SENAI CIMATEC

Tecnologia, Inovação
e Educação para a Indústria

Sistema FIEB | SENAI CIMATEC

PELO FUTURO DA INOVAÇÃO

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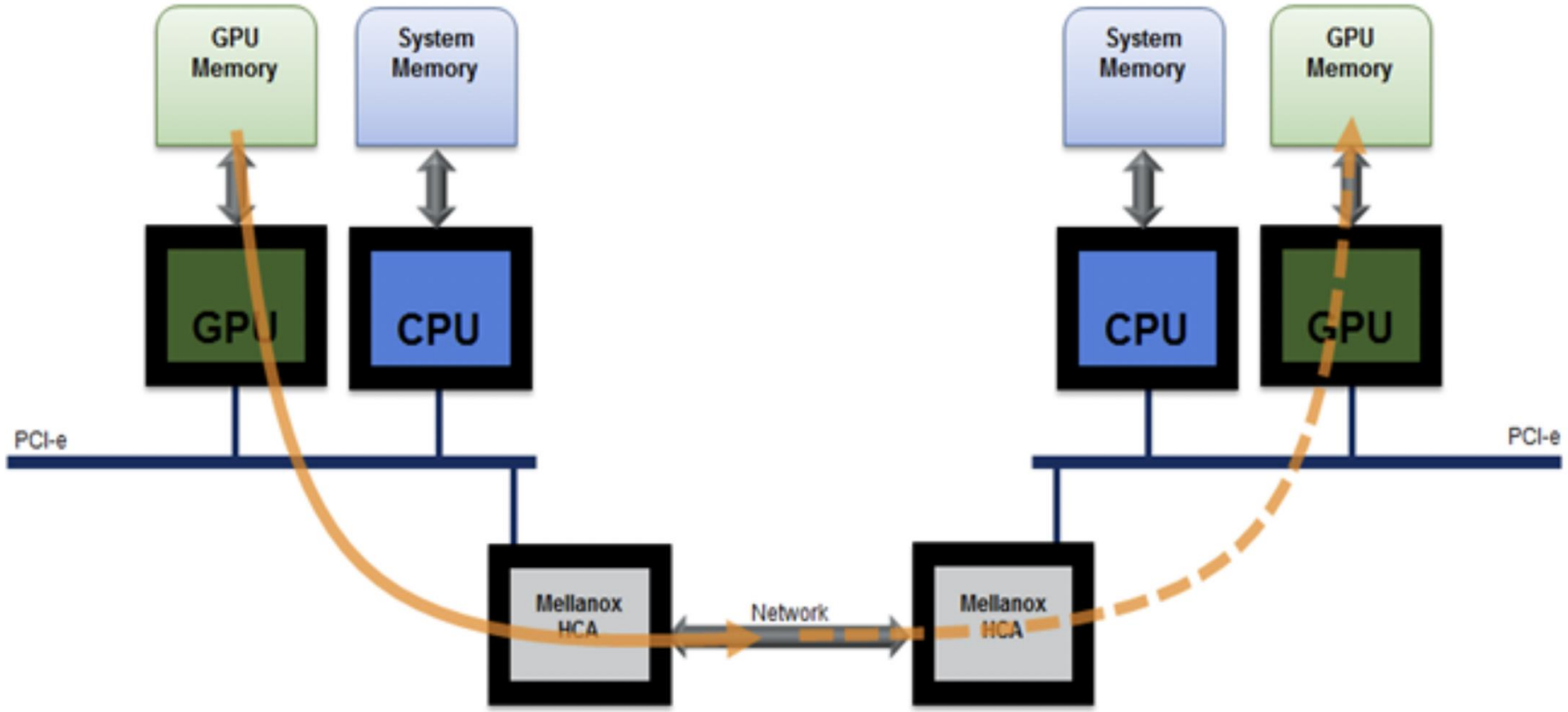
GPU Programming Applied to Industrial Problems

