

# Summit System Overview

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Hands-on with the Summit Supercomputer  
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ORNL is managed by UT-Battelle, LLC for the US Department of Energy



# OLCF Summit Overview

## The system includes

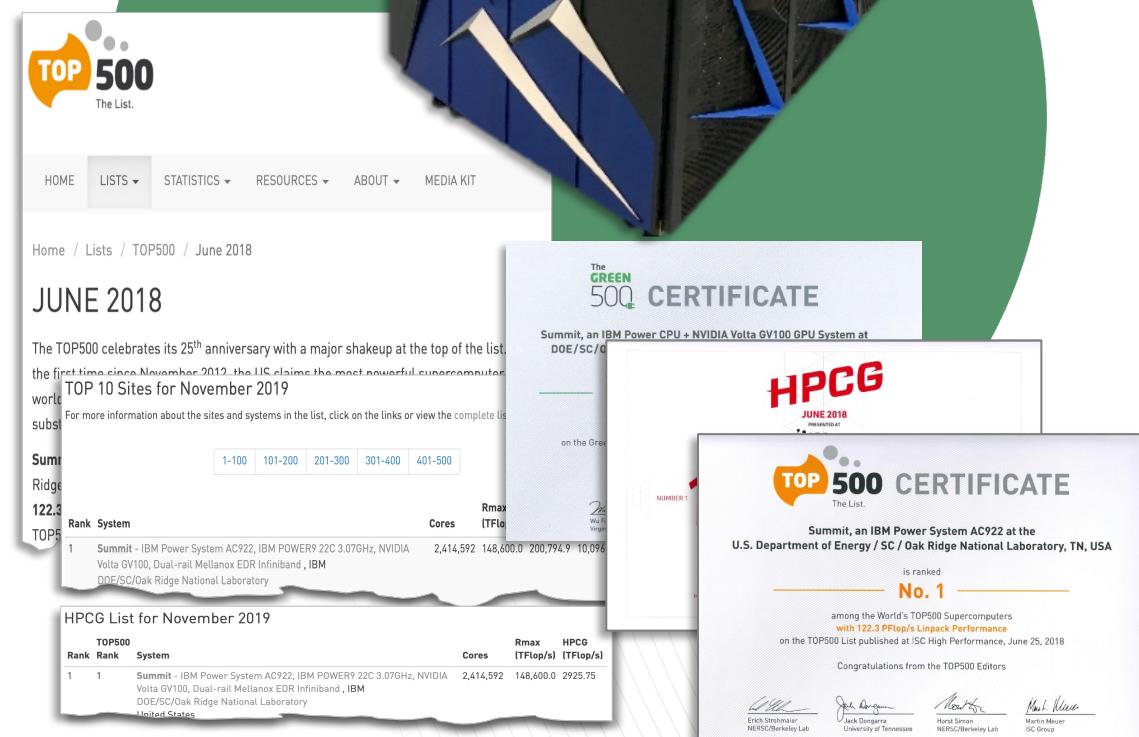
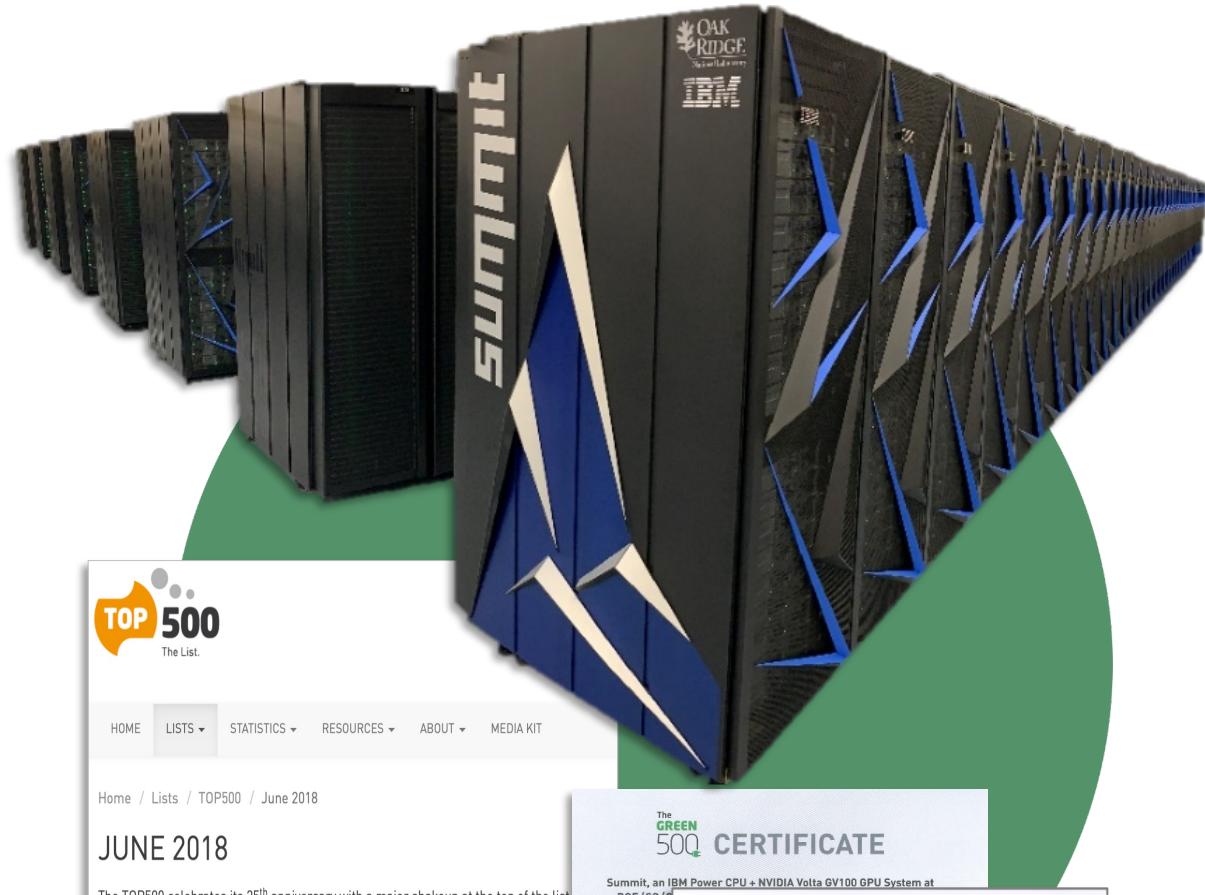
- 4,608 nodes
- Dual-port Mellanox EDR InfiniBand network
- 250 PB IBM file system transferring data at 2.5 TB/s

