Microsoft

UCX on Azure HPC and AI Clusters

Jithin Jose, Microsoft
jijos@microsoft.com

Agenda

Overview of Azure HPC

Azure HBv3, NDv4

Network features

Azure HPC VM Images

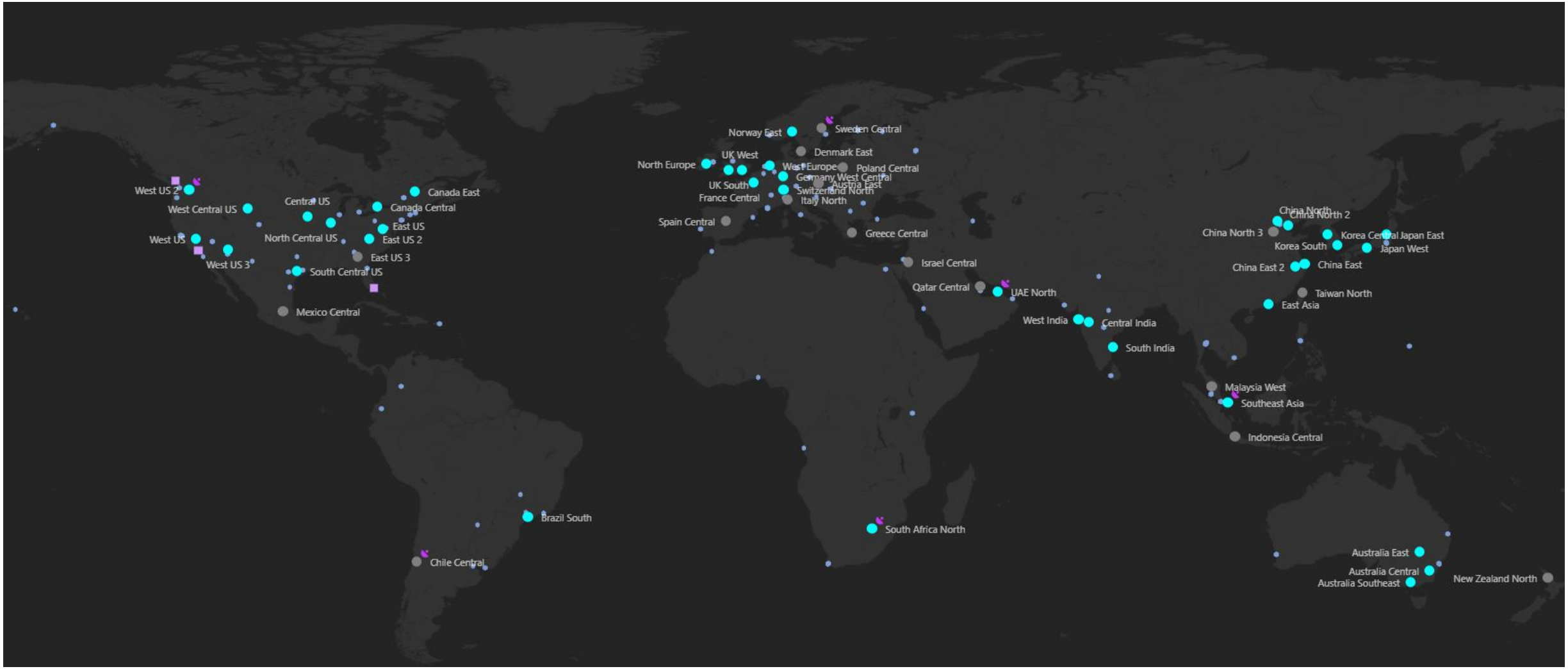
Performance Highlights

UCX on HBv3

UCX on NDv4

Conclusion

Global Infrastructure



Compliance and data residency

Service availability

Pricing

Azure HPC/AI VM Series

Standard HPC VMs

Standard HPC Applications

High Compute/Memory + InfiniBand

HPC SKUs: HB, HC, HBv2, HBv3

GPU VMs

Deep Learning, AI workloads

Visualization SKUs:

NV series

Deep Learning/AI SKUs

NC, ND series

- "r" in VM type indicates RDMA support (InfiniBand)
- InfiniBand/RDMA enabled VMs: One VM per Host
- InfiniBand exposed to VMs using SR-IOV, offers full host bypass with full feature support
- Partition Key (P-key) based isolation

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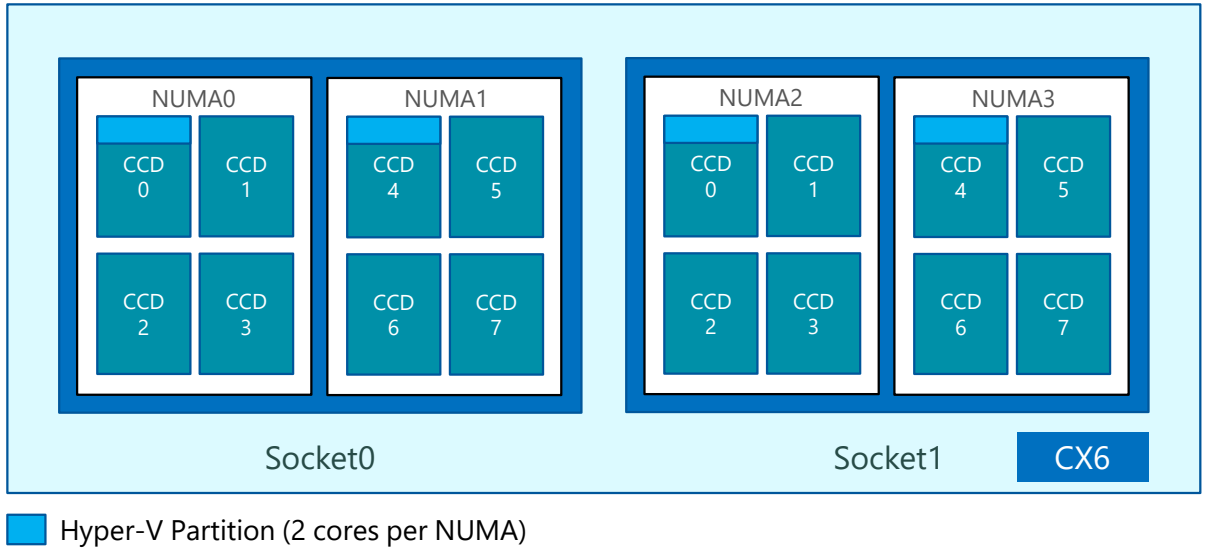
Azure HBv3 (Milan-X)

