Open MPI State of the Union XVII Community Meeting

Howard Pritchard, LANL
George Bosilca, NVIDIA
Aurelien Bouteiller, AMD
Thomas Naughton, ORNL

Version Roadmaps

v4.1.x (Still supported)

- Release managers
  - Brian Barrett, AWS
  - Jeff Squyres, Cisco

- Current release: 4.1.8
  - February 2025
- Likely to be the last release

Open MPI v5.x (Current stable)

Many improvements !

v5.0.x

- Release managers
  Tomislav Janjusic, NVIDIA

- Current release
  v5.0.9 - November 2025
- Likely to have a v5.0.10 release - 2026

Open MPI v5.0.x Major Changes

- Replaced launcher ORTE with PRRTE
  - PMIx Reference Runtime Environment (v2.0.x)
  - Requires PMIx v4.1.x or newer
- Added a new *accelerator* framework
  - Allows for modularized implementation of various devices
- Support for MPI Sessions added
- OpenIB BTL has been removed
- Replaced Debugger (MPIR) interface with PMIx Tools Debugger interface

New and Improved Runtime Environment

- PRRTE is our new launcher!
  - PMIx Reference Runtime Environment (v2.0.x)
  - PMIx standard based
- Run time no longer specifically tied to Open MPI
  - Also works with other MPI implementation
  - And in other non-MPI/HPC environments

Open MPI v5.0.6 to v5.0.9

- **Collective Operations (coll)**
  - **coll/ucc**: Fixed initialization in non-blocking/persistent operations, set node local id, and improved MPI_IN_PLACE handling
  - **coll/tuned**: Added version identifier and extended dynamic rules file for alltoall_algorithm_max_requests
  - **coll/basic/adapt/han/hcoll/cuda**: Fixed MCA variable scopes and type mismatches
- **Point-to-Point Messaging (PML/MTL/BTL)**
  - **pml**: Fixed memory overrun bug in ob1, added node local id support for UCX
  - **mtl/ofi**: Added rcache for hmem, improved CXI provider support, set accelerator rcache flags
  - **btl/ofi**: Exported memory monitor, removed EFA cache hack, fixed multi init/fini scenarios
- **One-Sided Communication (OSC)**
  - **osc/ucx**: Added "no_locks" info key support to disable lock table
  - **osc/rdma**: Fixed component compatibility when not using ob1

Open MPI v5.0.6 to v5.0.9

- **Fortran Support**
  - Fixed common symbol sizes, alignments, and alignment detection
  - Fixed string copy errors in c2f conversion (off-by-one and length mismatches)
  - Added missing profile symbols in use-mpi-f08, improved complex(real16) testing
  - Added support for new compilers (flang-new, nvfortran)
- **Accelerator Support**
  - **opal/accelerator/rocm**: Added missing memcpy headers
  - Fixed ROCm 6.0 and ROCm 7.0 compatibility issues
  - Fixed accelerator rcache flag handling across mtl/ofi and btl/ofi
  - Improved CUDA selection and updated documentation
- **Memory Management**
  - **mpool/hugepage**: Fixed sizing for better memory management
  - **rcache**: Cleaned up base struct, fixed reference counting in UCX dynamic windows
  - Fixed opal_atomic_int128_t alignment for s390x architecture

Open MPI v5.0.6 to v5.0.9

- **MPI Sessions**
  - Added UCX support and improved multi init/fini handling
  - Enhanced argument checking for comm constructors and PMIx_Group_construct
  - Added hello_sessions example and fixed singleton session directory creation
- **I/O (io)**
  - **io/ompio**: Fixed file_seek calculation when using SEEK_END
  - **romio314**: Removed cudart linking dependency
- **ARM/AARCH64 Support**
  - Added SVE detection alongside NEON in aarch64 op component
- **Documentation**
  - Added "Last updated on" footer, fixed numerous typos and formatting issues
  - Updated MPI_Init/*Finalize*/Session* man pages and MCA variable documentation
  - Enhanced mpirun documentation for --pmixmca and --prtemca options

Open MPI v6.0.0

Even more improvements are coming!