## System Performance

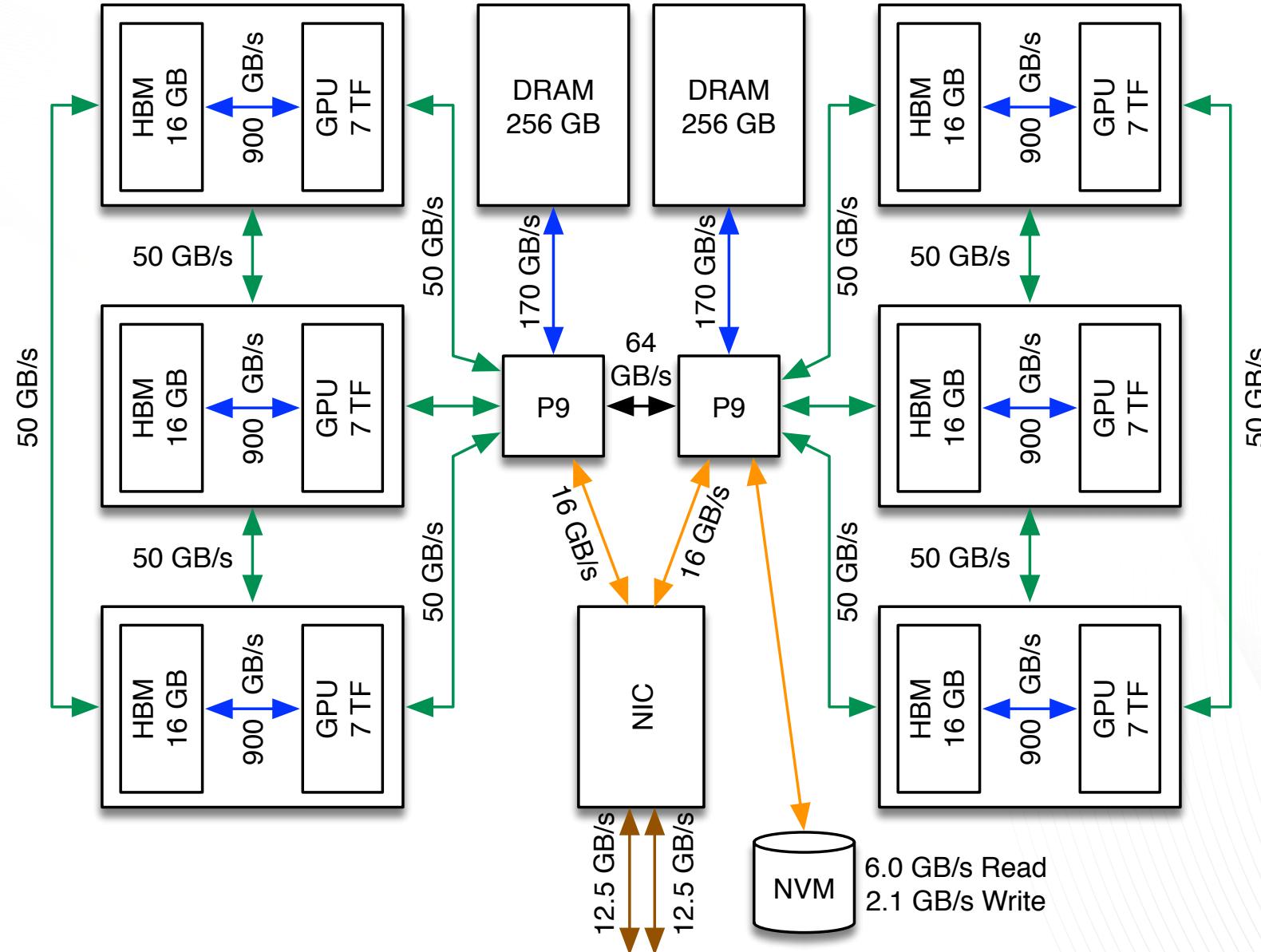
- Peak of 200 Petaflops (FP<sub>64</sub>) for modeling & simulation
- Peak of 3.3 ExaOps (FP<sub>16</sub>) for data analytics and artificial intelligence

