2023 OFA Virtual Workshop

STATUS OF OPENFABRICS INTERFACES (OFI) SUPPORT IN MPICH

Yanfei Guo, Computer Scientist

Argonne National Laboratory

OVERVIEW

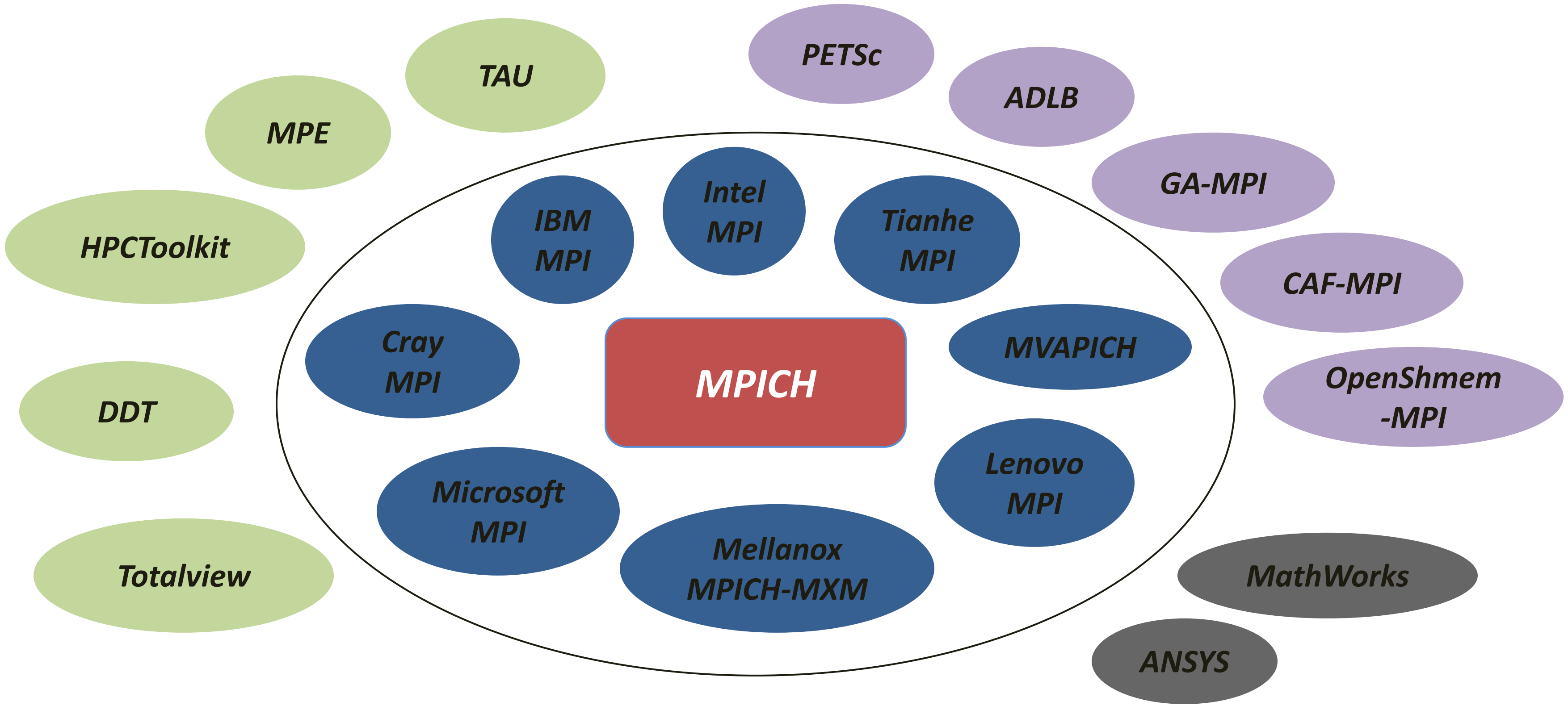
- **What is MPICH?**
- **Why OFI?**
- **Current Support**
- **Future Plan**

WHAT IS MPICH?

