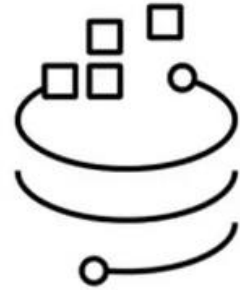


IBM Storage Scale on ARM CPU Technology News and Roadmap

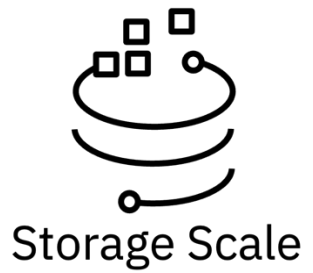
IBM Storage Scale User Group
Heidelberg
March 19, 2025

Ingo Meents
IT Architect
Storage Scale Development



Storage for
Data and AI

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Why ARM?



- Advanced RISC Machine
- Processor design licensed from ARM limited
- Simple RISC architecture, 32 and 64 bit
- Efficiency: embedded, mobile devices
- Growing into HPC, AI, ML

<https://www.arm.com/markets/computing-infrastructure/high-performance-computing>



TOP 500 list
Fugaku super computer

<https://www.top500.org/system/179807/>



European
Processor Initiative

<https://www.european-processor-initiative.eu/>



Grace-CPU
DPU

<https://www.nvidia.com/de-de/data-center/grace-cpu/>



AWS
Graviton 2 and 3

<https://aws.amazon.com/de/ec2/graviton/>

Fugaku super computer

<https://www.top500.org/system/179807/>

List	Rank	System	Vendor	Total Cores	Rmax (PFlop/s)	Rpeak (PFlop/s)	Power (kW)
11/2024	6	Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D	Fujitsu	7,630,848	442.01	537.21	29,899.23
06/2024	4	Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D	Fujitsu	7,630,848	442.01	537.21	29,899.23
11/2023	4	Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D	Fujitsu	7,630,848	442.01	537.21	29,899.23
06/2023	2	Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D	Fujitsu	7,630,848	442.01	537.21	29,899.23
11/2022	2	Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D	Fujitsu	7,630,848	442.01	537.21	29,899.23
06/2022	2	Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D	Fujitsu	7,630,848	442.01	537.21	29,899.23
11/2021	1	Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D	Fujitsu	7,630,848	442.01	537.21	29,899.23
06/2021	1	Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D	Fujitsu	7,630,848	442.01	537.21	29,899.23
11/2020	1	Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D	Fujitsu	7,630,848	442.01	537.21	29,899.23
06/2020	1	Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D	Fujitsu	7,299,072	415.53	513.85	28,334.50



Alps

<https://www.top500.org/system/180259/>

List	Rank	System	Vendor	Total Cores	Rmax (PFlop/s)	Rpeak (PFlop/s)	Power (kW)
11/2024	7	HPE Cray EX254n, NVIDIA Grace 72C 3.1GHz, NVIDIA GH200 Superchip, Slingshot-11, HPE Cray OS	HPE	2,121,600	434.90	574.84	7,124.00
06/2024	6	HPE Cray EX254n, NVIDIA Grace 72C 3.1GHz, NVIDIA GH200 Superchip, Slingshot-11	HPE	1,305,600	270.00	353.75	5,194.00

Note: Systems exploiting ARM processors, not necessarily Scale

Top 500: Nov 24, Processor generation

IBM Storage for Data and AI



	Processor Generation	Count	System Share (%)	Rmax (GFlops)	Rpeak (GFlops)	Cores
1	AMD Zen-3 (Milan)	71	14.2	2,800,456,750	4,043,863,695	25,527,824
2	Xeon Gold 62xx (Cascade Lake)	70	14	266,621,090	506,973,014	6,673,752
3	AMD Zen-2 (Rome)	61	12.2	699,207,000	976,208,256	11,495,184
4	Xeon Platinum (Sapphire Rapids)	57	11.4	1,865,189,440	2,792,332,744	8,558,232
5	Xeon Gold (Skylake)	42	8.4	132,229,890	226,964,260	3,169,028
6	Xeon Platinum 83xx (Ice Lake)	35	7	421,598,380	607,804,680	4,969,236
7	Xeon Platinum 82xx (Cascade Lake)	32	6.4	124,531,650	222,585,260	2,618,512
8	AMD Zen-4 (Genoa)	30	6	2,341,574,600	3,594,181,890	15,665,648
9	Intel Xeon E5 (Broadwell)	17	3.4	61,314,194	74,758,062	1,912,180
10	Xeon Platinum (Skylake)	13	2.6	92,817,998	133,786,221	1,616,212
11	NVIDIA Grace	9	1.8	768,594,000	1,031,628,340	3,796,848
12	Intel Xeon E5 (Haswell)	9	1.8	47,788,060	65,587,808	1,381,020
13	Fujitsu A64FX	9	1.8	534,794,900	646,034,527	9,183,744