Introduction to scaling multi-node applications

Murilo Boratto

Multi-GPU Environments



Multi-GPU Environments

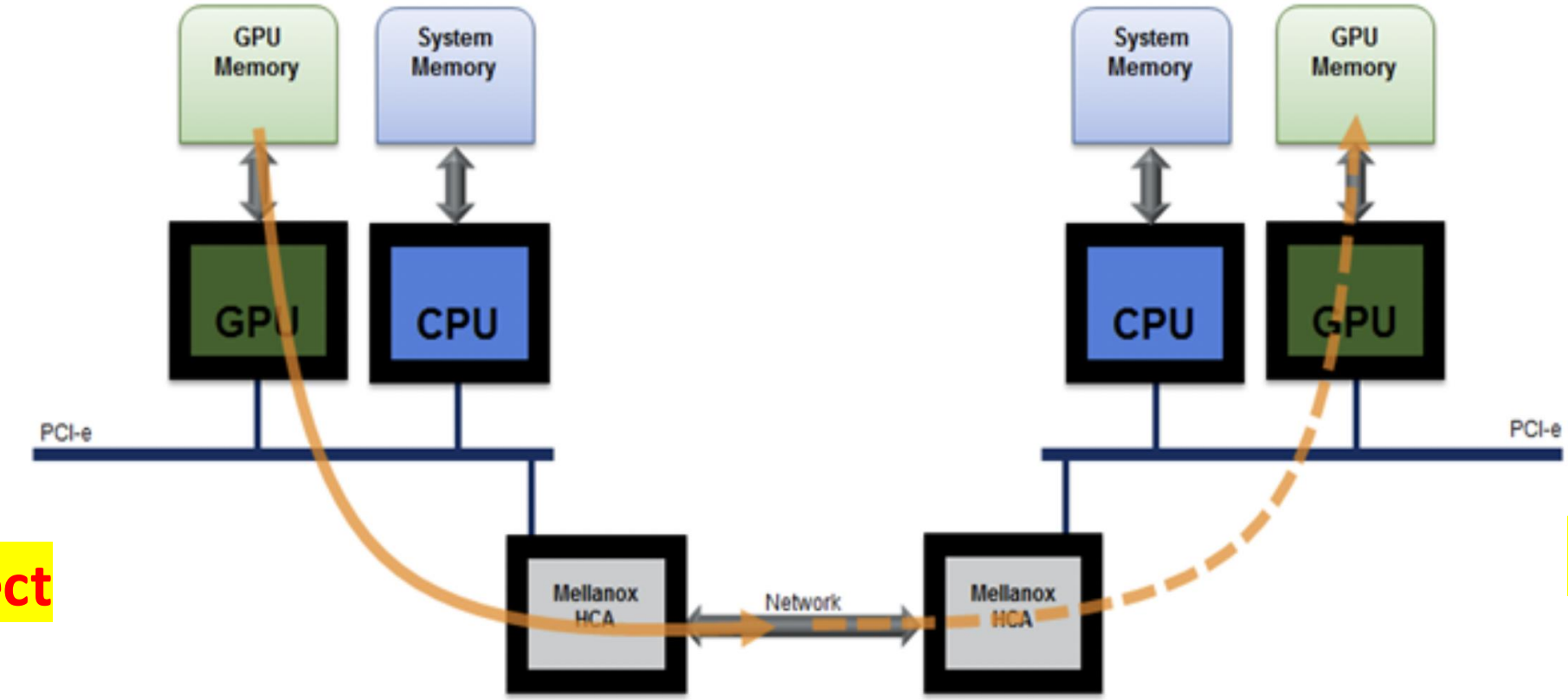
CUDA

OPENACC

OPENMP

NCCL

NVLINK



RDMA

UCX

GPUDirect

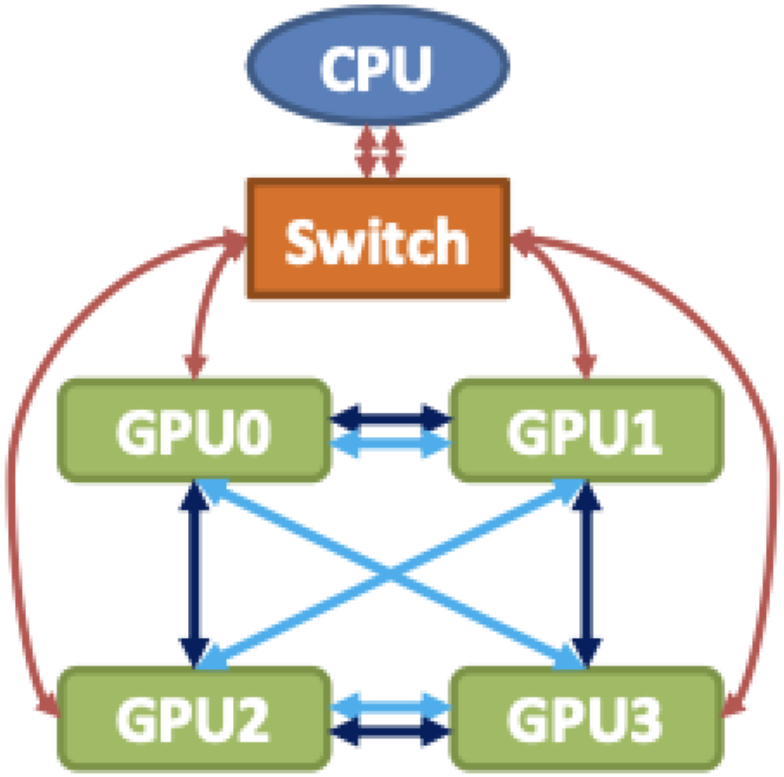
MPI+CUDA

INFINIBAND (MELLANOX)

