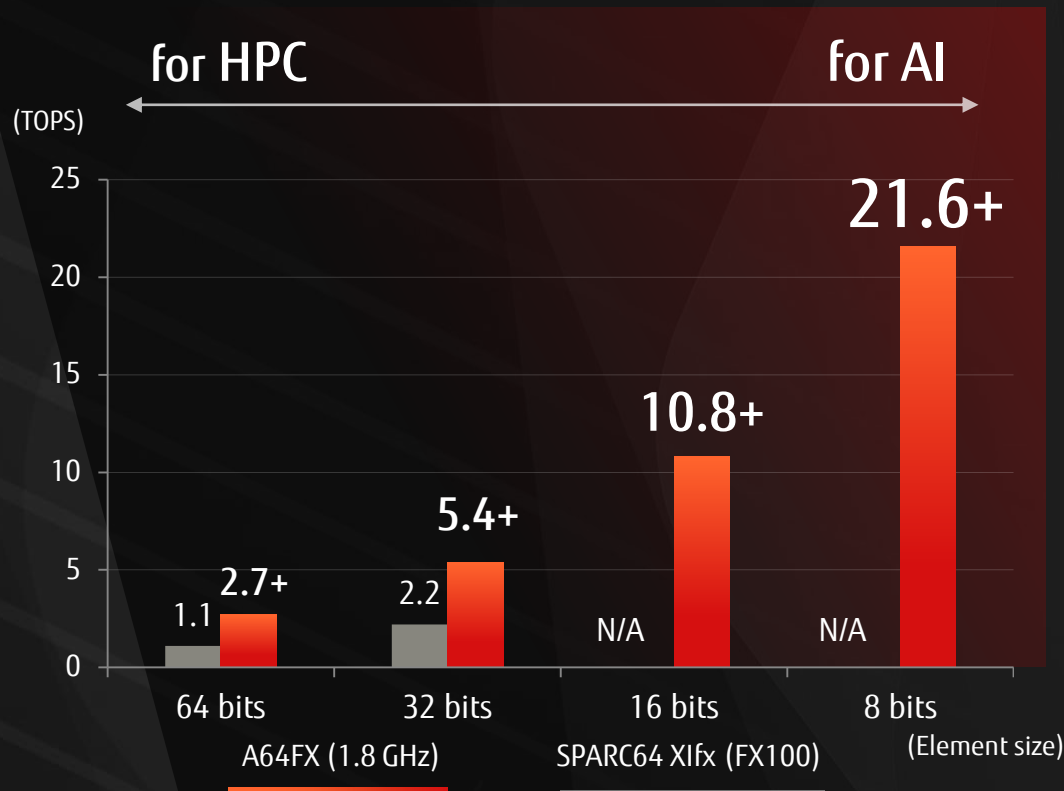
- Armv8.2-A & SVE

512-bit wide SIMD

- Supports a wide

variety of precisions.

- FP64/32/16, INT64/32/16/8



Scalable Vector Extensions for Future Continuity

The SVE enables implementation choices for vector lengths

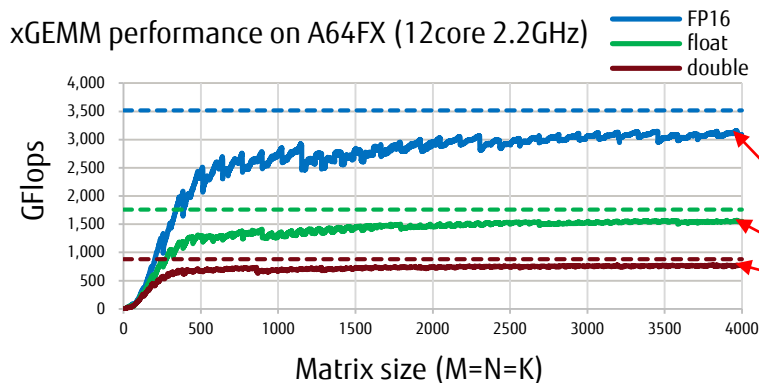
- Providing the vector-length agnostic programming model
- Avoiding the need to recompile or rewrite when longer vectors appear in the future

Sophisticated Arm SVE Instructions

Fujitsu contributed to the specifications

- Per-lane predication
- Gather-load and scatter-store
- HPC-focused instructions
e.g. Reciprocal inst., Math. acceleration inst., etc.