- **MPICH is a high-performance and widely portable open-source implementation of MPI**
- **It provides all features of MPI that have been defined so far (up to MPI-4.0)**
- **Active development lead by Argonne National Laboratory and University of Illinois at Urbana-Champaign**
  - Several close collaborators who contribute features, bug fixes, testing for quality assurance, etc.
    - IBM, Microsoft, Cray, Intel, Ohio State University, Queen’s University, Mellanox, RIKEN AICS and others
- **www.mpich.org**

MPICH: GOAL AND PHILOSOPHY

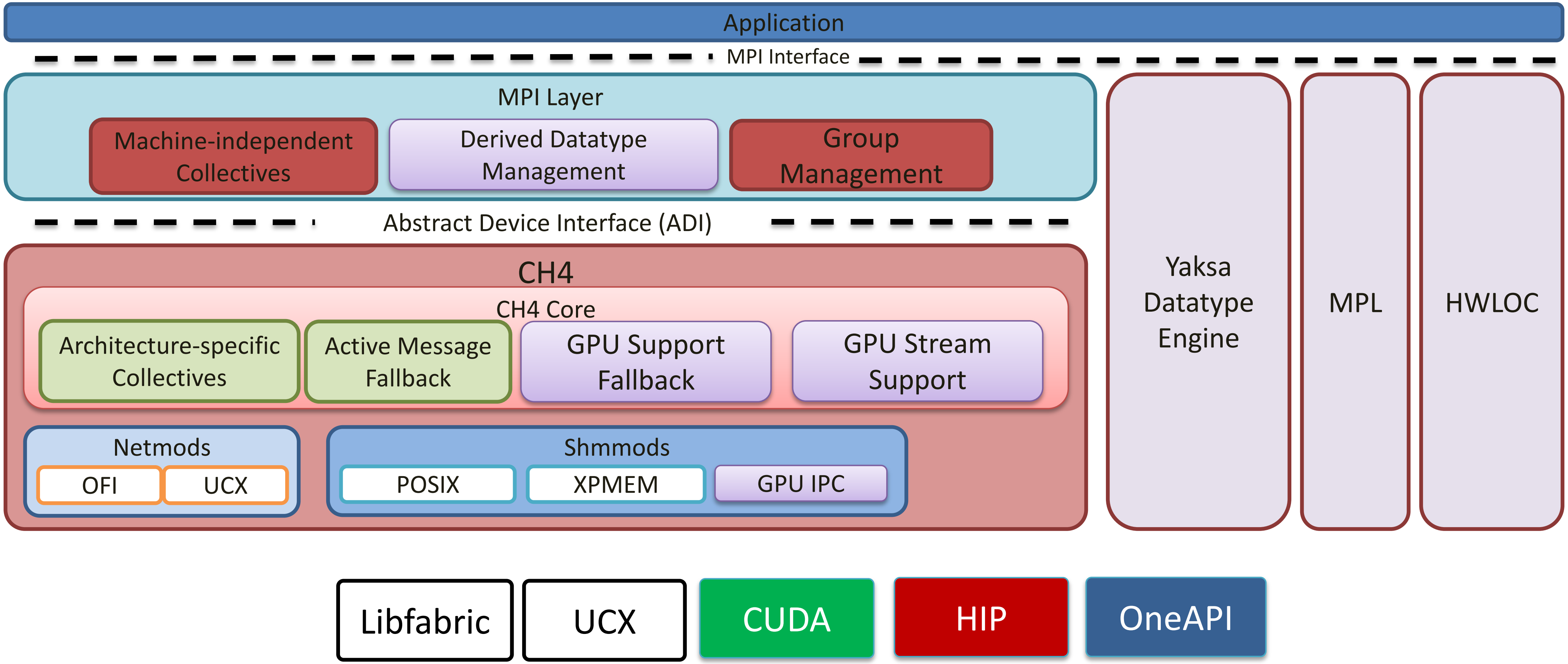
- **MPICH aims to be the preferred MPI implementation on the top machines in the world**
- **Our philosophy is to create an “MPICH Ecosystem”**