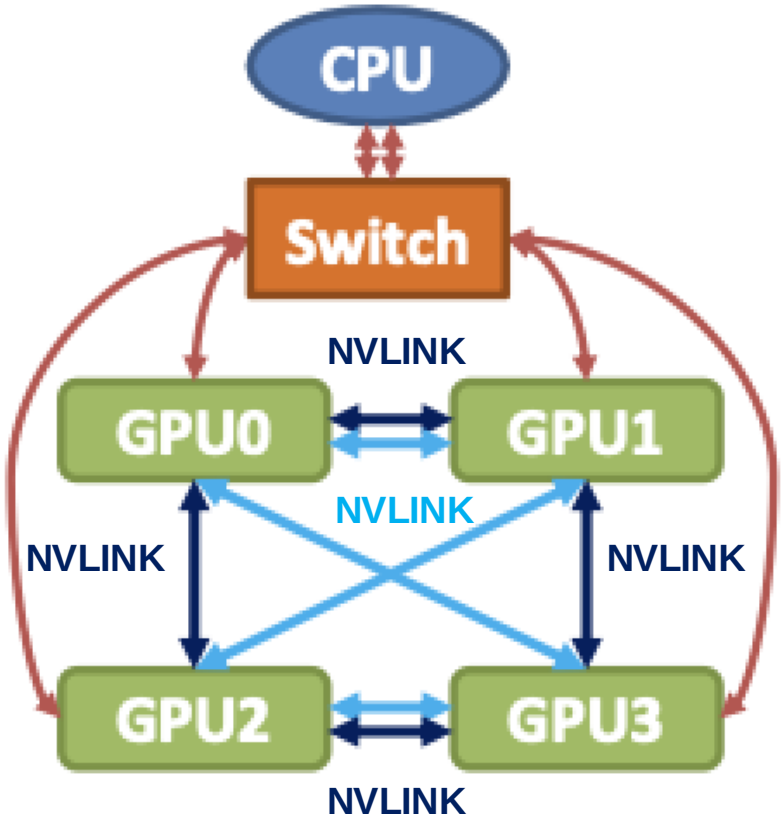
CUDA-aware

NVSHMEM

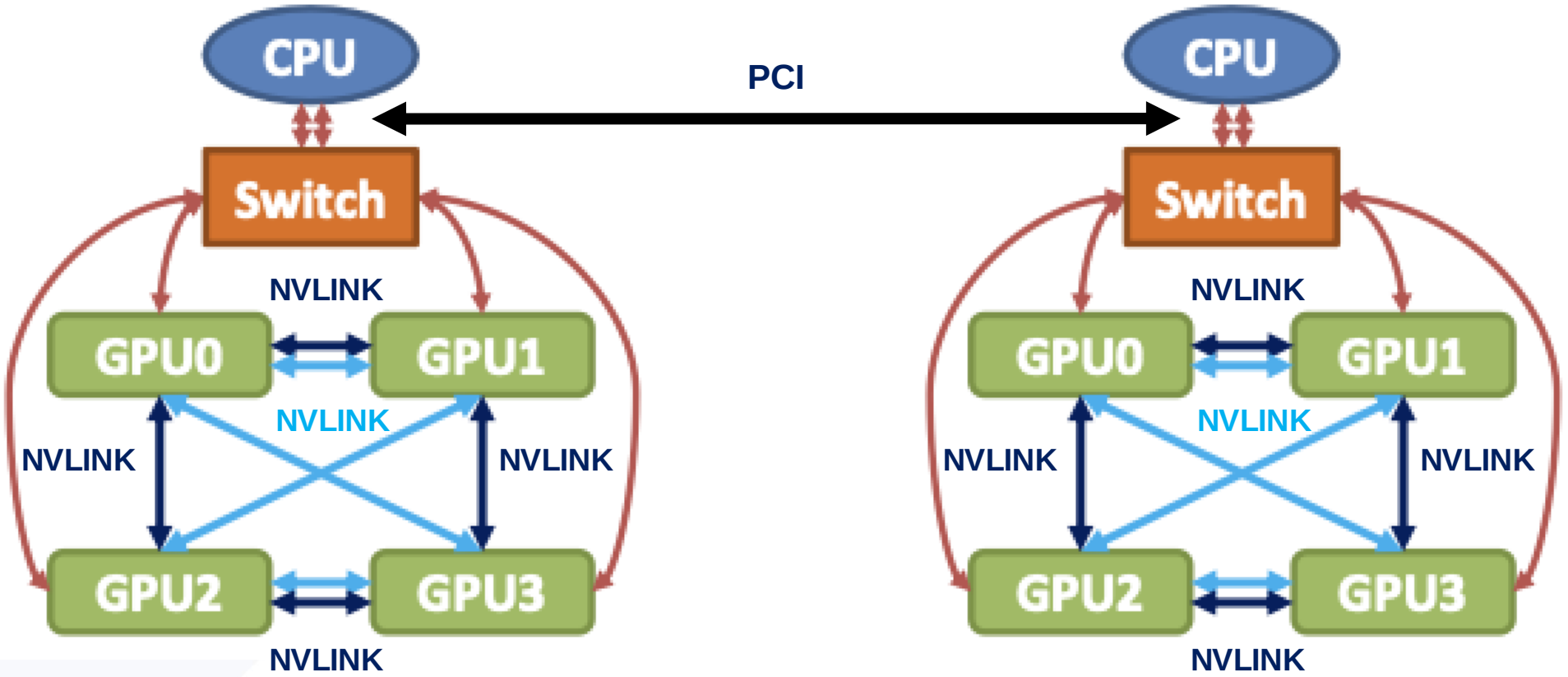
Multi-GPU Nodes



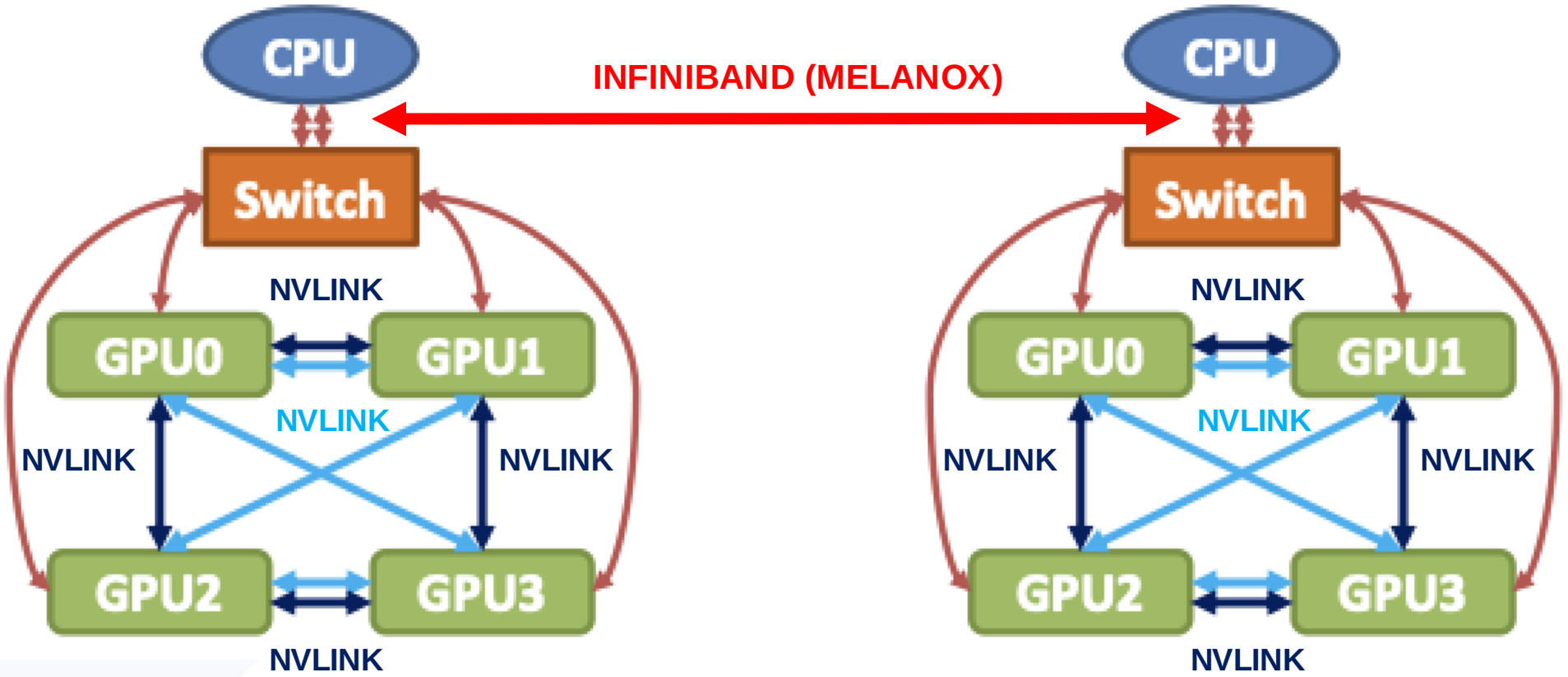
Multi-GPU Nodes