AMD EPYC
Milan-X

InfiniBand HDR
200Gbps



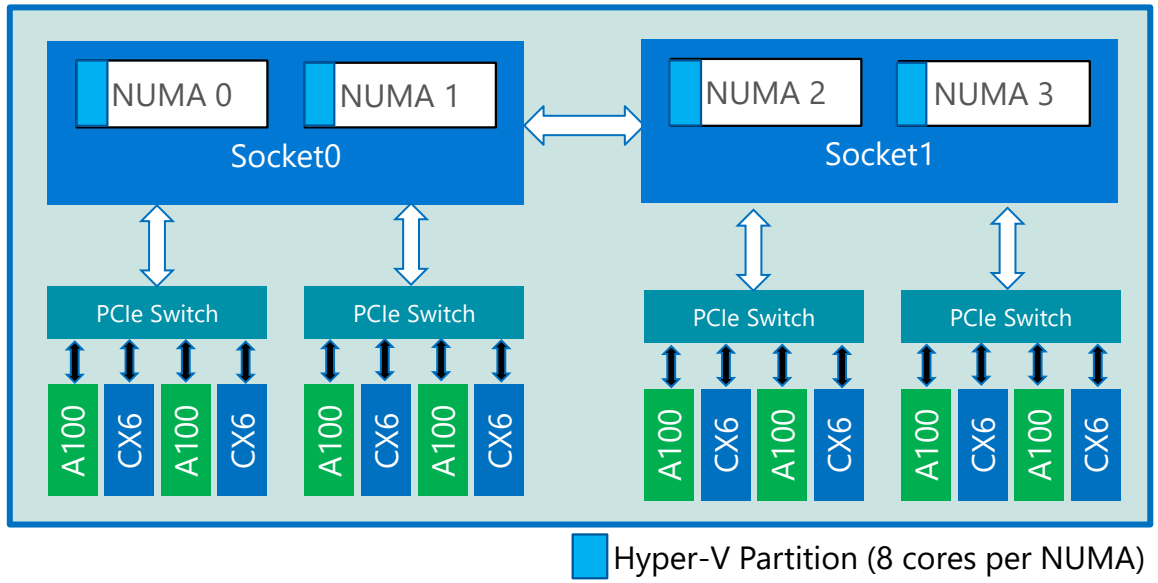
- VM Specs:
  - AMD Milan-X (NPS = 2)
  - VM Cores: 120
  - L3 Cache: 1.5 GB per VM
  - Memory: 448 GB
  - Local Disk: 2 x 900 GB NVMe SSD
  - Network: 200 Gbps HDR (SR-IOV)

HBv3 VM Sizes (one VM per Host):

- Standard_HB120rs_v3 (all 120 cores)
- Standard_HB120-96rs_v3 (6 cores per CCD)
- Standard_HB120-64rs_v3 (4 cores per CCD)
- Standard_HB120-32rs_v3 (2 cores per CCD)
- Standard_HB120-16rs_v3 (1 cores per CCD)

Azure NDv4

- VM Specs:
  - AMD Rome (NPS=2)
  - VM Cores: 96 (48 per socket)
  - Memory: 900 GB
  - 8 x NVIDIA A100 GPUs
  - 8 x HDR 200Gbps InfiniBand
  - Local Disk: 6.4 TB local NVMe SSD



Standard_ND96asr_v4 (NDv4)

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InfiniBand Features in Azure

- **HB, HC, NDv2:** 

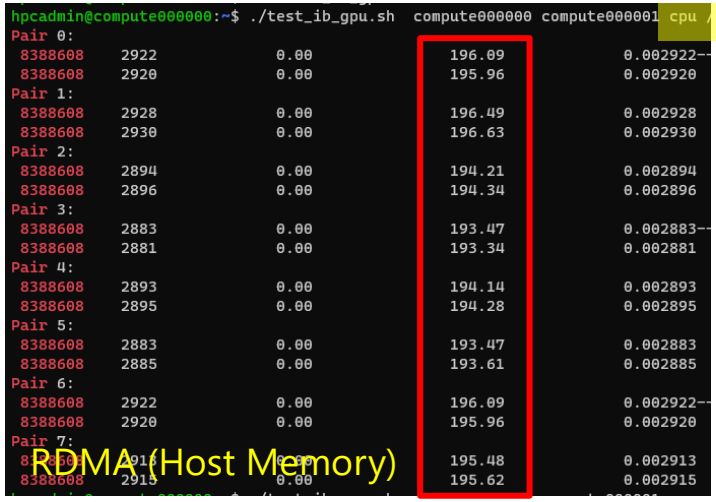
  - EDR 100 Gb/s InfiniBand
  - Up to 200 M messages/second
- **HBv2, HBv3, NDv4:** 