MOTIVATION

- **Why OFI/OFIWG?**
  - Support for diverse hardware through a common API
  - Actively, openly developed
    - Hosted on Github
  - Close abstraction for MPI
    - MPI community engaged from the start
  - Fully functional sockets provider
    - Prototype code on a laptop
  - Strong Vendor Support

MPICH WITH CH4 DEVICE OVERVIEW



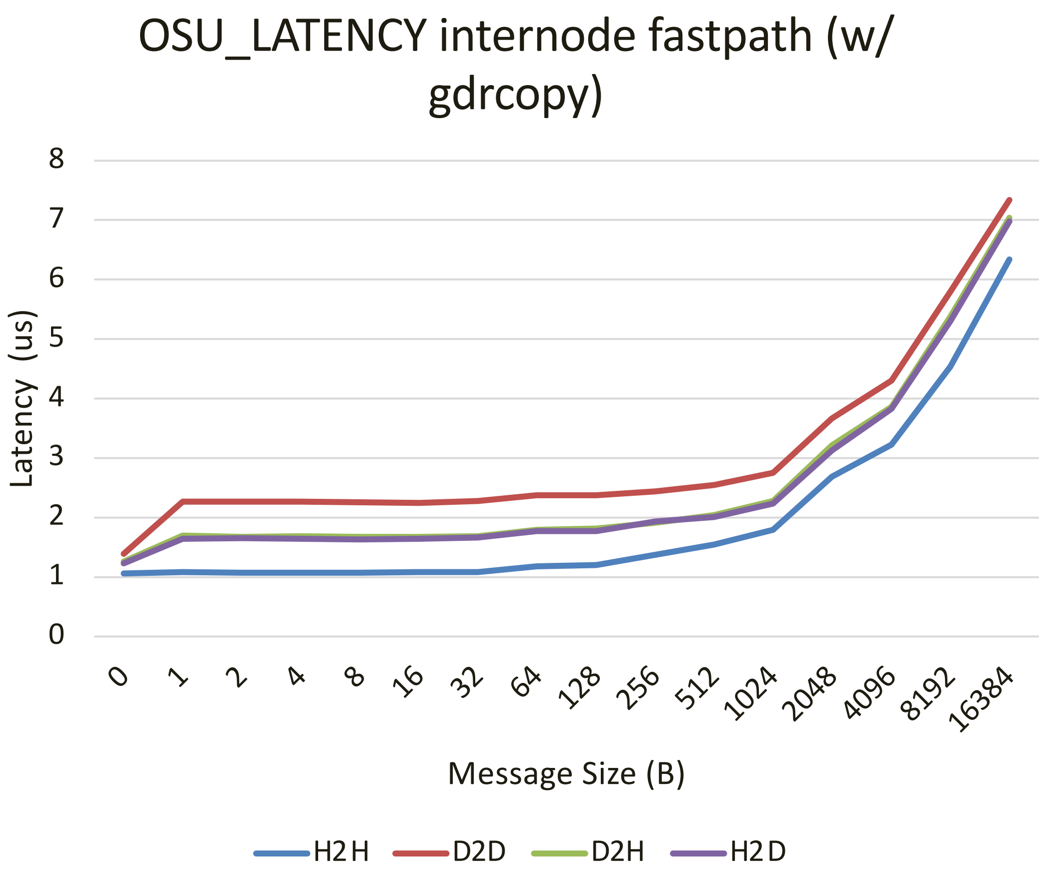
MPICH 4.1 RELEASE SERIES

- **MPIX Stream prototype**
- **Standalone PMI Library**
- **MPICH Testsuite**
  - Comprehensive testsuite for MPI implementations in general
  - Now available as separate release target
- **Accelerate CI builds**
  - CI is key for productivity, we do hundreds of CI builds daily
  - Projects are getting more complex, and slower to build
  - Option to prebuild submodules, `./autogen.sh -quick` to avoid repeated rebuild
- **Improved ch4 and yaksa stability**