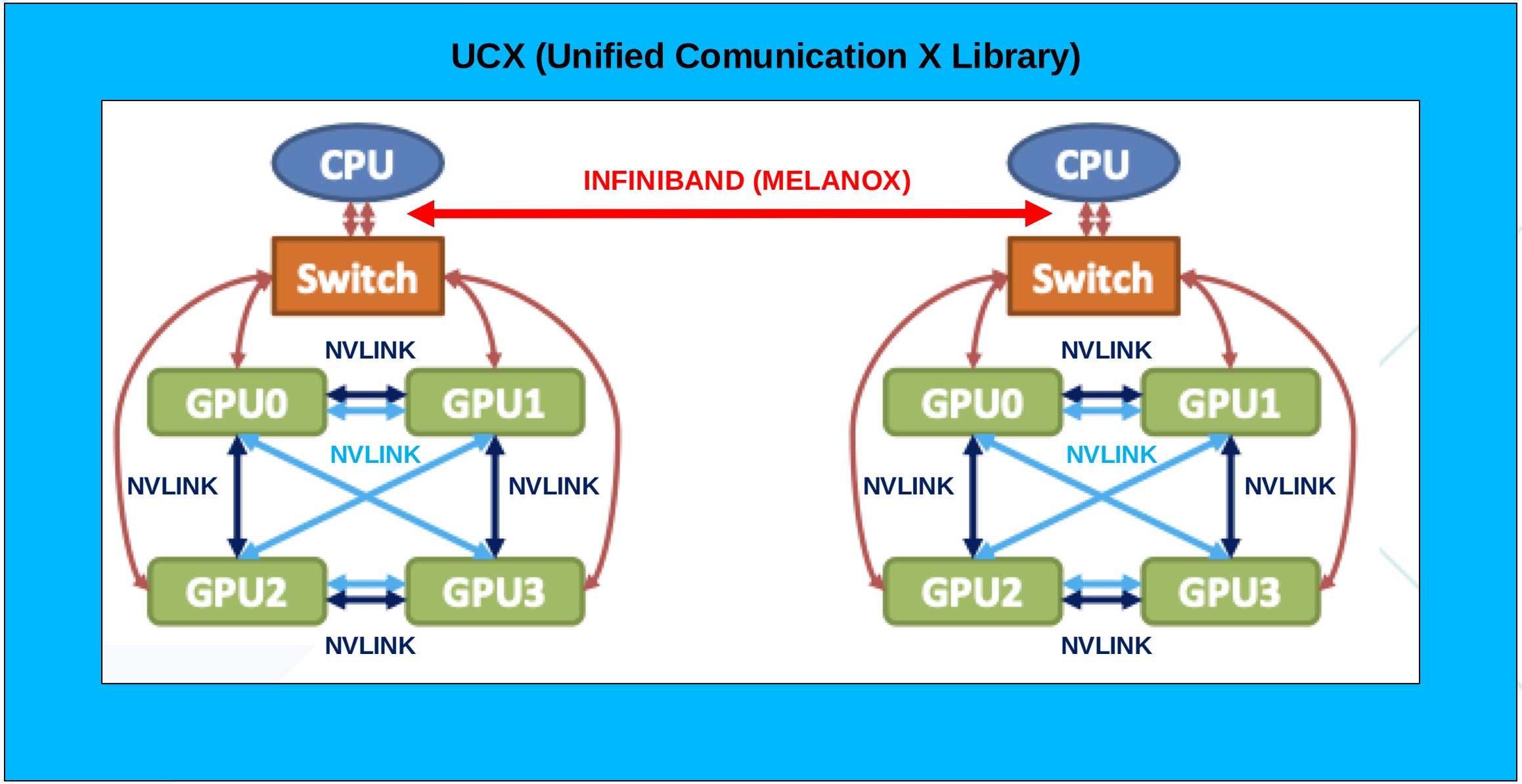
Multi-GPU Nodes



Multi-GPU Nodes



Multi-GPU Nodes



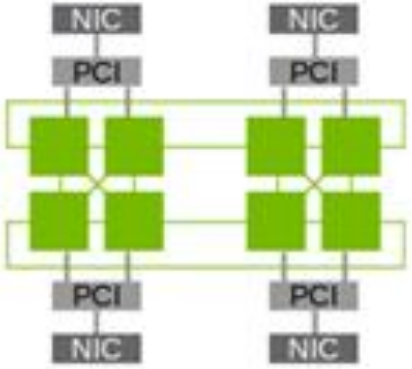
NCCL

NVIDIA Collective Communication Library

Topology detection

Build graph with all GPUs, NICs, CPUs, PCI switches, NVLink, NVSwitch.

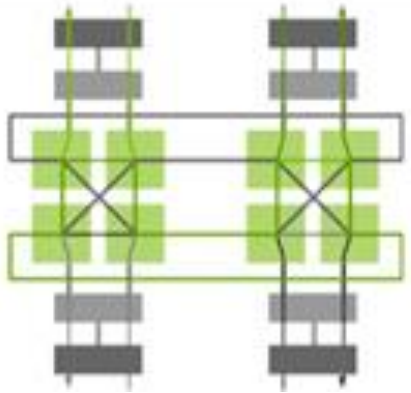
Topology injection for VMs.



Graph search

Extensive search to find optimal set of rings or trees.