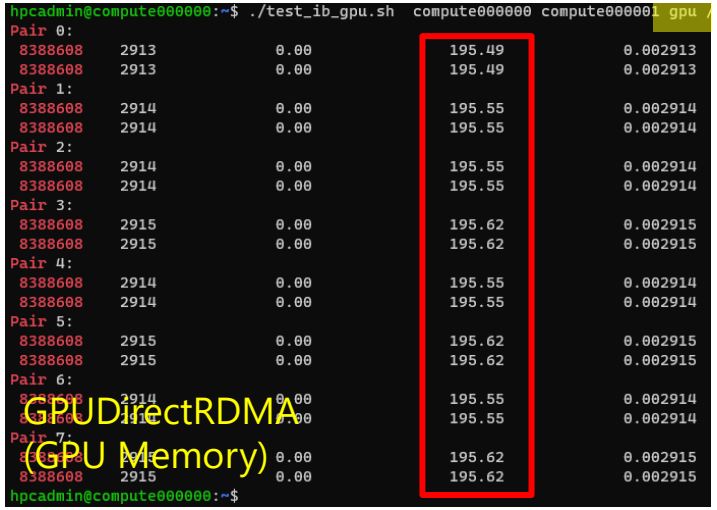
  - HDR 200 Gb/s InfiniBand
  - Up to 215 M messages/second

- **Dynamically Connected Transport (DCT)**
  - Reliable and scalable transport
  - Lesser Memory footprint
- **Hardware offload**
  - Collectives offload framework
  - Hardware tag matching
- **UD multicast (MCAST)**
  - Unreliable datagram (UD) based multicast
- **SHARP**
  - Switch based collectives
- **Dynamic Routing**
  - Advanced Congestion Control
  - Adaptive Routing
- **Better Reliability**
  - SHIELD detects link failures and reroutes

GPUDirect RDMA

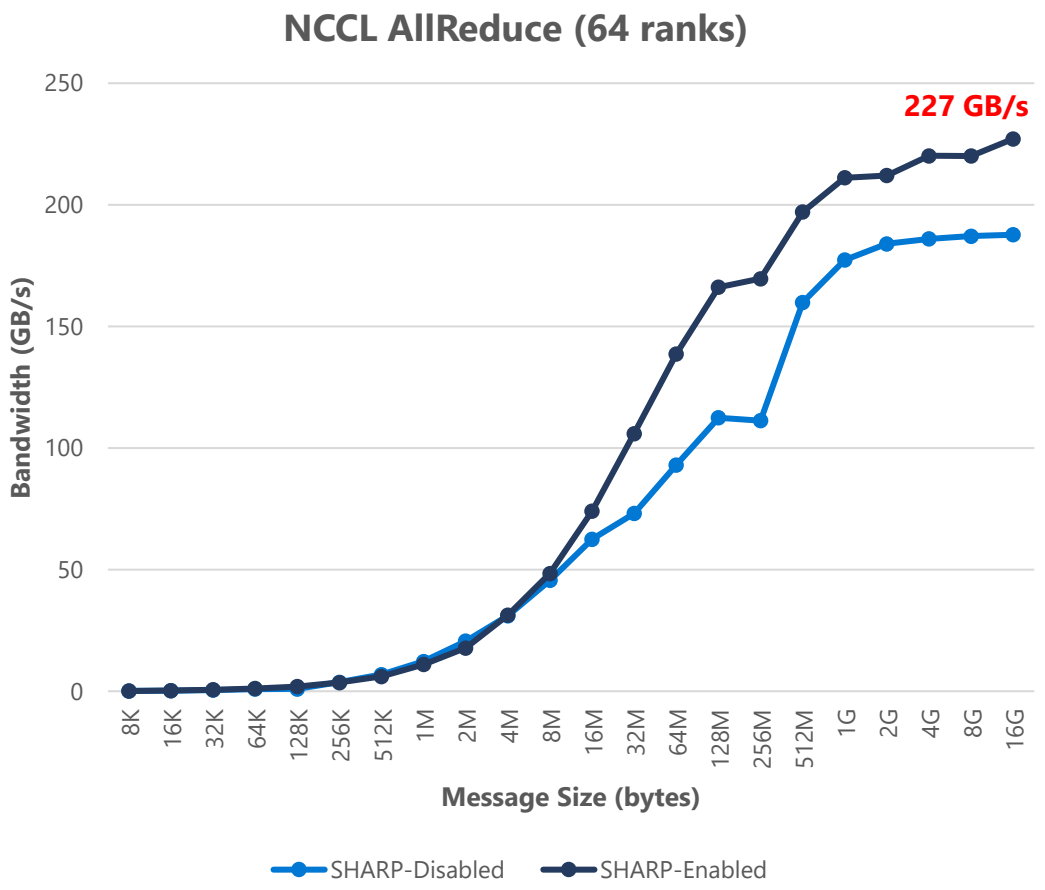
- Available on Azure NDv4
- Direct data path b/w A100 GPU and HDR200
- Each NIC/GPU pair gets peak b/w simultaneously
- Combined GPUDirect RDMA b/w of **1.6 Tbps**
- Supports *all* GDR capable MPI libraries/middleware