Applicabilities of SVE are proven

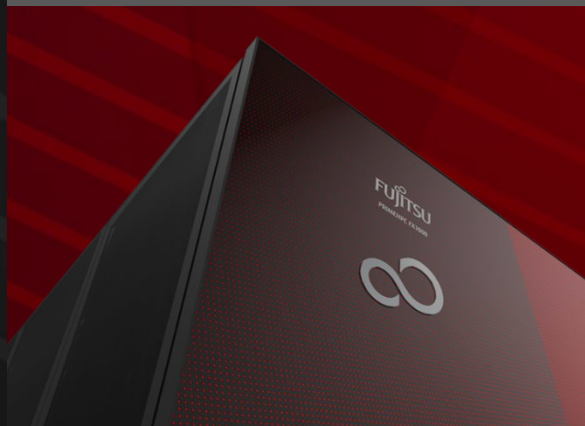


The vector-length agnostic kernel of xGEMM achieved over 90% of the peak performance in each precision for big matrices

A64FX for Everyone



For Fujitsu Products



Used in Fujitsu
high-end computing servers
FX1000/FX700

For Partners



Open the door
to all partners

For Arm Ecosystem



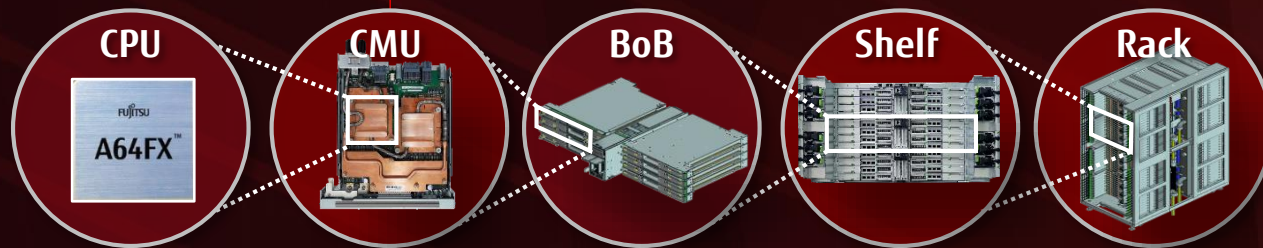
Building the
Arm HPC ecosystem

A64FX in Fujitsu Products : FX1000



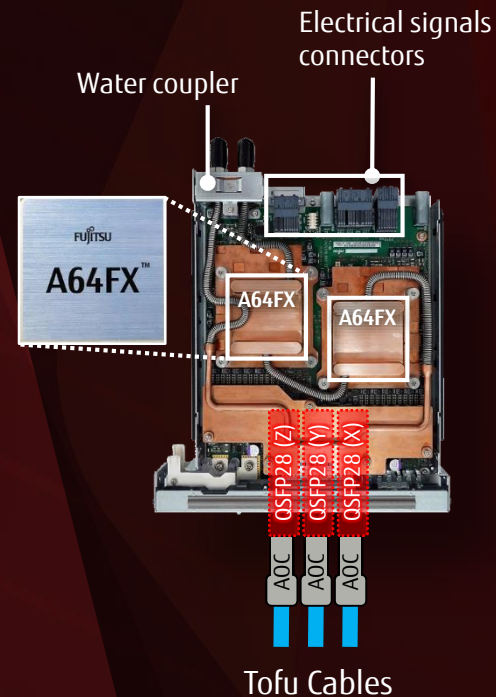
High-density hardware design

- 2 CPUs are accommodated in a CMU
- 100% direct water cooling
- Single-sided blind mate connectors for electrical signals and water



