Perspective and Experience with OFI in MPICH

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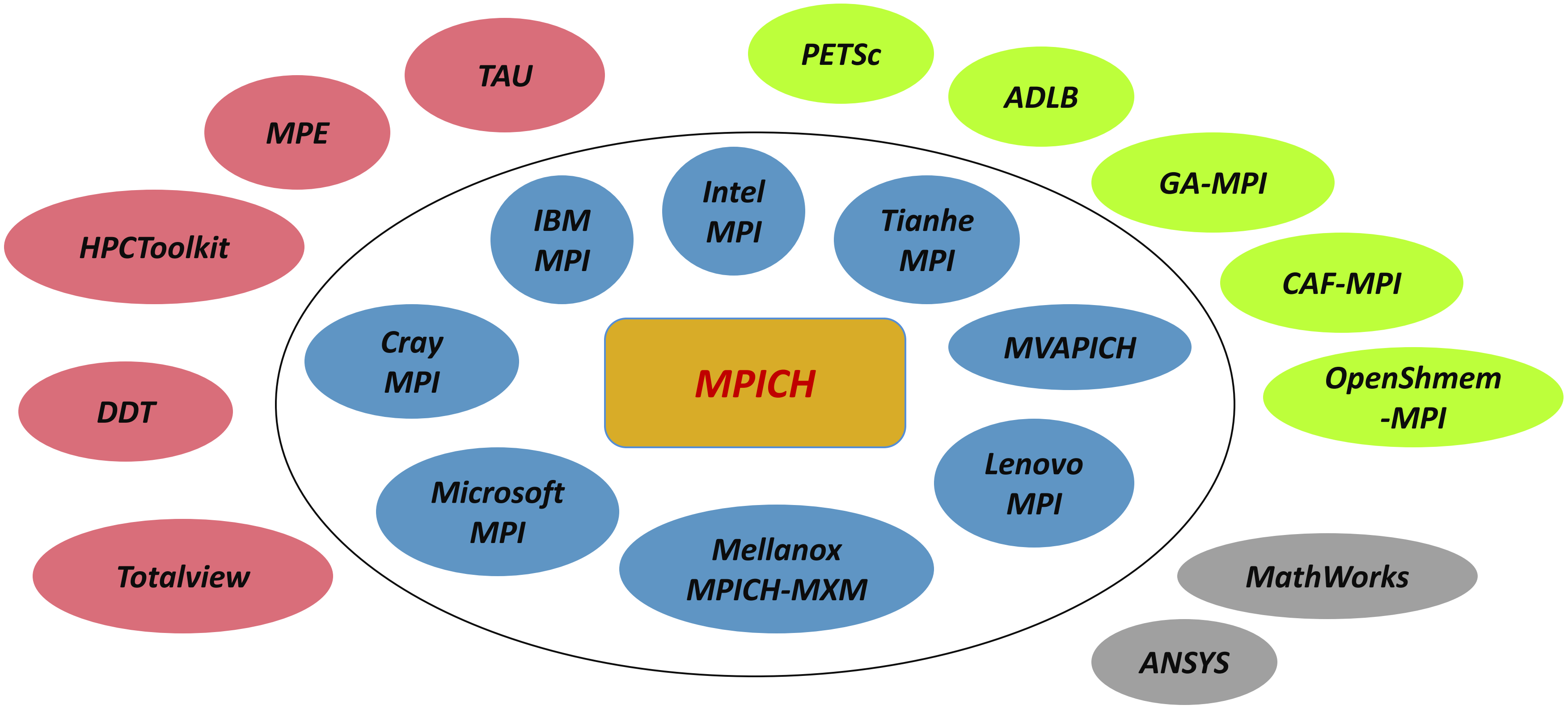
What is MPICH

- 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 (including MPI-1, MPI-2.0, MPI-2.1, MPI-2.2, and MPI-3.0)
- Active development lead by Argonne National Laboratory and University of Illinois at Urbana-Champaign
  - Several close collaborators who contribute many features, bug fixes, testing for quality assurance, etc.
    - IBM, Microsoft, Cray, Intel, Ohio State University, Queen's University, Mellanox, RIKEN AICS and many others
- Current stable release is MPICH-3.1.4
- www.mpich.org

