DS 7347
High-Performance Computing (HPC) and Data Science
Session 4

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May 5, 2022

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Office of Information Technology
Center for Research Computing
Southern Methodist University

Outline

Session Question

Session Question

What HPC components can perform application-specific computations?

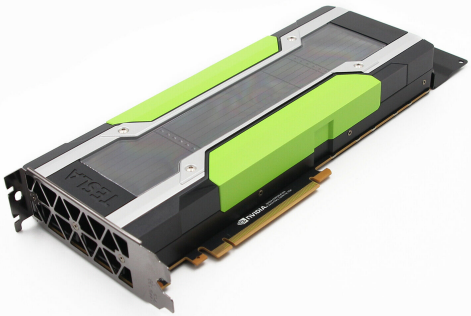
Accelerators

NVIDIA Tesla K80 with PCIe

- 4992 NVIDIA CUDA cores with a dual-GPU design
- 2.91 TFLOPS double-precision
- 8.73 TFLOPS single-precision
- 24 GB of GDDR5 memory
- 480 GB/s aggregate memory bandwidth
- ECC protection for increased reliability

NVIDIA Tesla P100 with PCIe

- 3584 NVIDIA CUDA cores
- 4.7 TFLOPS double-precision
- 9.3 TFLOPS single-precision
- 18.7 TFLOPS half-precision
- 16 GB HBM2
- 732 GB/s aggregate memory bandwidth
- 32 GB/s PCIe Gen3



NVIDIA Tesla P100 with NVLink

- 3584 NVIDIA CUDA cores
- 5.3 TFLOPS double-precision
- 10.6 TFLOPS single-precision
- 21.1 TFLOPS half-precision
- 16 GB HBM2
- 732 GB/s aggregate memory bandwidth
- 160 GB/s NVLink

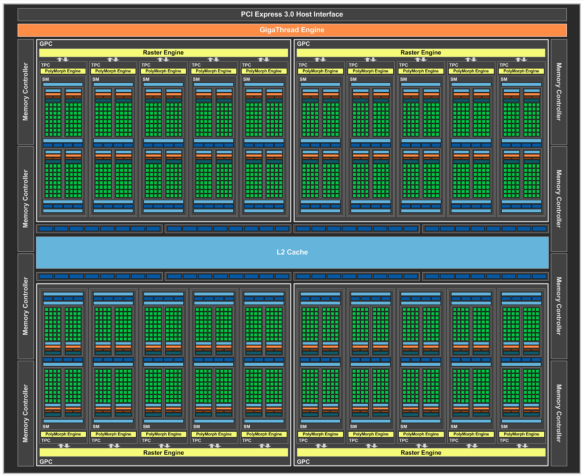
NVIDIA Tesla V100 with NVLink

- 5120 NVIDIA CUDA cores
- 640 NVIDIA Tensor Cores
- 7.8 TFLOPS double-precision
- 15.7 TFLOPS single-precision
- 125 TFLOPS half-precision
- 32 GB HBM2
- 900 GB/s aggregate memory bandwidth
- 160 GB/s NVLink

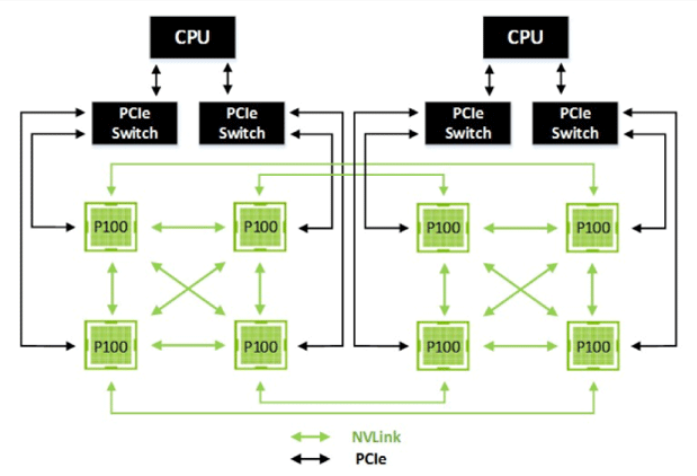
NVIDIA Tesla A100 with NVLink

- 6912 NVIDIA CUDA cores
- 432 NVIDIA Tensor Cores (Third Generation)
- 9.7 TFLOPS double-precision
- 19.5 TFLOPS double-precision (Tensor Cores)
- 19.5 TFLOPS single-precision
- Tensor Float (TF32): 312 dense, 624 sparse
- BFLOAT16: 312 dense, 624 sparse TFLOPS (Tensor Cores)
- INT8: 624, 1248 TOPS (Tensor Cores)
- 80 GB HBM2e
- 2039 GB/s aggregate memory bandwidth
- 600 GB/s NVLink