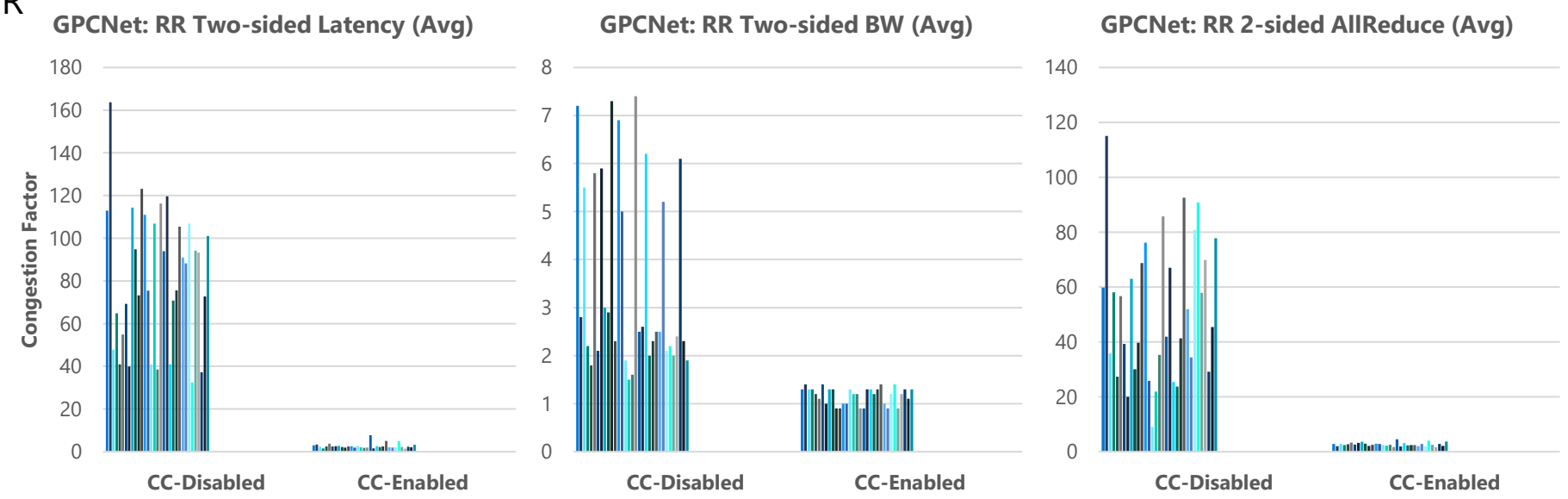
SHARP

- Enabled on dedicated NDv4 clusters
- UCX-based Sharp-AM / SharpD communication
- Optimized SHARP tree initialization
- Connection keepalive
- GRH support



Adv. Congestion Control

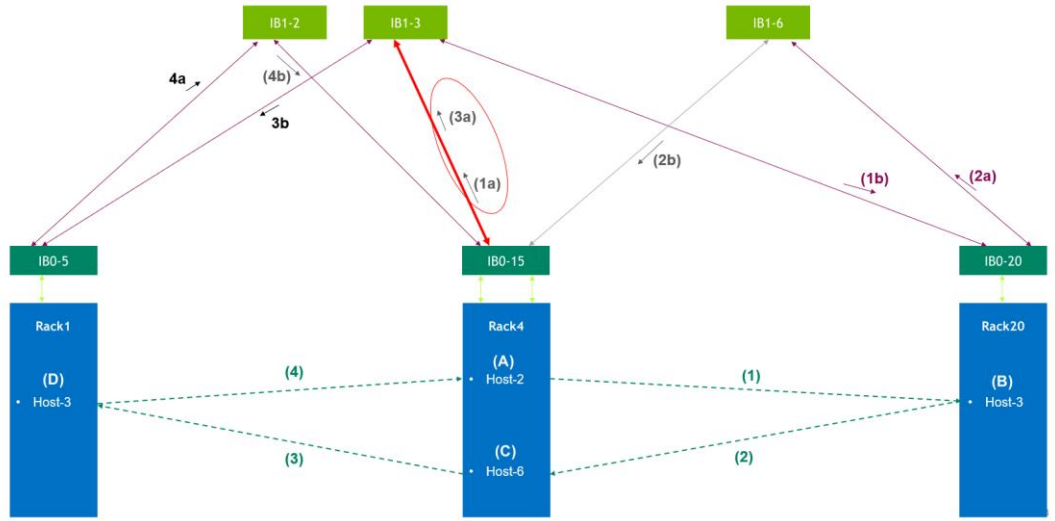
- Available on all VM Series with HDR
- Transparent to customer applications
- Avoids congestion, Improve tail latencies
- Critical in public multi-customer environments