## Each node has

- 2 IBM POWER9 processors
- 6 NVIDIA Tesla V100 GPUs
- 608 GB of fast memory (96 GB HBM2 + 512 GB DDR4)
- 1.6 TB of NV memory

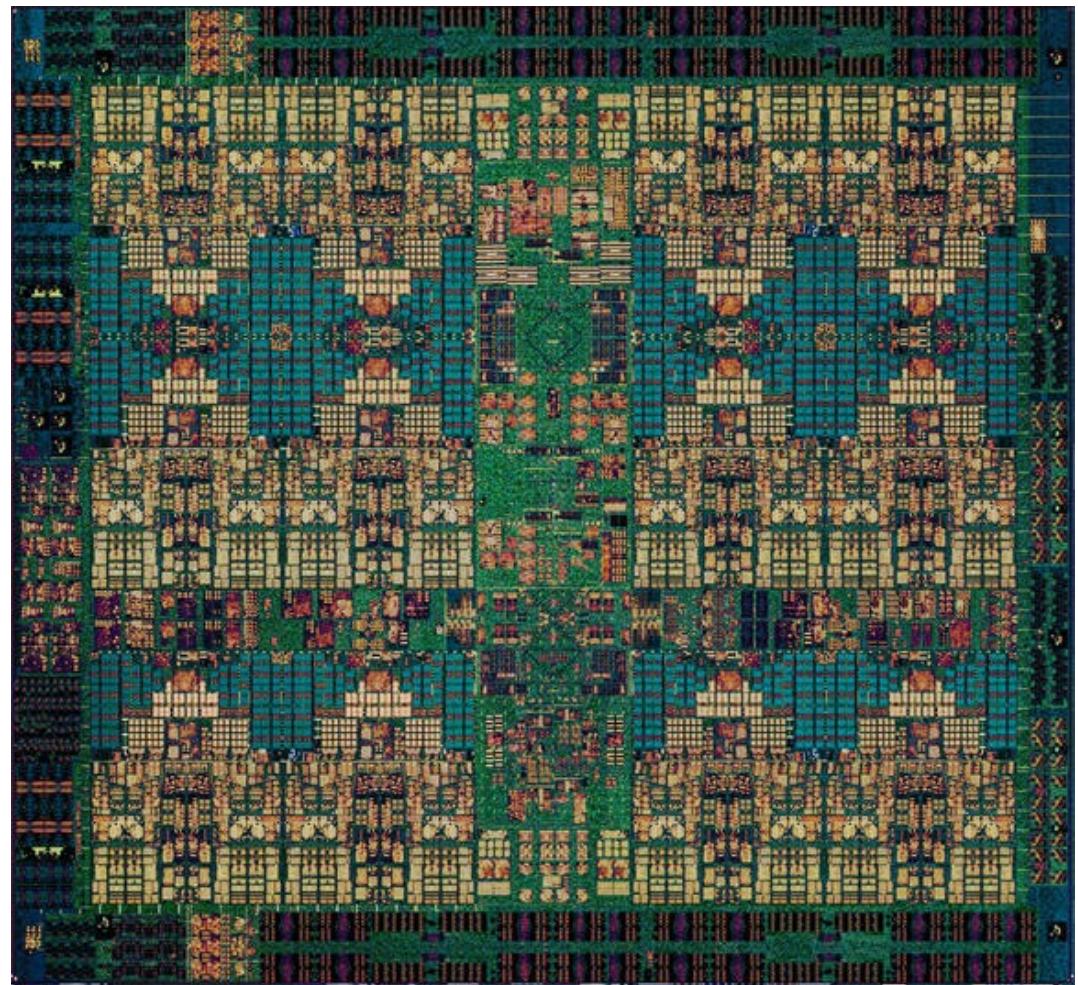


# Summit Node Schematic



# IBM Power9 Processor

- Summit's P9s: 22 cores (4 hwthreads/core)
- PCI-Express 4.0
  - Twice as fast as PCIe 3.0
- NVLink 2.0