Open MPI v6.0.0

- Release managers
  - Edgar Gabriel, AMD
  - Howard Pritchard, LANL
- Pre-releases expected in December


Open MPI v6.0.0 Major Enhancements

- MPI 4.1 compliant
  - Support for MPI_Count (aka big count)
- Enhanced GPU support
  - Extended *accelerator* framework to support IPC methods provided by CUDA and ROCm
  - Support for memkind (➡see AMD presentation)
  - Intel Level-Zero support (without IPC)
- Significant enhancements to collective operations
- ROMIO removed
  - Very old version, no support big count
- Support for Eviden BXI networks

Open MPI v6.0.0 Runtime Changes

- Replaced PRRTE with our own fork (https://github.com/open-mpi/prrte)
  - Renamed PRRTE executables to avoid name clashes with native PRRTE install (should be transparent to users using mpirun/mpiexec)
  - Emphasis on stability rather than features
  - Open MPI can still be built against external OpenPMIx and PRRTe installations
  - Requires PMIx 6.0.0 or later if building Open MPI with the internal OMPI PRRTE

Collective operations

- ***xhc***: new shared memory collective component using xpmem
- ***acoll***: new ➡ see AMD presentation
- ***ucc***: added support for persistent collective (or ➡ see NVIDIA presentation, to be clarified with George)
- ***han***: alltoall performance enhancements
- ***accelerator***: ➡ see AMD presentation
- ***tuned***: new json based configuration file (do we want to show an example?)

- ***hcoll***: component removed
- ***sm***: component removed

Collective operations

Enable user to determine which component is used for a collective operation:

```
$ mpirun --mca coll_base_verbose 10 -np 2 ./osu_bcast
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 allgather -> accelerator
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 allgatherv -> tuned
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 allreduce -> accelerator
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 alltoall -> accelerator
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 alltoallv -> tuned
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 alltoallw -> basic
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 barrier -> tuned
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 bcast -> accelerator
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 iallgather -> libnbc
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 iallgatherv -> libnbc
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 iallreduce -> libnbc
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 ialltoall -> libnbc
 coll:base:comm_select: communicator MPI_COMM_WORLD rank 0 ialltoallv -> libnbc
```

Note: some components forward execution to another component under certain conditions

MPI 5.0 ABI Support

- May be too late for 6.0.x release stream but still under consideration
- Plan is to first support ‘c’ ABI, including helper functions for external Fortran bindings implementations
- Lots of thanks to Lisandro Dalcin for testing/providing fixes
- Leverages Python framework used for big count support
  - Thanks to Jake Tronge (GATech) and Joe Downs (Univ. Louisville)
- ABI mpi.h generated from MPI standard using https://github.com/mpi-forum/pympistandard + patches
- Plans for Fortran ABI less certain, may rely on external Fortran bindings (e.g. vapaa) to provide this support

Backup

Open MPI versioning

- Open MPI uses "A.B.C" version number triple
- Each number has a specific meaning:

A This number changes when backwards compatibility breaks

B This number changes when new features are added

C This number changes for all other releases

What does that encompass?

- “Backwards compatibility” covers several areas:
  - Binary compatibility, specifically the MPI / OSHMEM API OMPI ABI
  - MPI / OSHMEM run time system
  - `mpirun` / `oshrun` CLI options
  - MCA parameter names / values / meanings

Definition

- Open MPI vY is *backwards compatible* with Open MPI vX (where Y>X) if:
  - Users can compile a correct MPI / OSHMEM program with vX
  - Run it with the same CLI options and MCA parameters using vX or vY
  - The job executes correctly

Open MPI v5.0.0 to v5.0.9

- Documentation
  - Documentation updates
  - Improved installation and configuration guides
  - Updated man pages and error messages
  - Added better guidance for packagers
- Third-party Component Updates
  - Updated OpenPMIx and PRRTE to latest versions
  - Improved integration with third-party libraries
  - Better handling of dependencies
- Testing improvements
  - Added CUDA and ROCm compile checks
  - Enhanced CI/CD workflows
  - Added macOS testing
  - Improved mpi4py + HDF5 testing support

Open MPI v5.0.0 to v5.0.9

- Performance & Reliability
  - Fixed race conditions in various components
  - Improved memory handling and leak fixes
  - Enhanced error handling in several components
  - Added AARCH64 OP component with NEON and SVE ISA support
  - Added MCS-based implementation for SHMEM locks for better scaling in OSHMEM
- CUDA/ROCm Updates
  - Fixed ROCm 6.0 and ROCm 7.0 compatibility issues
  - Improved handling of CUDA memory management
  - Fixed build system and linkage for non-standard libcuda.so locations
- Build System & Configuration
  - Added support for new compilers (flang-new, nvfortran)
  - Improved DSO (Dynamic Shared Objects) handling
  - Updated build configurations for better packaging