384 CPUs are accommodated in a rack

Achieve 1PF/rack



A64FX in Fujitsu Products : FX700



- High-performance Arm server featuring the A64FX CPU

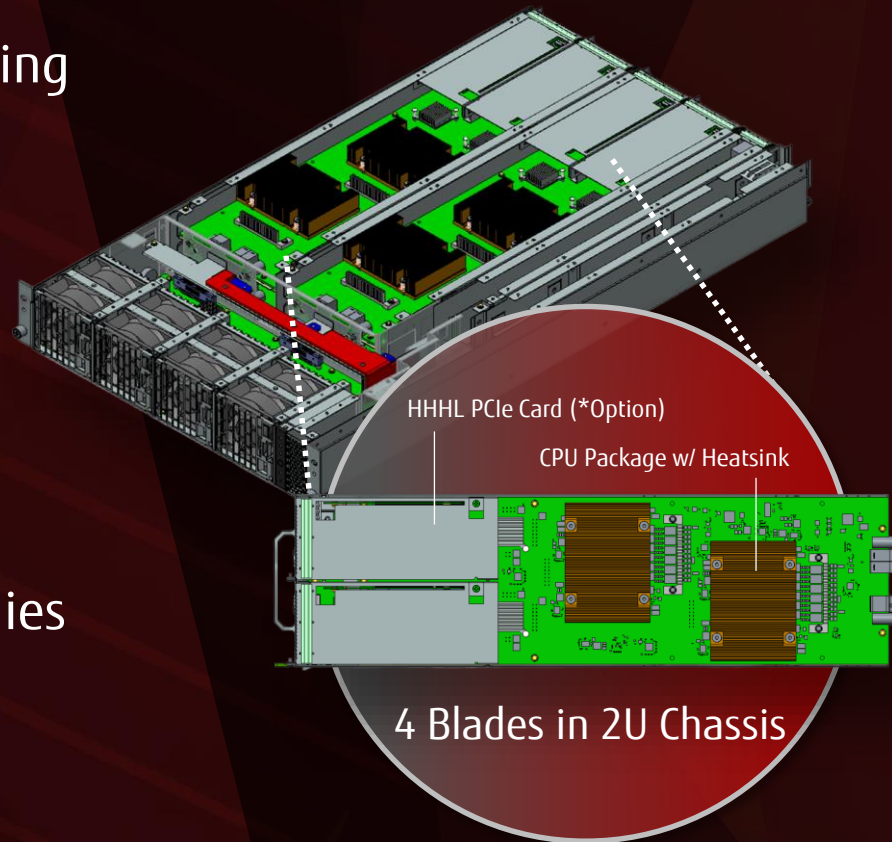
- Same CPU as Fugaku and FX1000

- Easy deployment and flexible configuration

- Air-cooled, 2U rack-mountable chassis
- From 2 to 8 CPUs per chassis

- Utilize open and standard technologies

- InfiniBand
- RHEL 8, OpenHPC, Bright Cluster Manager, etc.

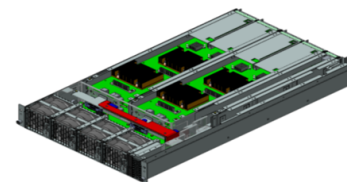


Cray to ship Fujitsu A64FX announced Nov. 12



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



Building the Arm HPC Ecosystem



Fujitsu collaborates closely with partners and communities to contribute to the prosperity of the Arm HPC Ecosystem making Arm system easy-to-use



Hardware

Providing high performance and efficient HPC processors and servers

Middleware

Porting and optimizing HPC software stacks

Application

Porting and tuning HPC applications

OSS Build Verification on the aarch64

FUJITSU



RIKEN and Fujitsu verify Spack's 3000+ recipes with multiple compilers

Spack is a package manager for supercomputers



- The verification results are available on the RIKEN's web page

<https://postk-web.r-ccs.riken.jp/oss/public/>

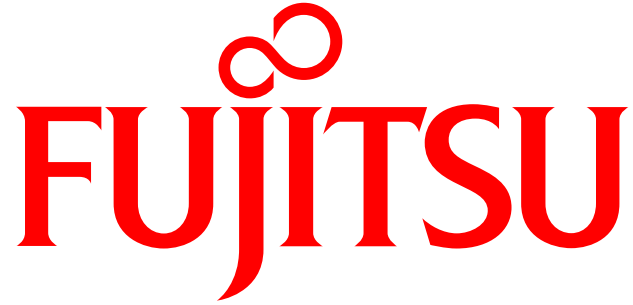


- Summary of results

- Spack version used: September 6, 2019
- Pull Requests made: RIKEN 47, Fujitsu 46

	Fujitsu Compiler (under development)	GNU GCC	LLVM Clang
Aarch64	2072/3451 (60.04%)	2387/3451 (69.17%)	288/3451 (8.35%)
X86	N/A	2479/3451 (71.83%)	768/3574 (21.49%) #

Spack version: October 31 2019



shaping tomorrow with you