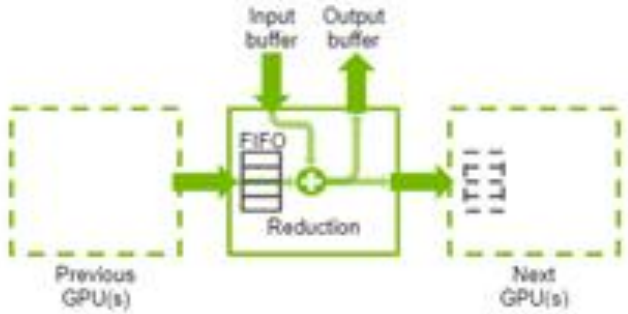
Performance prediction of each algorithm and auto-tuning.

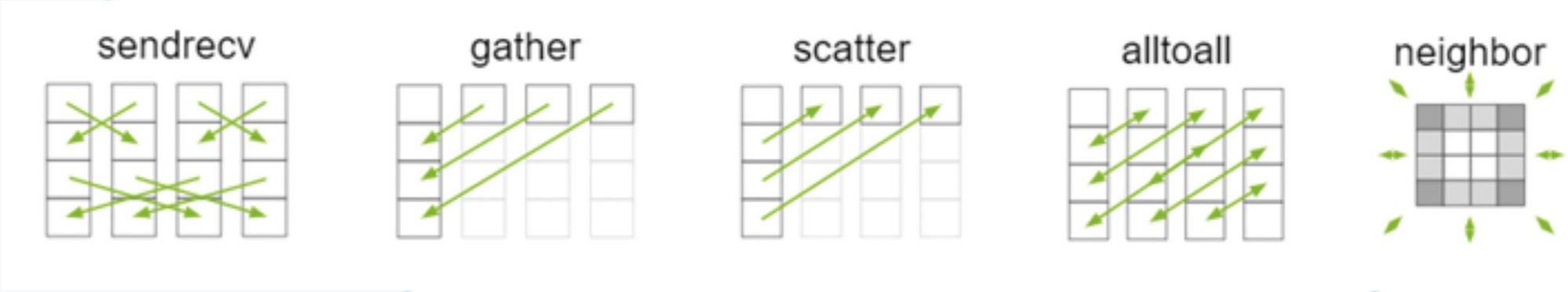


CUDA kernels

Optimized reductions and copies for a minimal SM usage.

CPU threads for network communication.