ARM Neoverse Family

Group of 64-bit ARM processor cores intended for datacenter, edge computing, and high-performance computing

Neoverse Series	Intended Usage	Level	Instruction Set	Examples
Neoverse N-series (scale out performance)	data center usage	N1	ARMv8.2-A	Ampere Altra (2-socket 80 cores) AWS Graviton2 (64 cores) Huawei Kunpeng 920
		N2	ARMv9.0-A	Alibaba Yitian 710
Neoverse E-series (efficient throughput)	edge computing	E1	ARMv8.2-A	
		E2	ARMv9.0-A	
Neoverse V-series (max performance)	high performance computing	V1	ARMv8.4-A	AWS Graviton3 (64 cores) Center for Dev of Advanced Computing (C-DAC) AUM
		V2	ARMv9.0-A	Nvidia Grace (144 cores) AWS Graviton 4 Google Axion
A64FX, Fujitsu	HPC		Armv8.2-A + SVE	Supercomputer Fugaku



V3 announced
in fall 2024

This is a general list of where ARM can be found, how it can be categorized and some examples. This is not a Scale support list.

NVIDIA ARM HPC Developer Kit Server - Ampere® Altra® Max ARM Server

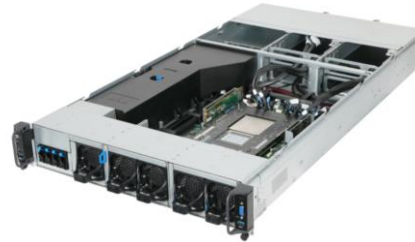
- Single socket Ampere® Altra® Max or Altra® Processor
- Up to 2 x NVIDIA® A100 PCIe Gen4 GPU cards
- Up to 2 x NVIDIA® BlueField-2 DPUs
- 8-Channel RDIMM/LRDIMM DDR4, 16 x DIMMs



*Our development
& test platform*

QuantaGrid S74G-2U

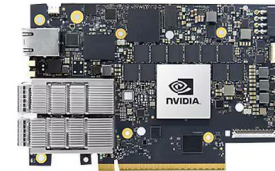
- NVIDIA GH200 Grace™ Hopper™ Superchip
- NVIDIA Grace™ 72 Arm® Neoverse V2 cores
- 1 Processor
- NVIDIA® NVLink®-C2C 900GB/s
- 3 PCIe 5.0 x16 FHFL Dual Width slots



Grace Hopper

Blue Field3 DPU

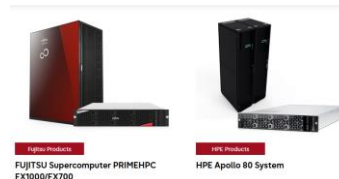
- Up to 16 Armv8.2+ A78 Hercules cores (64-bit)
- 16GB on-board DDR5



DPU

CPU Fujitsu A64FA

<https://www.fujitsu.com/global/products/computing/servers/supercomputer/a64fx/>



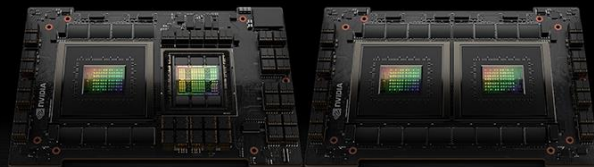
AWS Graviton-Prozessor in Amazon EC2

<https://aws.amazon.com/de/ec2/graviton/>



NVIDIA Grace CPU

Purpose-built to solve the world's largest computing problems.



Grace Grace Super Chip
Grace Hopper Super Chip

NVIDIA GB200 NVL72

The NVIDIA GB200 Grace Blackwell Superchip combines two NVIDIA Blackwell Tensor Core GPUs and a Grace CPU and can scale up to the GB200 NVL72, a massive 72-GPU system connected by NVIDIA® NVLink®, to deliver 30X faster real-time inference for large language models.