Open MPI Updates from AMD

Edgar Gabriel
Aurelien Bouteiller
Manu Shantharam
Nithya VS

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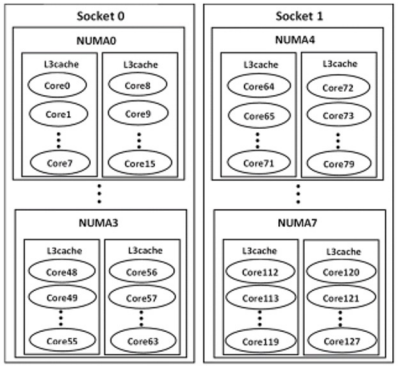
AMD
together we advance_

Upcoming in Open MPI 6.0: acoll collective component

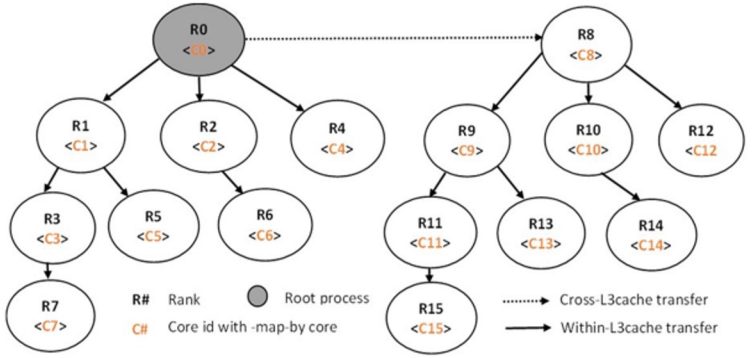
Affinity-Aware collectives for intra-node communication (acoll)

- "acoll" is optimized for communications within a single node of AMD "Zen"-based processors
- provides support for many commonly used collective operations, including MPI_Bcast, MPI_Allreduce, MPI_Reduce, MPI_Gather, MPI_Allgather, and MPI_Barrier



Two stages: Instantiation and Communication

- **Instantiation** – once during initialization of communicator
  - **Identify affinity** related information through hardware locality software package like 'hwloc', form groups of processes/ranks with similar affinities
- **Communication** stage: 2 steps
  - perform communication among **local ranks** within a group
  - perform communication **across affinity groups**



acoll: How-to and what's next?

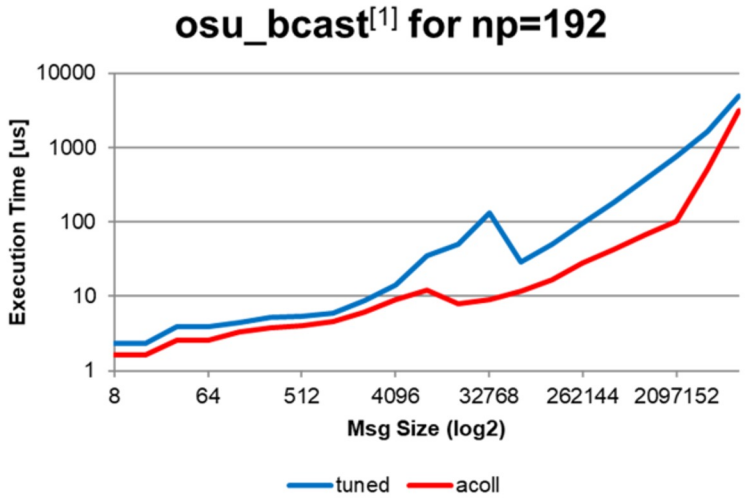
How to build and run with acoll

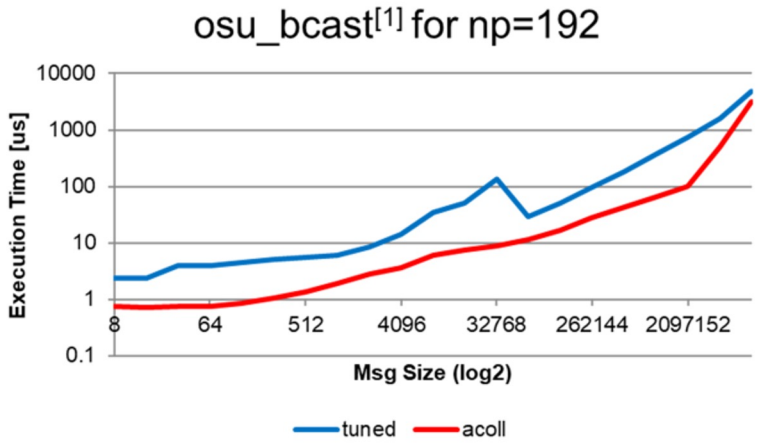
- Part of the main branch and will be part of 6.0.x
- Clone the Open MPI repository, build and install according to documentations
- Running with acoll component

```
mpirun <common mpi runtime parameters> --mca coll
acoll,tuned,libnbc,basic -mca coll_acoll_priority 40
./<executable>
```