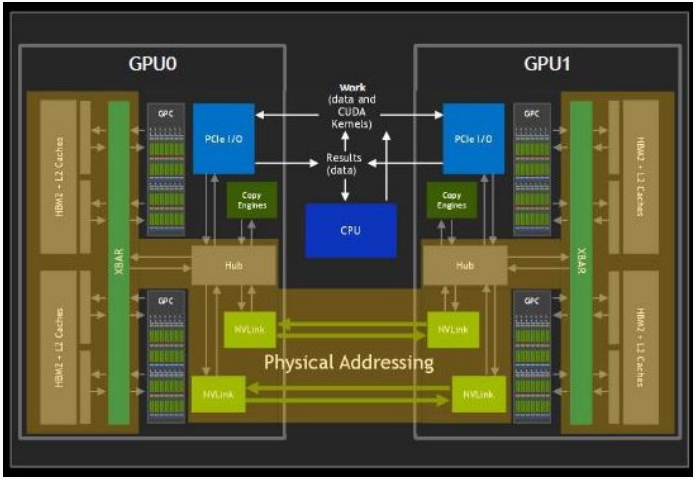
NVIDIA Tesla Block Diagram



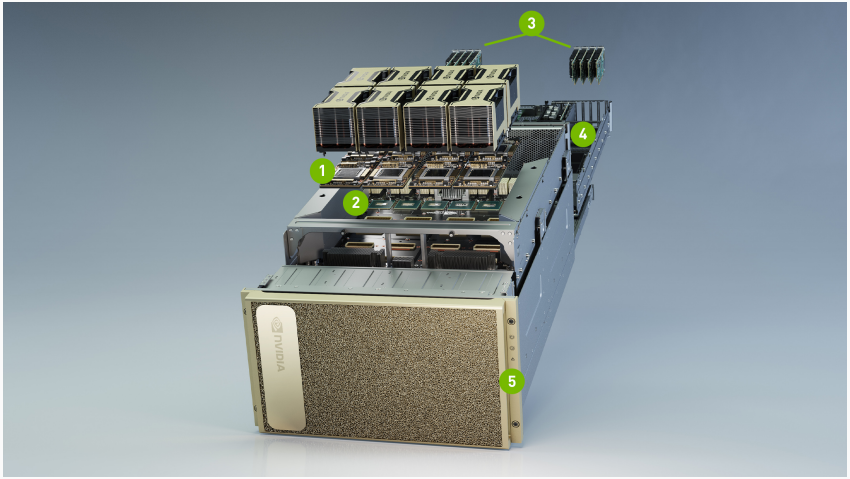
NVIDIA NVLink and PCIe



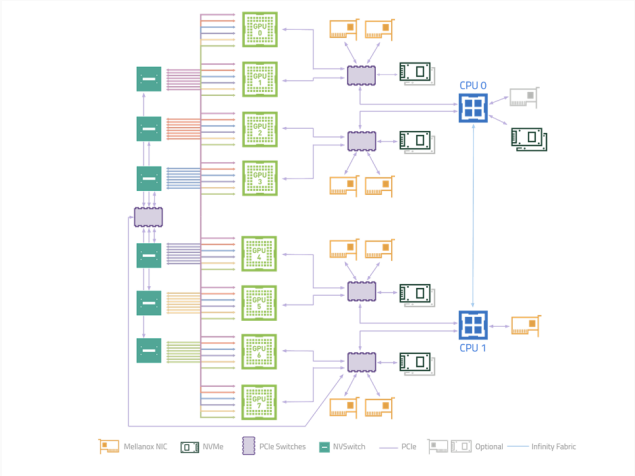
NVIDIA NVSwitch Shared Memory



NVIDIA SuperPOD DGX Node



NVIDIA SuperPOD DGX Node



Networks and Storage

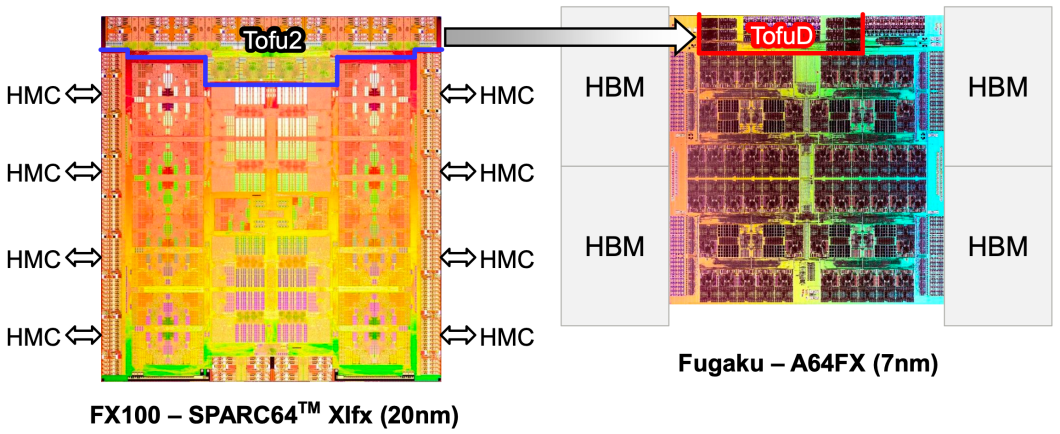
Common HPC Networks

- Management Networks (2): 1 Gb/s Ethernet
- Network File System (NFS) Network: 10 Gb/s Ethernet
- High-Performance Network: $>$ 50 Gb/s InfiniBand