[Learn More >](#)

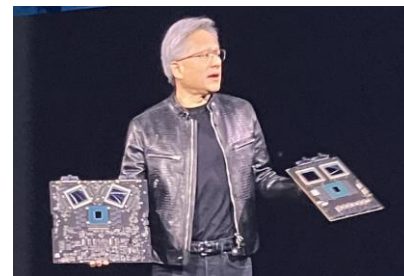
[Read the Press Release >](#)



Grace Blackwell Super Chip
announced in March
at GTC24

<https://www.nvidia.com>

Grace = ARM CPU where our clients runs
Hopper or Blackwell = GPU where we can put data with GDS

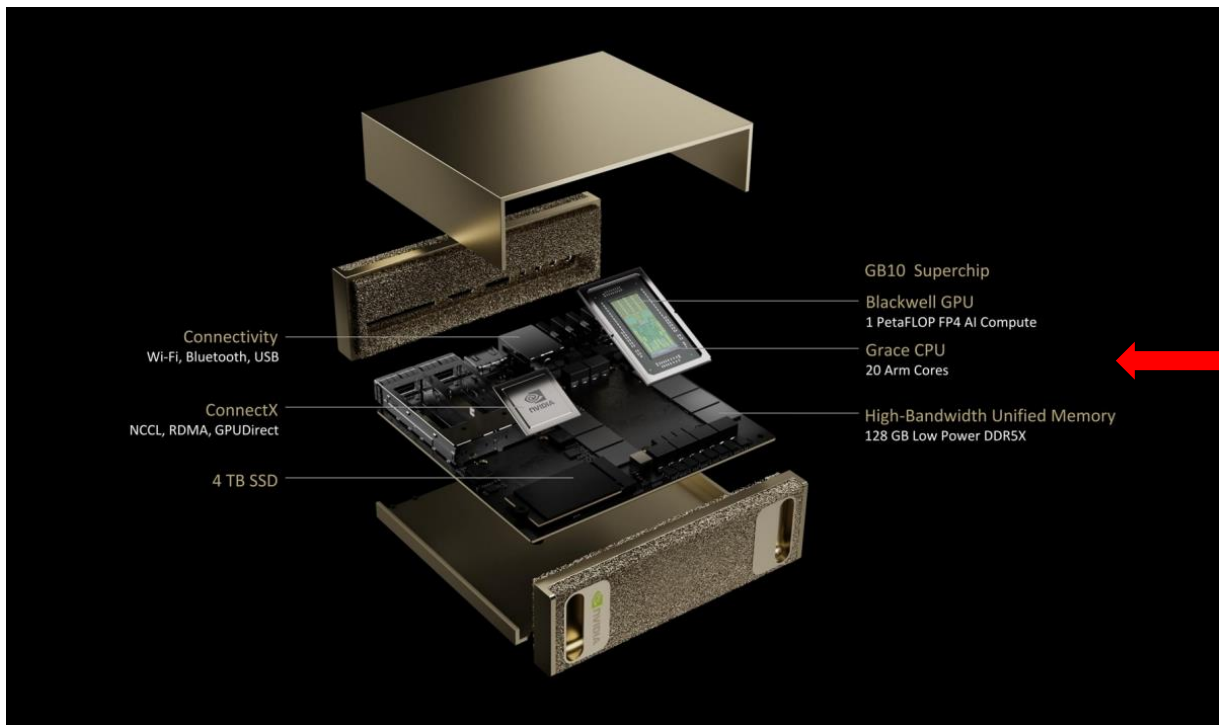


Grace Blackwell & Grace Hopper

Nvidia Project DIGITS

IBM Storage for Data and AI

CES announcement 2025



ARM GPU

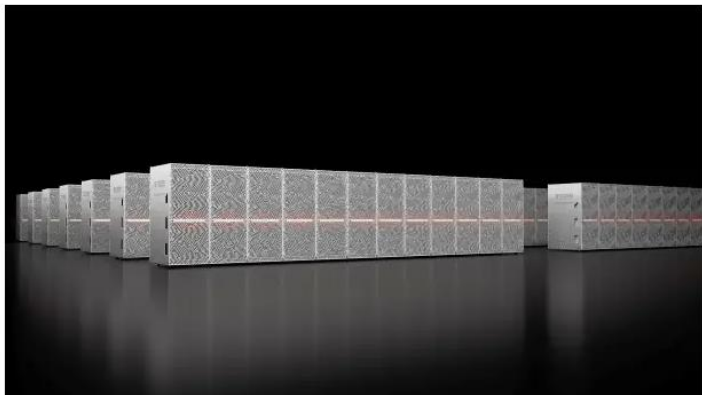
<https://www.nvidia.com/en-us/project-digits/>

Jupiter becomes the first German exaflops supercomputer

FZ Jülich explains how Jupiter 2024 combines the EU processor Rhea1, US technology from Nvidia and British ARM calculation cores.