MPI+GPU

- **Native GPU Data Movement**
  - Multiple forms of “native” data movement
  - GPU Direct RDMA is generally achieved through Libfabrics or UCX (we work with these libraries to enable it)
  - GPU Direct IPC is integrated into MPICH
- **GPU Fallback Path**
  - GPU Direct RDMA may not be available due to system setup (e.g. library, kernel driver, etc.)
  - GPU Direct IPC might not be possible for some system configurations
  - GPU Direct (both forms) might not work for noncontiguous data
  - Datatype and Active Message Support
  - New GPU-aware datatype engine

The GPU support in MPICH is developed in close collaboration with vendor partners including Including AMD, Cray, Intel, Mellanox and NVIDIA



On Summit with MPICH 4.0, UCX 1.11.0, CUDA 11.4.2, GDRCOPY 2.3

MPIX STREAM – EXPLICITLY TELL MPI ABOUT THREAD CONTEXT

- **`MPIX_Stream` identifies a serial execution context**

```
int MPIX_Stream_create(MPI_Info info, MPIX_Stream *stream)
int MPIX_Stream_free(MPIX_Stream *stream)
```

- **`info` can be `MPI_INFO_NULL`, identifies a generic thread context**
- **In the case of threads, it is the application's responsibility to ensure access to an MPIX_Stream is serialized. Essentially MPI_THREAD_SERIAL, but at the object-level, rather than all of MPI.**

Hui Zhou, Ken Raffenetti, Yanfei Guo, and Rajeev Thakur. 2022. MPIX Stream: An Explicit Solution to Hybrid MPI+X Programming. In Proceedings of the 29th European MPI Users' Group Meeting (EuroMPI/USA'22).

STREAM COMMUNICATOR

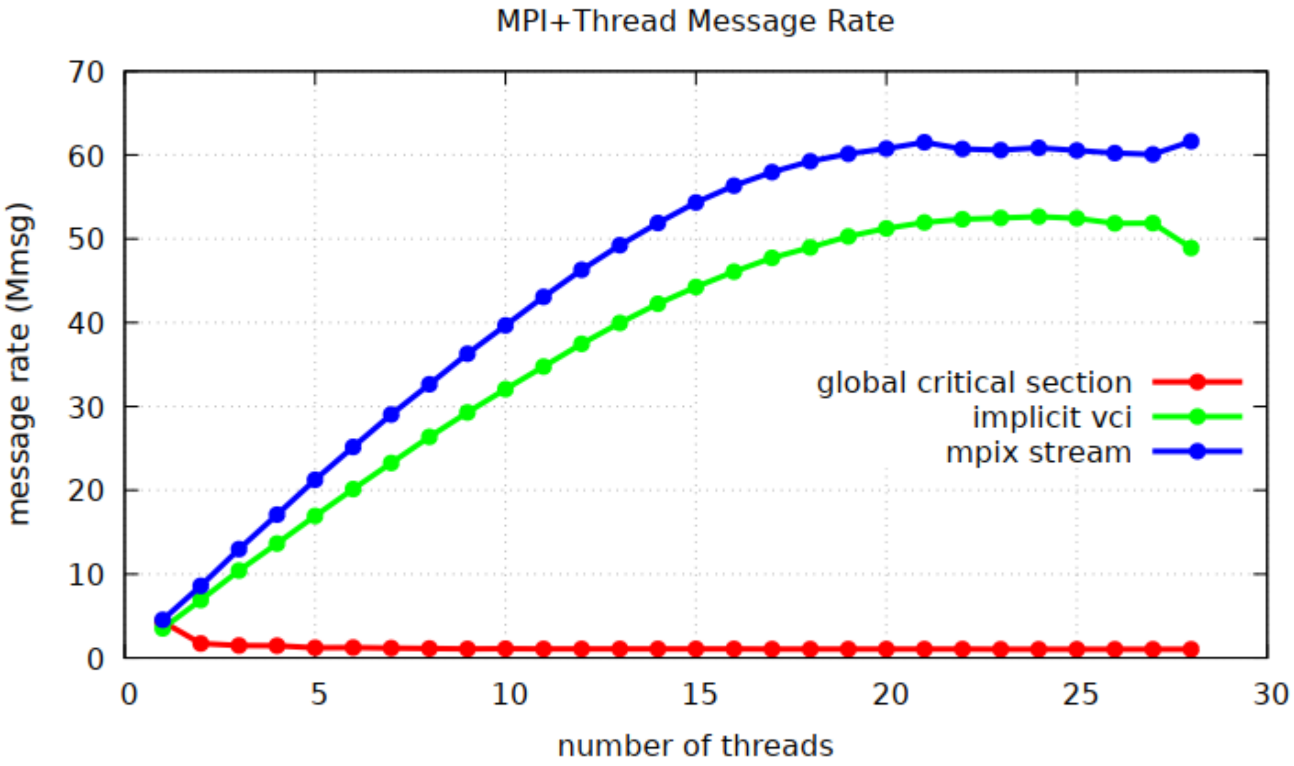
- **Stream communicator is a communicator with local streams attached.**

```
int MPIX_Stream_comm_create(MPI_Comm parent_comm,
   MPIX_Stream stream, MPI_Comm *stream_comm)
```