  - Coherent, high-bandwidth links to GPUs
- 14nm FinFET SOI technology
  - 8 billion transistors
- Cache
  - L1I: 32 KiB (per core, 8-way set associative)
  - L1D: 32 KiB (per core, 8-way)
  - L2: 512 KiB (per pair of cores)
  - L3: 120 MiB eDRAM, 20-way (shared by all cores)



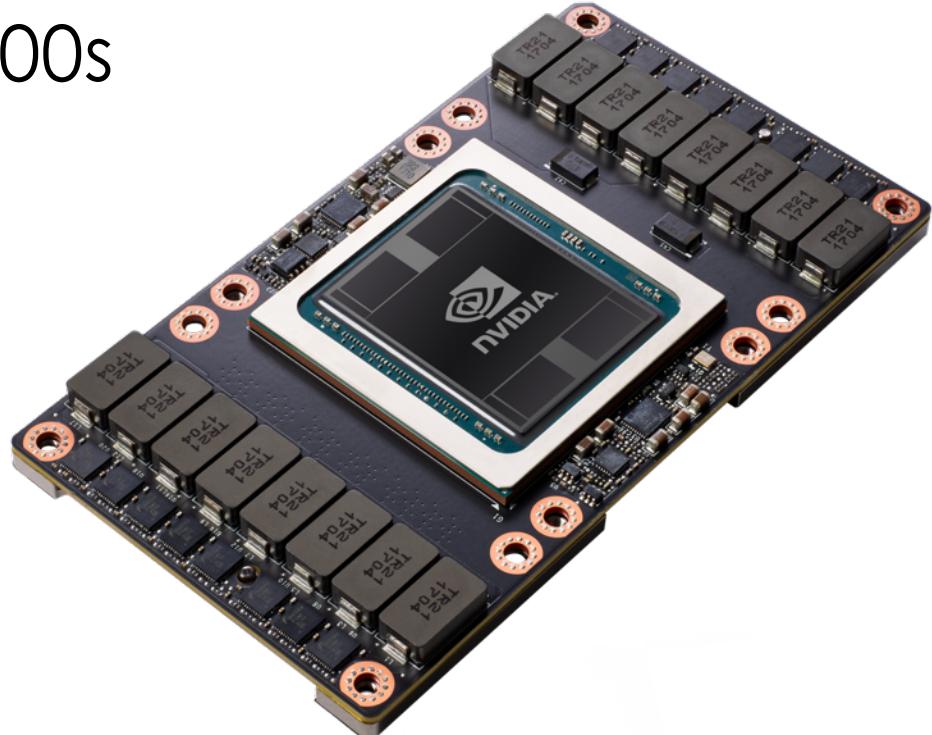
# Summit Contains 27,648 NVIDIA Tesla v100s