Reading time: 3 min.  Save in Pocket

   8



The exaflops supercomputer Jupiter at FZ Jülich (Image: Nvidia/Eviden)

Jupiter is equipped from 2024 and consists of two parts: Jupiter Booster and Jupiter Cluster. The latter consists of more than 1300 nodes, in which the European ARM processor SiPearl Rhea1 is stuck.

Booster power

In Jupiter Booster, around 6000 knots with four Nvidia Grace Hopper GH200s deliver about 1 FP64 flops. For AI algorithms that get by with only 8 bit accuracy, up to 93 eFlops are even ready – and a gigantic 2.3 petabyte of super-fast HBM3e storage.

The new quad GH200 modules from Nvidia are used in Jupiter. Each H100 chip (hopper) controls 96 GByte HBM3e-RAM with up to 4 TByte/s. For the 72 ARM cores of each Grace chips, 120 GB of LPDDR5X RAM with up to 500 GB/s are available. The H100 GPUs can also use this memory.

Jupiter is also equipped with 21 petabytes of fast mass storage, with 40 IBM Elastic Storage Servers 3500 with NVMe SSDs. Together, they should provide data transfer rates of up to 4 TByte/s when reading and 3 TByte/s when writing.



Quadruple module Nvidia Quad GH200 with four Grace and Hopper chips each, which are networked with each other. (Image: Nvidia)

Quad Nvidia ConnectX-7 Cedar module

IBM Storage for Data and AI



BullSequana XH3515-HMQ

At Super Computing, Hamburg, 2024

Quad Nvidia ConnectX-7 Cedar module

4 CX-7, GH200
Liquid cooled

SE packages

```
-rwxr-xr-x 1 root root 128181750 Apr 19 01:38 Storage_Scale_Data_Access-5.2.0.0-aarch64-Linux-install
-rw-r--r-- 1 root root          90 Apr 19 01:38 Storage_Scale_Data_Access-5.2.0.0-aarch64-Linux-install.md5
-rwxr-xr-x 1 root root 137226406 Apr 19 01:38 Storage_Scale_Data_Management-5.2.0.0-aarch64-Linux-install
-rw-r--r-- 1 root root          94 Apr 19 01:38 Storage_Scale_Data_Management-5.2.0.0-aarch64-Linux-install.md5
```

RHEL

```
gpfs_rpms/gpfs.license.dm-5.2.0-0.aarch64.rpm
gpfs_rpms/gpfs.crypto-5.2.0-0.aarch64.rpm
gpfs_rpms/gpfs.compression-5.2.0-0.aarch64.rpm
gpfs_rpms/gpfs.gskit-8.0.55-19.1.aarch64.rpm
gpfs_rpms/gpfs.gpl-5.2.0-0.noarch.rpm
gpfs_rpms/gpfs.base-5.2.0-0.aarch64.rpm
```

Ubuntu

```
gpfs_debs/gpfs.compression_5.2.0-0_arm64.deb
gpfs_debs/gpfs.gpl_5.2.0-0_all.deb
gpfs_debs/gpfs.gskit_8.0.55-19.1_arm64.deb
gpfs_debs/gpfs.crypto_5.2.0-0_arm64.deb
gpfs_debs/gpfs.license.dm_5.2.0-0_arm64.deb
gpfs_debs/gpfs.base_5.2.0-0_arm64.deb
```