What's next

- Extend acoll to interact with accelerator component
- Inter-node support

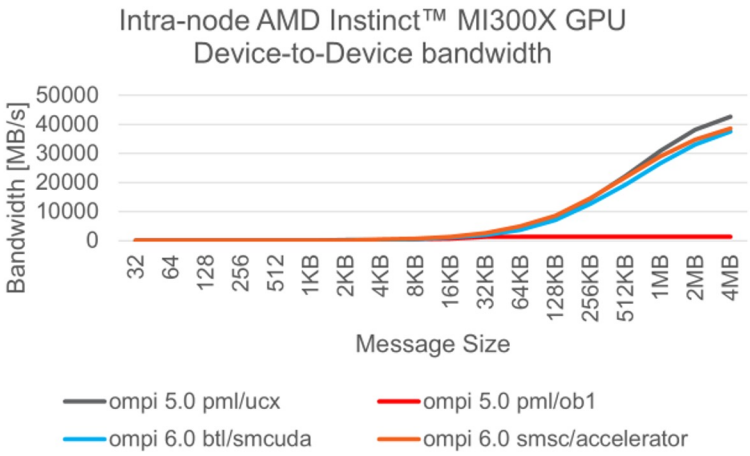




[1] OSU Benchmark Suite https://mvapich.cse.ohio-state.edu/benchmarks/ (BSD License)

Open MPI 6.0 upcoming enhancements for GPU devices

- **Added support for Open MPI native intra-node device-to-device transfers**
  - **Single copy** accelerator component (***smsc/accelerator***)
  - Generalized the existing ***btl/smcuda*** component to work **with any accelerator** supported by Open MPI
  - Both components achieve similar performance to UCX for device-to-device transfers
  - Brings **performance parity** for system configuration that are not supported by UCX
  - Components have to be explicitly requested by user

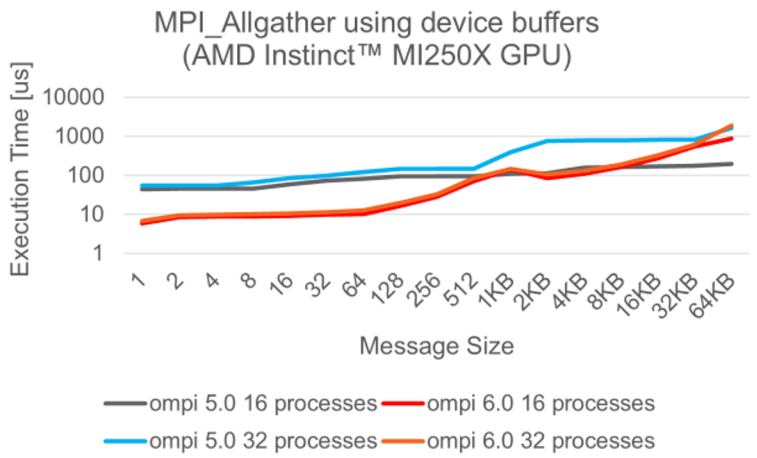


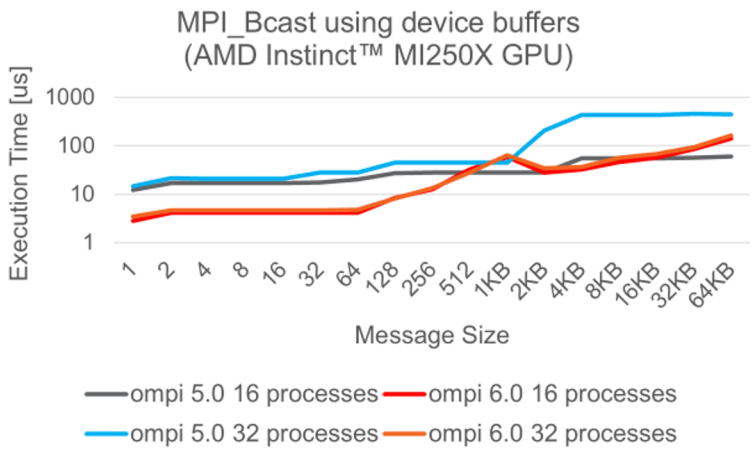

```
mpirun --mca pml ob1 --mca smsc_accelerator_priority 80 -np 4 ./<executable>
```