## Each Tesla v100 GPU has:

- 150+150 GB/s total BW (NVLink v2.0)
- 5,120 CUDA cores (64 on each of 80 SMs)
- 640 Tensor cores (8 on each of 80 SMs)
- 20MB Registers | 16MB Cache | 16GB HBM2 @ 900 GB/s
- 7.5 DP TFLOPS | 15 SP TFLOPS | 120 FP<sub>16</sub> TOPS
- Tensor cores do mixed precision multiply-add of 4x4 matrices

$$\mathbf{D} = \left( \begin{array}{cccc} \mathbf{A}_{0,0} & \mathbf{A}_{0,1} & \mathbf{A}_{0,2} & \mathbf{A}_{0,3} \\ \mathbf{A}_{1,0} & \mathbf{A}_{1,1} & \mathbf{A}_{1,2} & \mathbf{A}_{1,3} \\ \mathbf{A}_{2,0} & \mathbf{A}_{2,1} & \mathbf{A}_{2,2} & \mathbf{A}_{2,3} \\ \mathbf{A}_{3,0} & \mathbf{A}_{3,1} & \mathbf{A}_{3,2} & \mathbf{A}_{3,3} \end{array} \right) \text{FP16 or FP32} + \left( \begin{array}{cccc} \mathbf{B}_{0,0} & \mathbf{B}_{0,1} & \mathbf{B}_{0,2} & \mathbf{B}_{0,3} \\ \mathbf{B}_{1,0} & \mathbf{B}_{1,1} & \mathbf{B}_{1,2} & \mathbf{B}_{1,3} \\ \mathbf{B}_{2,0} & \mathbf{B}_{2,1} & \mathbf{B}_{2,2} & \mathbf{B}_{2,3} \\ \mathbf{B}_{3,0} & \mathbf{B}_{3,1} & \mathbf{B}_{3,2} & \mathbf{B}_{3,3} \end{array} \right) \text{FP16} + \left( \begin{array}{cccc} \mathbf{C}_{0,0} & \mathbf{C}_{0,1} & \mathbf{C}_{0,2} & \mathbf{C}_{0,3} \\ \mathbf{C}_{1,0} & \mathbf{C}_{1,1} & \mathbf{C}_{1,2} & \mathbf{C}_{1,3} \\ \mathbf{C}_{2,0} & \mathbf{C}_{2,1} & \mathbf{C}_{2,2} & \mathbf{C}_{2,3} \\ \mathbf{C}_{3,0} & \mathbf{C}_{3,1} & \mathbf{C}_{3,2} & \mathbf{C}_{3,3} \end{array} \right) \text{FP16 or FP32}$$

$$\mathbf{D} = \mathbf{AB} + \mathbf{C}$$



Type	Size	Range	$u = 2^{-t}$
half	16 bits	$10^{\pm 5}$	$2^{-11} \approx 4.9 \times 10^{-4}$
single	32 bits	$10^{\pm 38}$	$2^{-24} \approx 6.0 \times 10^{-8}$
double	64 bits	$10^{\pm 308}$	$2^{-53} \approx 1.1 \times 10^{-16}$
quadruple	128 bits	$10^{\pm 4932}$	$2^{-113} \approx 9.6 \times 10^{-35}$