Included in the “new” licences

- data access edition
- data management edition

Not available in standard, advanced
and Erasure code editions

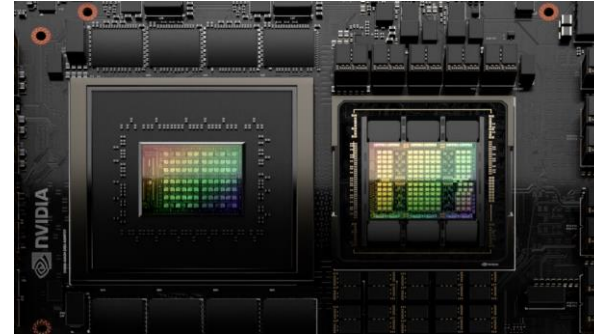
A Look At Grace Hopper

```
[root@fscg-ghv1-1 ~]# lscpu
Architecture:      aarch64
CPU op-mode(s):   64-bit
Byte Order:       Little Endian
CPU(s):           72
On-line CPU(s) list: 0-71
Vendor ID:        ARM
BIOS Vendor ID:   NVIDIA
BIOS Model name:  Grace A02
Model:            0
Thread(s) per core: 1
Core(s) per socket: 72
Socket(s):        1
Stepping:         r0p0
Frequency boost:   disabled
CPU max MHz:      3474.0000
CPU min MHz:      81.0000
BogoMIPS:         2000.00
Flags:             fp asimd evtstrm aes pmull sha1 sha2 crc32 atomics fphp asimdhp cpuid asimdrdm jscvt fcma lrcpc dcpop
                  sha3 sm3 sm4 asimdhp sha512 sve asimdfhm dit uscat ilrcpc flagm ssbs sb dcpodp sve2 sveaes svepmull sv
                  ebitperm svesha3 svesm4 flagm2 frint svei8mm svebf16 i8mm bf16 dgh

Caches (sum of all):
  L1d:            4.5 MiB (72 instances)
  L1i:            4.5 MiB (72 instances)
  L2:             72 MiB (72 instances)
  L3:            114 MiB (1 instance)

[root@fscg-ghv1-1 ~]# uname -a
Linux fscg-ghv1-1 5.14.0-284.30.1.el9_2.aarch64+64k #1 SMP PREEMPT_DYNAMIC Fri Aug 25 10:26:28 EDT 2023 aarch64 aarch64 aarch64 GNU/Linux

[root@fscg-ghv1-1 ~]# cat /etc/os-release | grep -i pretty
PRETTY_NAME="Red Hat Enterprise Linux 9.2 (Plow)"
```



<http://www.nvidia.com>

```
[root@fsc-ghv1-1 ~]# nvidia-smi
Mon Apr 22 16:36:02 2024
```

+-----+											
NVIDIA-SMI 550.54.14			Driver Version: 550.54.14				CUDA Version: 12.4				
+-----+											
GPU	Name		Persistence-M		Bus-Id	Disp.A	Volatile Uncorr. ECC				
Fan	Temp	Perf	Pwr:Usage/Cap		Memory-Usage		GPU-Util	Compute M.			
								MIG M.			
+-----+											
0	NVIDIA	GH200	480GB	Off		00000009:01:00.0	Off	0			
N/A	29C	P0	66W / 900W		1MiB / 97871MiB		6%	Default			
								Disabled			
+-----+											
+-----+											
Processes:											
GPU	GI	CI	PID	Type	Process name				GPU Memory		
		ID	ID					Usage			
+-----+											
No running processes found											
+-----+											

```
[root@fsc-ghv1-1 ~]# ofed_info -s
MLNX_OFED_LINUX-24.01-0.3.3.1:
```

```
[root@fsc-ghv1-1 ~]# gdsio -f /gpfs/gpfs1/foo -x0 -I1 -s1G -i4k -d0 -w8      # functional test against dummy storage
IoType: WRITE XferType: GPUD Threads: 8 DataSetSize: 1047476/1048576(KiB) IOSize: 4(KiB) Throughput: 0.905979 GiB/sec,
Avg_Latency: 33.545450 usecs ops: 261869 total_time 1.102620 secs
```

Some Major Porting Steps

- Adjust memory layout for ARM64 (shared segment, pagepool, token manager area, GNR area)
- Updates to “legacy” assembler code (memory barriers, atomic operations)
- Assembler optimizations for GPFS Mutexes (kernel & userspace, stats, debug/tracing)
- Hardware Interfaces (timer counter, memory management)
- Build system needs to account for new architecture (makefiles, packaging)
- Test tools need to be re-compiled / changed (unit, function, system & performance tests)
- Ksh – move to distro korn shell

Storage Scale on ARM - Timeline

- **5.1.9 / 5.1.9.1 Tech Preview (Nov 2023)**
 - RHEL 9.2. only
 - Some functional restrictions (client only, GDS, encryption, GUI, AFM, etc.)
- **5.2.0 Scale on ARM GA (April 2024)**
 - RHEL 9.3, Ubuntu 22.04
 - Client only, 4K & 64K kernels, most base scale functionality
 - Grace Hopper included
- **5.2.1 Scale on ARM 5.2.1 (August 2024)**
 - NSD server functionality
- **5.2.2.1**
 - RHEL 9.5 support – missed Ubuntu 24.04 support
- **Roadmap items**
 - ECE, AFM, BlueField-3 support
- **Currently not in plan**
 - Protocols, BDA / HDFS, CNSA, TCT, HSM

Any questions?

meents@de.ibm.com

Thank You

Special thanks to the team: Swen Schillig, Olaf Weiser, Ralph Würthner, Anthony Wong, Richard Zollo

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