- **Support for MPI 4.1 memory-allocation kinds**
  - User can restrict memory types supported for an `MPI_Comm`, `MPI_Win`, `MPI_File`, or `MPI_Session`
  - A few optimizations taking advantage of this feature already available in Open MPI 6.0
    - Some components can disqualify themselves during object creation based on the info object value
    - Buffer-pointer type-check bypass depending on the info object value in the parallel file I/O component
    - More to follow

Enhancements to collective operations on device buffers

- Added support to the ***coll/accelerator*** component for MPI_Bcast, MPI_Allgather, and MPI_Alltoall
- Significant performance improvements for short messages





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AMD

Open MPI Activities at DOE – ORNL/LANL

Howard Pritchard (LANL)
Thomas Naughton (ORNL)
Amir Shehata (ORNL)

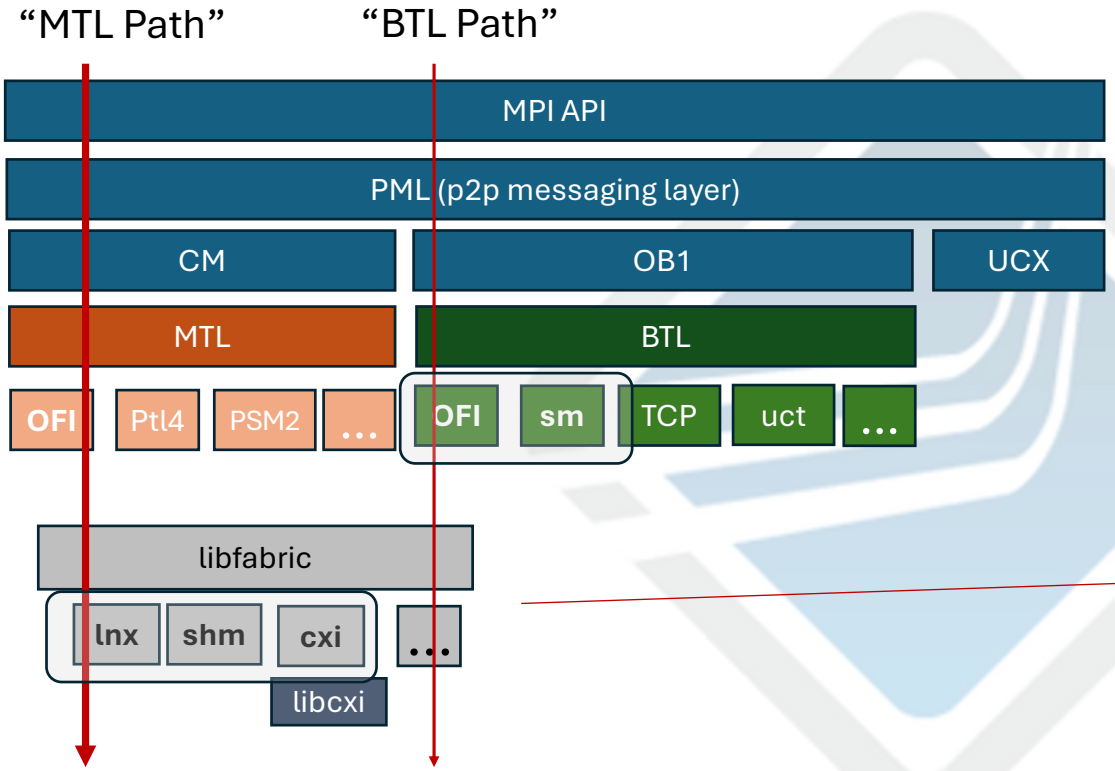
Open MPI on DOE Systems

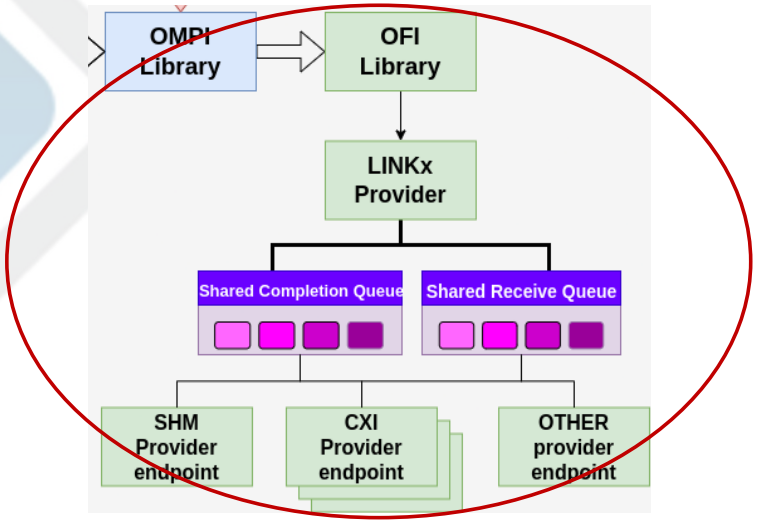
- DOE Exascale systems
  - Slingshot 11, different GPU devices & node topologies
- ORNL & LANL working on SS11 items for
  - Different resource managers via OpenPMIx/PRRTE
  - Both MTL & BTL paths usable with libfabric provider

https://s4pst.org

https://cass.community

Where Libfabric fits in Open MPI Architecture Diagram





Libfabric “lnx” provider

- Links two or more providers for seamless use
  - Renamed “LINKx” → “LNX
  - Provider must support FI_PEER capability
  - Useful for linking Slingshot 11 (CXI) and Shared Memory (SHM) providers
  - Can be used for multi-rail setups

Usage with Open MPI

- OFI provider to 'lnx'