- **MPIX streams are local, but communications are between pairs of them**
- **Otherwise, synchronization is unavoidable at receiver or sender.**
- **It okay for `stream` to be `MPIX_STREAM_NULL`.**
- **Conventional communicators are the same as stream communicators with `MPIX_STREAM_NULL` on every process.**

STREAM COMMUNICATION IMPROVES ON IMPLICIT VCI PERFORMANCE

- **Implicit VCI mapping in MPICH-4.0 scales well with multiple threads**
- **Advice to users**
  - Use different communicators
  - Same communicator, use different tags and set hints
- **Explicit VCI with MPIX_Stream communicator in MPICH-4.1 removes thread safety overhead**



STANDALONE PMI

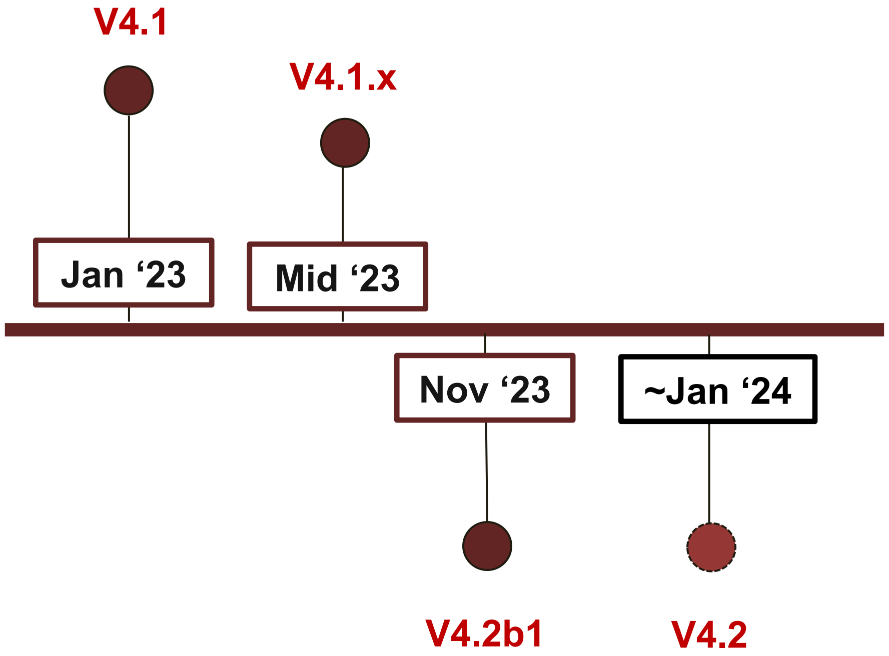
- **PMI remains an internal component in MPICH**
- **Supporting both PMI-1 and PMI-2 is confusing**
  - PMI-1 is the default in MPICH/Hydra, well tested
  - PMI-2 is/was experimental, not feature-complete, less stable
  - Slurm documents PMI-2, but supports PMI-1
  - Cray supports PMI-2
- **Interest in using PMI/Hydra independently from MPICH**
  - PMI interface is a universal interface that works everywhere MPI works
  - Hydra is a robust and versatile launcher
  - PMI/Hydra works well for multi-process runtimes, e.g. OpenSHMEM, NVSHMEM
- **Need to extend PMI/Hydra to support modern PMI features**
  - To (partially) support PMIx