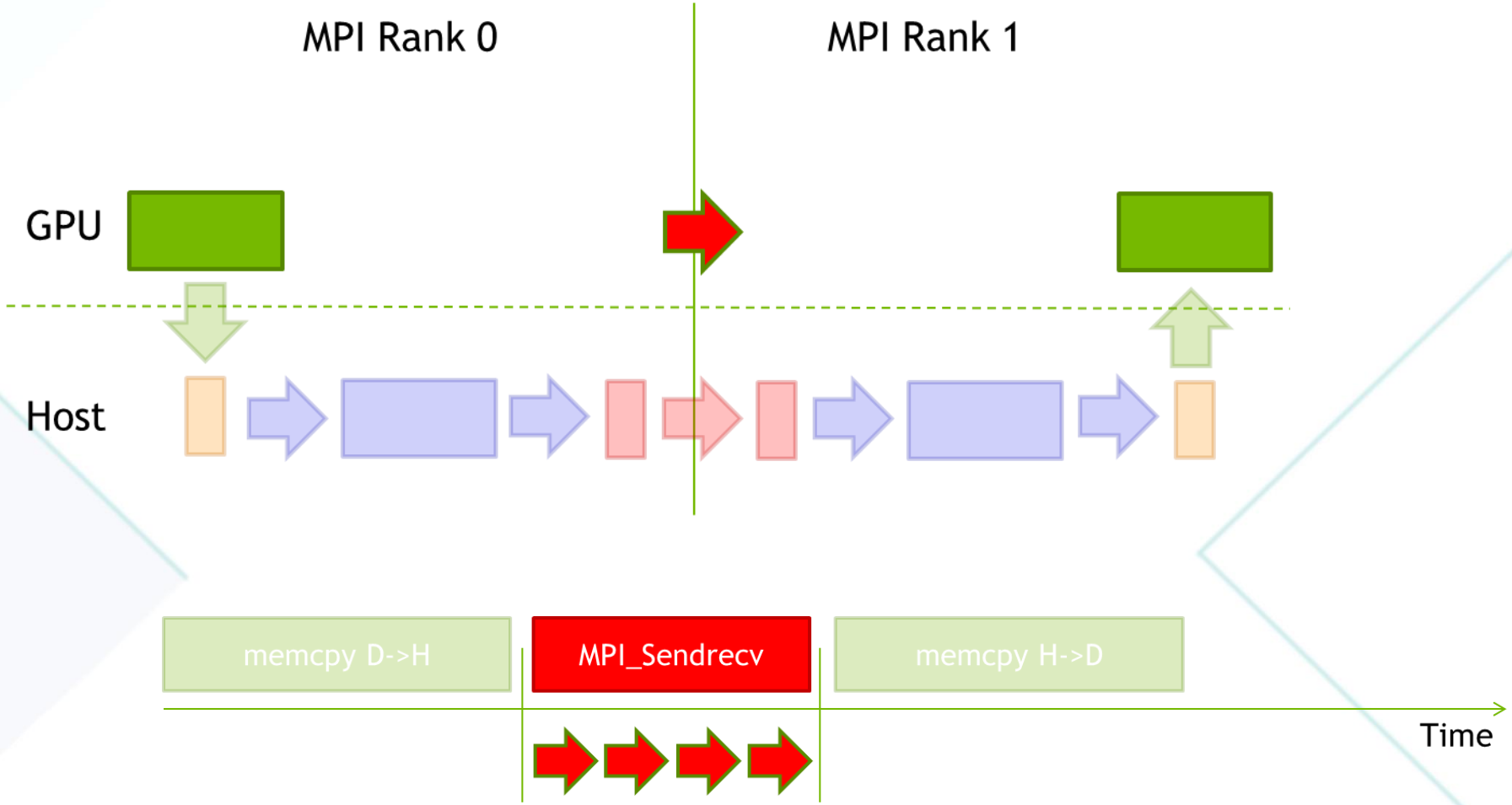



sendrecv
gather
scatter
alltoall
neighbor

CUDA-AWARE MPI

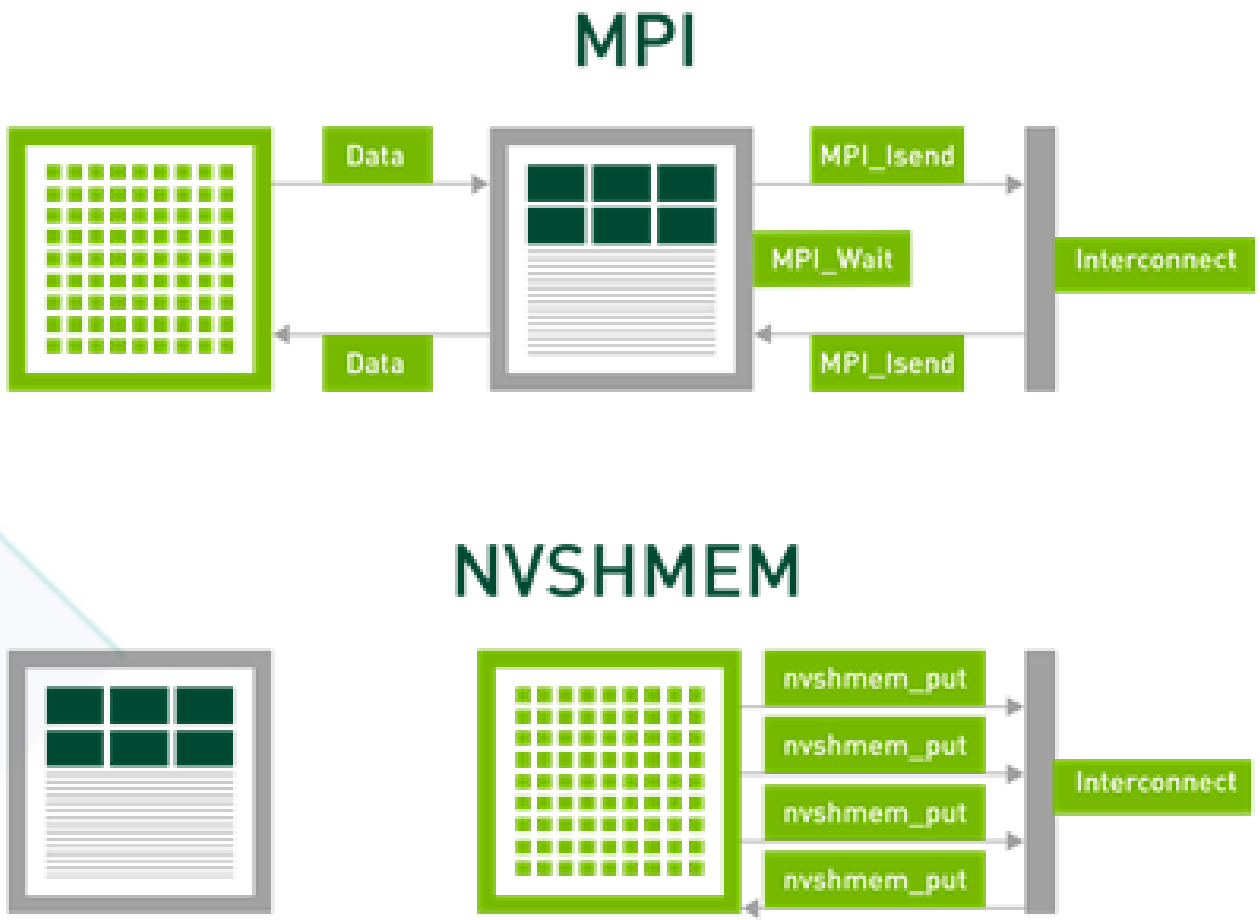
CUDA + MPI at GPUs

CUDAWARE-MPI

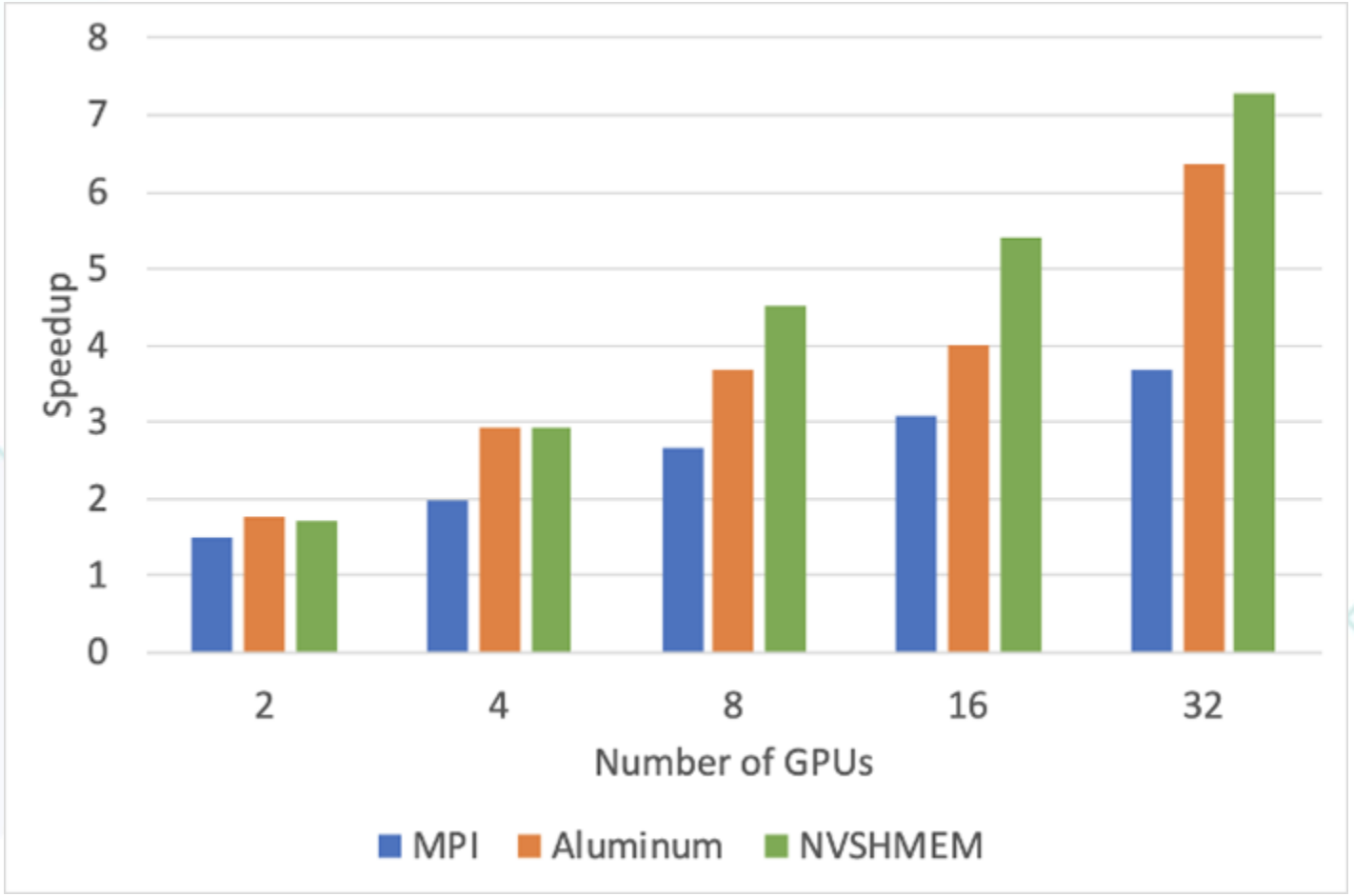


NVSHMEM

NVIDIA OpenSHMEM


MPI
Data
Data
MPI_Isend
MPI_Wait
MPI_Isend
Interconnect
NVSHMEM
nvshmem_put
nvshmem_put
nvshmem_put
nvshmem_put
Interconnect

NVSHMEM


Speedup
0
1
2
3
4
5
6
7
8
2
4
8
16
32
Number of GPUs
MPI
Aluminum
NVSHMEM

https://github.com/muriloboratto/GPU-programming

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