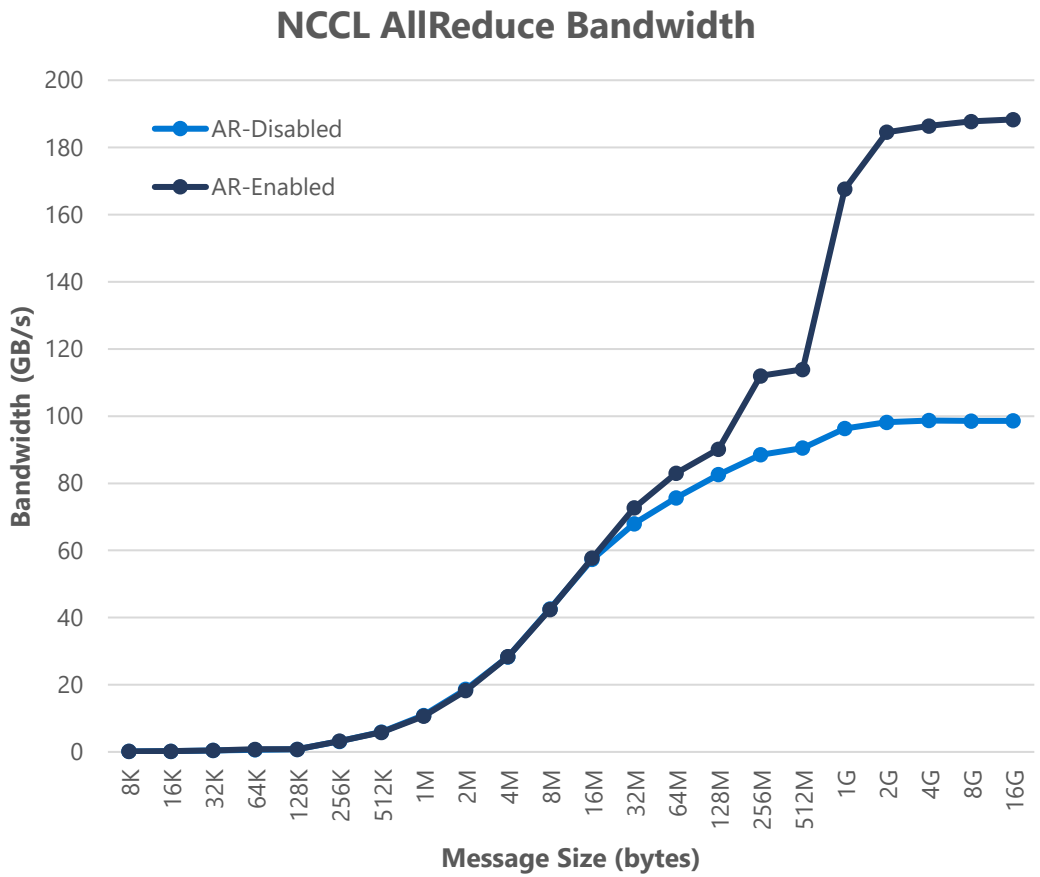
More results on Thursday's (12/02) session (10.30 am PST):

"**Cloud-Native Supercomputing Performance isolation**"

Adaptive Routing



Communication paths during NCCL AllReduce



Impact of Adaptive Routing

- Congestion can happen with static routing if a single link is being used by two or more communicating pairs
- AR avoids congestion and offers stable performance
- More details: [Adaptive Routing on Azure HPC Clusters]

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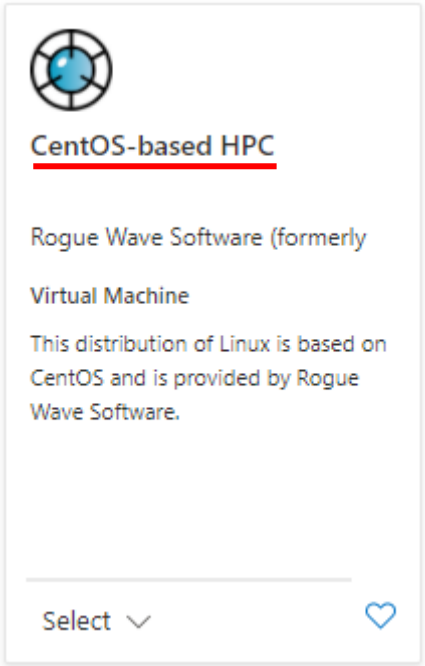
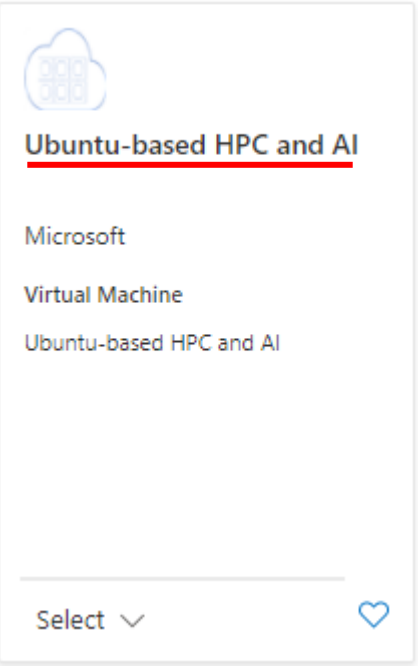
Azure HPC VM Images

- Optimized VM Images for HPC/AI workloads
- Mellanox OFED
- Pre-configured IPoIB
- InfiniBand based MPI Libraries
  - HPC-X, IntelMPI, MVAPICH2, OpenMPI
- Communication Runtimes
  - Libfabric, **UCX**
- Optimized HPC libraries
  - Blis, FFTW, Flame, MKL
- Recommended Compilers
- GPU Drivers
- NCCL, NCCL RDMA Sharp Plugin, SharpD
- Other platform optimizations