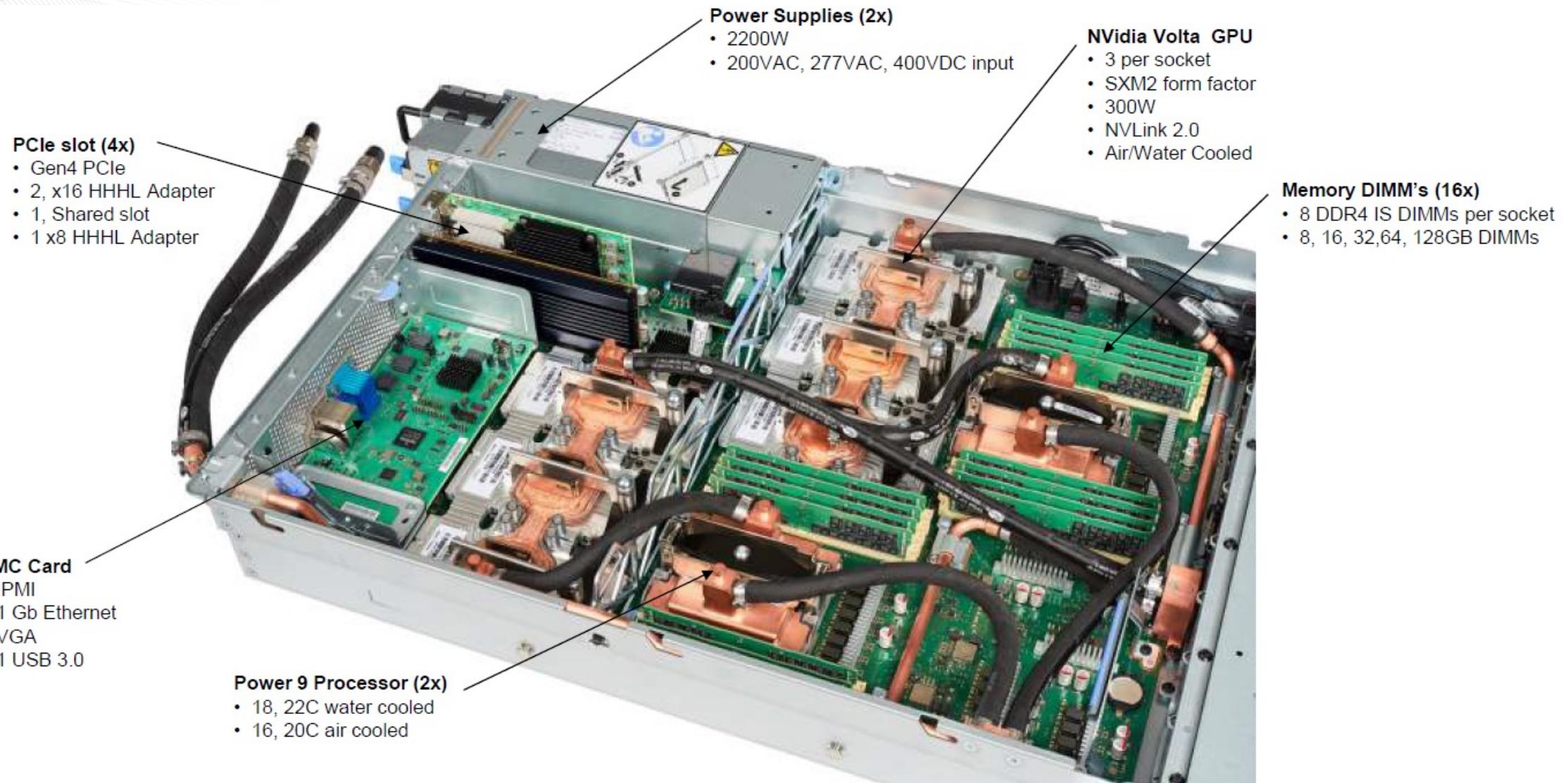
[https://docs.olcf.ornl.gov/systems/summit\\_user\\_guide.html#tensor-cores](https://docs.olcf.ornl.gov/systems/summit_user_guide.html#tensor-cores)

# Summit Node

(2) IBM Power9 + (6) NVIDIA Volta V100



# Summit Board (1 node) showing the Water Cooling



# Summit Specs



Feature	Summit
Peak FLOPS	200 PF
Max possible Power	13 MW
Number of Nodes	4,608
Node performance	42 TF
Memory per Node	512 GB DDR4 + 96 GB HBM2
NV memory per Node	1.6 TB
Total System Memory	2.8 PB + 7.4 PB NVM
System Interconnect	Dual Port EDR-IB (25 GB/s)
Interconnect Topology	Non-blocking Fat Tree
Bi-Section Bandwidth	115.2 TB/s
Processors on node	2 IBM POWER9™ 6 NVIDIA Volta™
File System	250 PB, 2.5 TB/s, GPFS™

# Available File Systems / Storage Areas on Ascent

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**NFS Directories** – This is where you might want to keep source code and build your application.

*NOTE: These directories are read-only from the compute nodes!*

</ccsopen/home/userid>

- Your personal home directory

</ccsopen/proj/gen158>

- Can be accessed by all participants of this event

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**GPFS Directories (parallel file system)** – This is where you should write data when running on Ascent's compute nodes.

</gpfs/wolf/gen158/scratch/userid>

- Your personal GPFS scratch directory

</gpfs/wolf/gen158/proj-shared>

- Can be accessed by all participants of the event

Questions?

Summit here

Frontier here