  OMPI_MCA_opal_common_ofi_provider_include=**lnx** **# OFI 2.x change**

- Runtime settings for Slurm

  PRTE_MCA_ras_slurm_use_entire_allocation=1 **# Give mpirun all CPUs**

  PRTE_MCA_ras_base_launch_orted_on_hn=1 **# Launch prted via srun**
  # to setup Slingshot VNI

- Versions

Open MPI	>= 5.0.7
Libfabric	>= 2.2.0
Slingshot	Libcxi 1.0.x (SHS 12.0.1)

Usage with Open MPI (2)

- PCI location of LNX fi_info from 1st device in link
  - Example: Frontier's 4 SS11 devices (cxi0,1,2,3)

FI_LNX_PROV_LINKS=**shm+cxi:cxi0|shm+cxi:cxi1|shm+cxi:cxi2|shm+cxi:cxi3**

Closest to **CPUs 48-63 NUMA 3** | **CPUs 16-31 NUMA 1** | **CPUs 0-15 NUMA 0** | **CPUs 32-47 NUMA 2**

FI_LNX_PROV_LINKS=**shm+cxi:cxi0,cxi1,cxi2,cxi3**

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~~FI_LNX_PROV_LINKS=**shm+cxi:cxi0,cxi1,cxi2,cxi3**~~

~~Closest to — CPUs 48-63 NUMA 3~~

On Frontier, **NOT** what you want

Full Listing: Environment Settings

```
PRTE_MCA_ras_slurm_use_entire_allocation=1
PRTE_MCA_ras_base_launch_orted_on_hn=1
OMPI_MCA_opal_common_ofi_provider_include=lnx
OMPI_MCA_mtl=ofi
OMPI_MCA_mtl_ofi_av=table

FI_SHM_USE_XPMEM=1
FI_LNX_PROV_LINKS=shm+cxi:cxi0|shm+cxi:cxi1|shm+cxi:cxi2|shm+cxi:cxi3
```

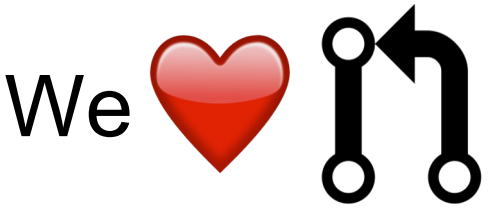
Getting Started on Frontier

```
module unload cray-mpich cray-pmi

module use   ums ums024
module load  ums ums024
module load  openmpi/5.0.9

mpirun --bind-to core --map-by ppr:1:l3cache \
       --np $SLURM_NTASKS \
       gpuwrapper.sh ./app
```

Questions?

Where Do We Need Help?

- Code
  - Any bug that bothers you
  - Any feature that you can add
- ***User documentation***
- Testing (CI, nightly)
- Usability



Come join us!