https://github.com/Azure/azhpc-images

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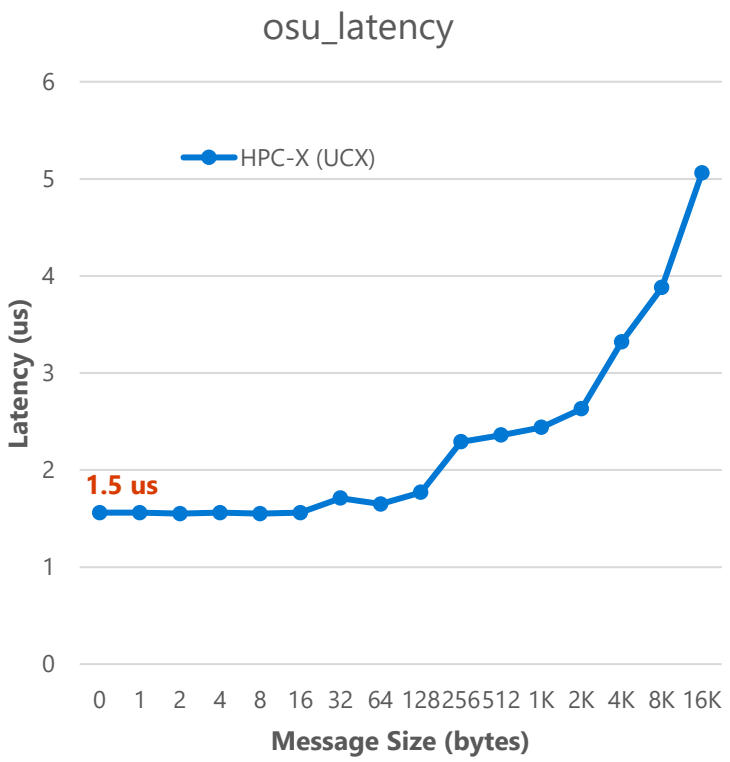
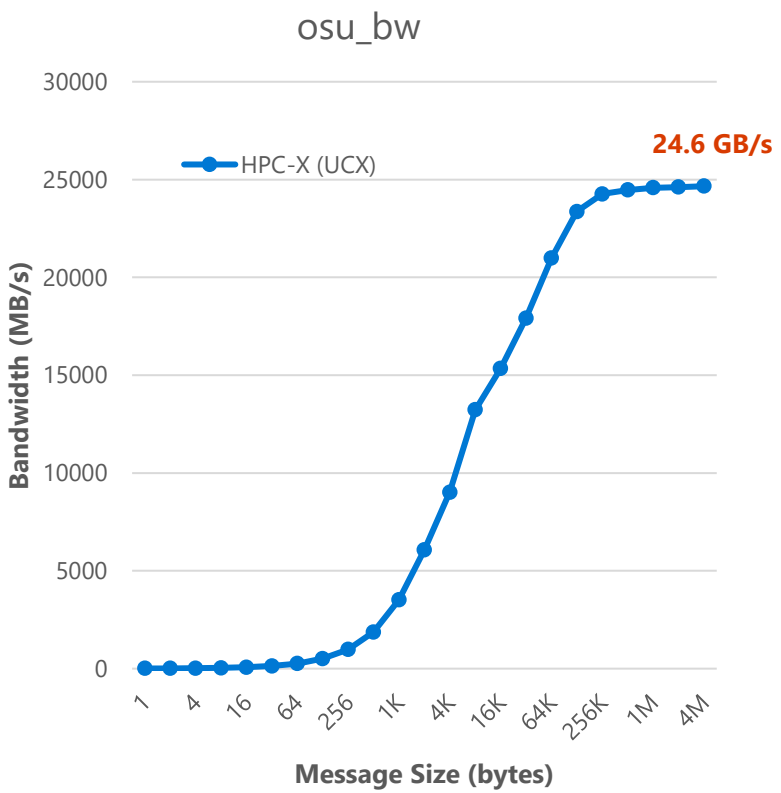
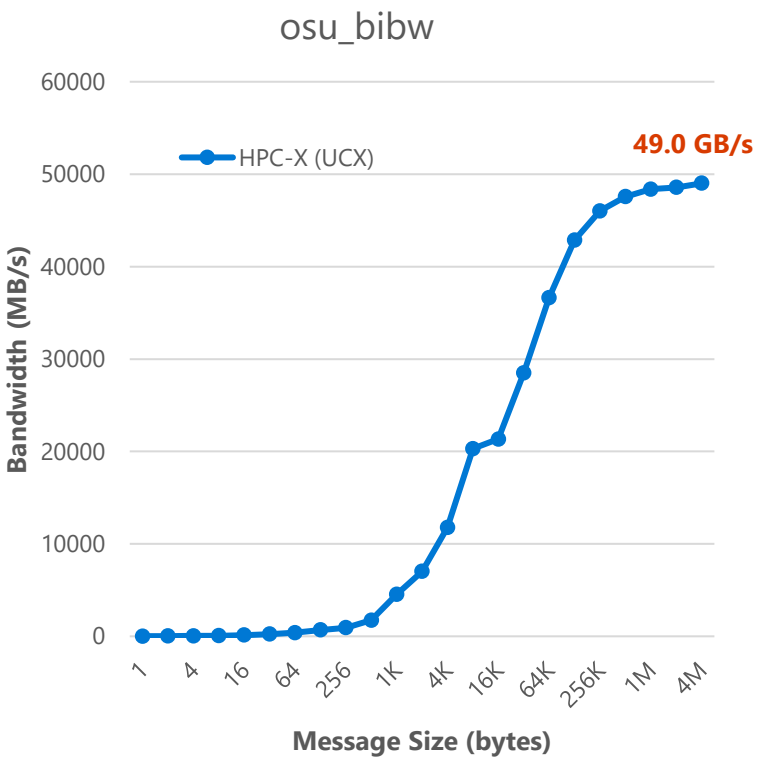
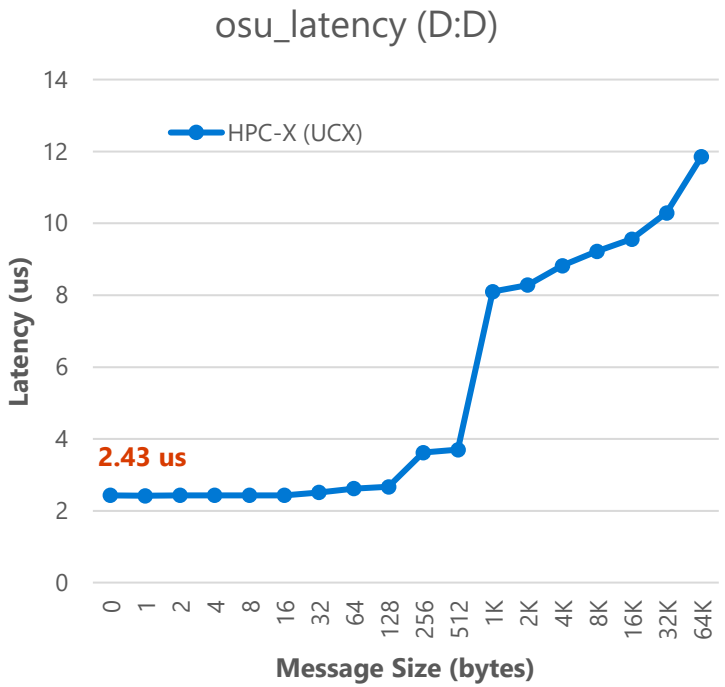
HBv3 MPI (UCX) Performance Characteristics