STANDALONE PMI -- AVAILABLE IN MPICH-4.1

- **Better configure options**
  - `--with-pmi={pmi1,pmi2,pmix}`
  - `--with-pmilib={mpich,slurm,cray,pmix}`
  - `--with-pm={no,hydra,gforker,remshell}`
  - `--with-pmi={slurm,cray} also works`
- **Separate release targets**
  - `pmi-4.1.tar.gz` and `hydra-4.1.tar.gz`
  - Provide `libpmi.so`
- **Consistent PMI headers**
  - Third party PMI implementation should support the same `pmi.h` and `pmi2.h`
- **Internal refactoring**
  - PMI-1 and PMI-2 are internally unified
  - Wire protocol layer and semantic layer are separated

MPICH 4.2 ROADMAP

- **MPICH-4.2a1 2H 2023**
- **MPICH-4.2b1 targeted for SC23**
  - 4.2.x branch will be created
- **GA release in early 2024**
- **Critical bug fixes will be backported to 4.1.x**



MPICH 4.2 FEATURES

- **Experimental Thread Communicator for interthread communication**
- **Experimental support for MPI-5 ABI proposal**
- **PMIx support in libpmi and Hydra**
- **Improved support for MPI-4 partitioned communication**
- **More in plan**

MPIX THREAD COMMUNICATOR

- Make MPI available for inter-thread communication within parallel regions.
- Break down thread and process silos for a unified communication API.

```
int MPIX_Threadcomm_init(MPI_Comm comm, int num_threads,
                         MPI_Comm threadcomm)
```

```
#pragma omp parallel {
    MPIX_Threadcomm_start(threadcomm);
    /* use threadcomm within parallel region */
    MPIX_Threadcomm_finish(threadcomm);
}
```

MPIX THREAD COMMUNICATOR - STATUS

- **Open pull request, will merge soon**
- **✓ Point-to-point functions (blocking and non-blocking, intra- and inter-node)**
- **✓ Blocking collectives (single algorithm)**
- **Non-blocking collectives**
- **Collective algorithm tuning**
- **Communicator functions**
- **? One-sided communication**

SUPPORT MPI-5 ABI

- **A working proposal currently being developed in MPI Forum**
- **Build once, work with either MPICH or Open MPI derivatives**
- **MPICH-4.2 will support both MPICH ABI and optionally MPI-5 ABI**
  - `mpicc` builds MPICH ABI, `mpicc_abi` builds MPI-5 ABI
  - `libmpi.so` implements MPICH ABI, `libmpi_abi.so` implements MPI-5 ABI
  - `mpi.h` will effectively become `mpi_abi.h` when `mpicc_abi` is used. User code always `#include <mpi.h>`

OPENFABRICS ALLIANCE

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THANK YOU

Yanfei Guo, Computer Scientist

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