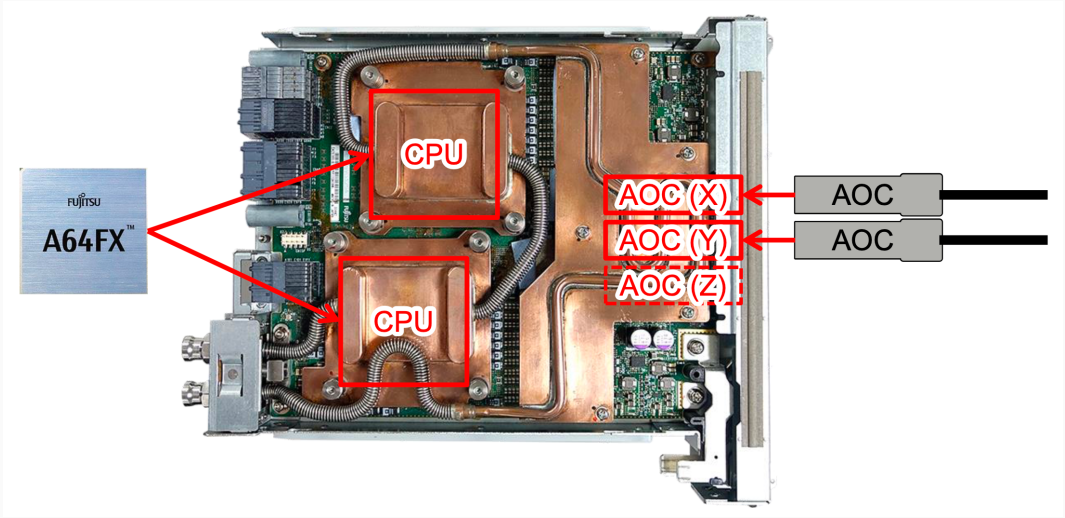
InfiniBand Generations

Connected with Four Links

- QDR: 32 Gb/s
- FHR: 54 Gb/s
- EDR: 100 Gb/s
- HDR: 200 Gb/s
- NDR: 400 Gb/s

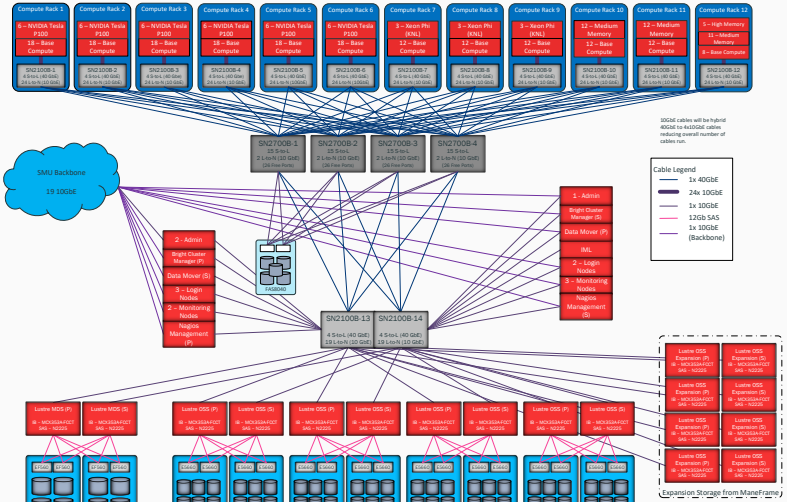

Tofu2
HMC
HMC
HMC
HMC
HMC
HMC
HMC
HMC
FX100 – SPARC64™ XIfx (20nm)
TofuD
HBM
HBM
HBM
HBM
Fugaku – A64FX (7nm)

Fugaku Node



NVIDIA Bluefield

M2 Network and Storage



Group Discussion

Items to Note for Path

- File systems
- Networks
- Interconnect
- Memory

Trace the Path

1. Run Python script from `$HOME`
2. Python script:
   - 2.1 Reads compressed data from files on `$WORK`
   - 2.2 Decompresses the data the CPU
   - 2.3 Performs computation on the data that generates intermediate data stored to `$SCRATCH`
   - 2.4 Launches computation on the GPU:
     - 2.4.1 Reads data "directly" from `$SCRATCH`
     - 2.4.2 Sends results back to Python script
   - 2.5 Writes data to `$HOME`

Readings and Assignments

Readings and Assignments

Readings

- Eijkhout chapter 22

Assignment

- Detail the CPU, GPU, memory, and hard drive for your own computer:
- CPU
  - Model
  - Number of cores
  - Instructure set architecture (ISA)
  - Notable vector extensions available
  - Cache sizes
- GPU
  - Model
  - Processing cores
  - Memory
  - Interconnect
- Memory
  - Speed
  - Size
- Hard drive
  - Size
  - Interconnect