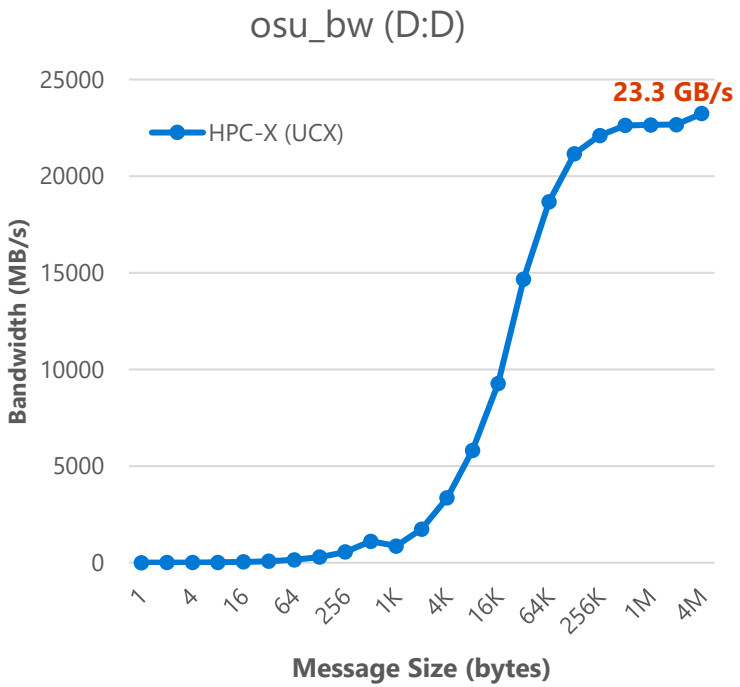


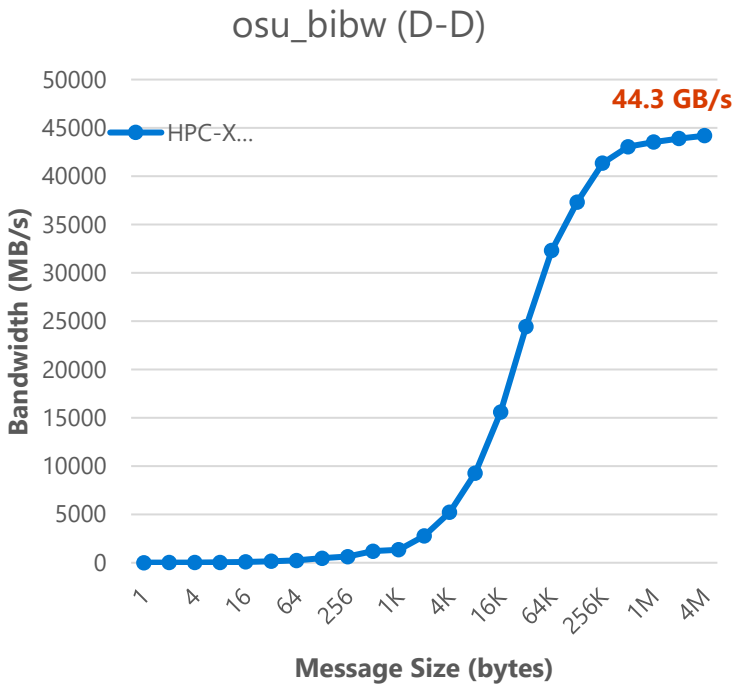




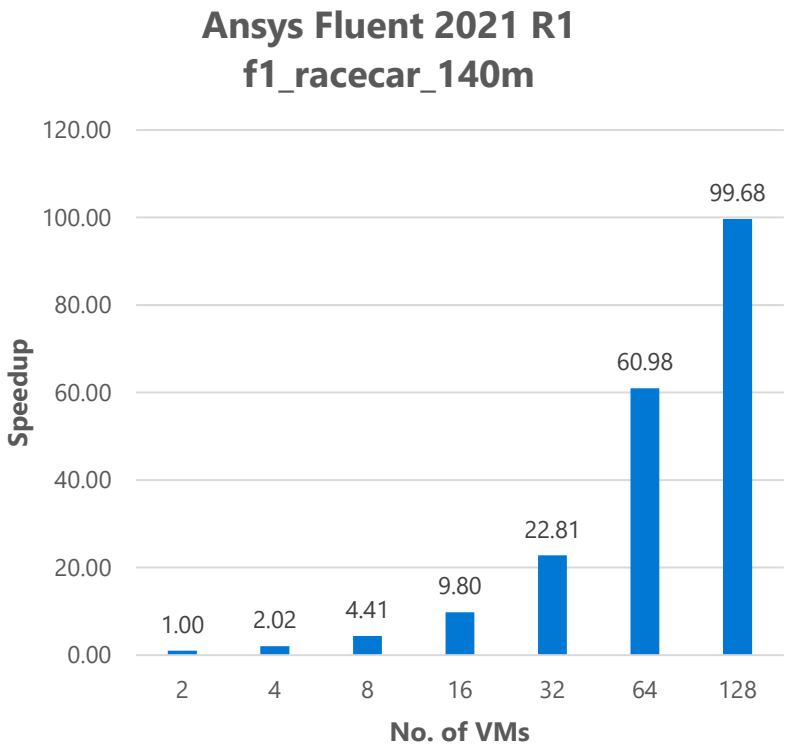
NDv4 MPI (UCX) Performance Characteristics (D:D)



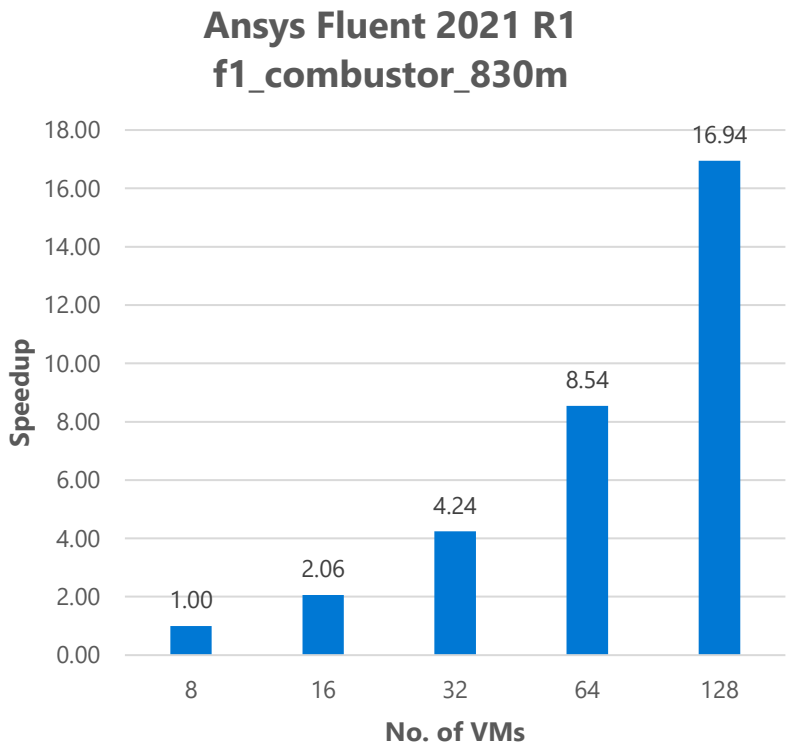




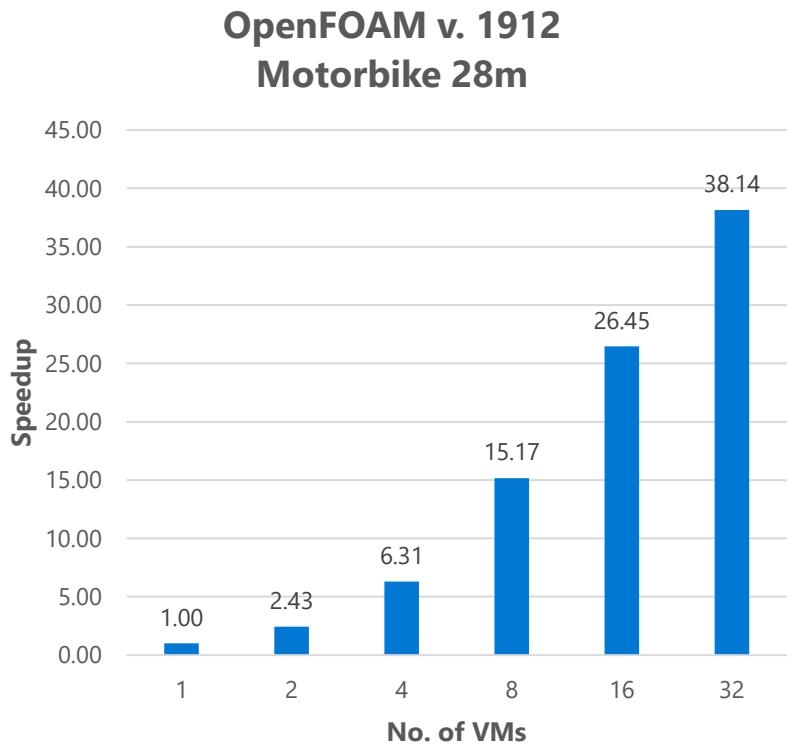
Scaling Efficiency on HBv3 (Milan-X) using UCX



156% scaling efficiency



106% scaling efficiency



119% scaling efficiency

https://aka.ms/MilanXPerf

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- Supercomputer on Cloud is real!
- Azure HPC Cloud in Top500, Graph500 top rankings
  - Rank 2 overall in MLPerf Dec. 2021
  - Rank 10 in Top500 Nov. 2021
  - Rank 17 in Graph500 Nov. 2020
- Cloud democratize Supercomputer
- High Performance middleware such as UCX enables cutting edge technology
  - Deliver High Scalability and Performance

Resources

Getting Started

- High Performance Computing (HPC) on Azure

HPC VM Images

- Azure HPC VM Images
- GitHub Repository

HPC VM Series

- Azure VM sizes - HPC - Azure Virtual Machines

HPC VM Deployment

- Sample HPC VM deployment scripts
- Azure CycleCloud

GPU VM Series

- Azure VM sizes - GPU - Azure Virtual Machines

Azure HPC Blogs

- Azure Compute - Microsoft Tech Community


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Thank you