MPICH: Goals and Philosophy

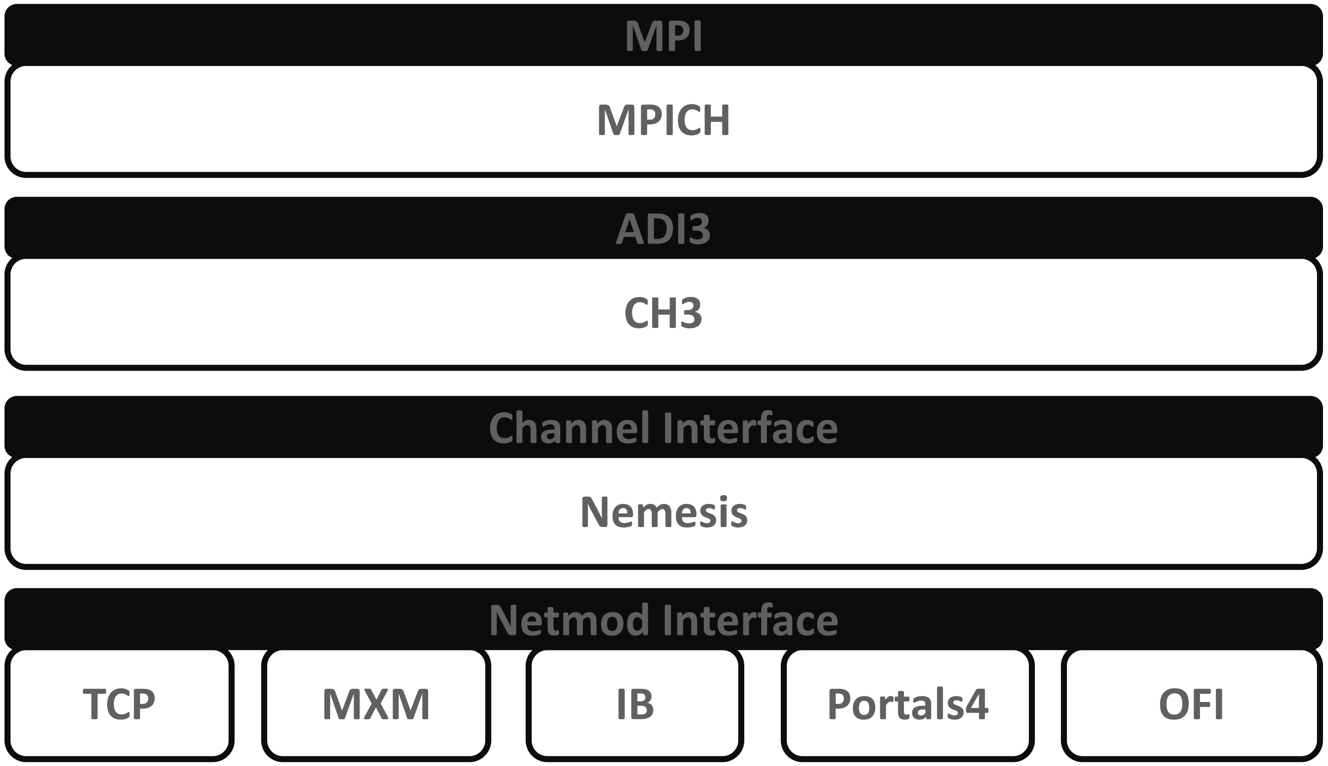
- MPICH aims to be the preferred MPI implementation on the top machines in the world
- Our philosophy is to create an "MPICH Ecosystem"



Motivations

- Why are we interested in OFI?
  - Not limited to a single hardware configuration
  - Actively, openly developed
  - OFI provides a nice abstraction for MPI
    - Less code
    - Hides nitty-gritty details
  - Promise of a fully functional sockets provider for laptop development

MPICH Layered Design



OFI Netmod

- Why a CH3/Nemesis Netmod?
  - Provides MPI correctness (all of MPI-3)
    - Years of testing and bugfixes
  - Highly-tuned shared memory transport
  - Netmod supports hardware matching
  - Upcoming improvements in MPICH 3.2 release series
    - RMA scalability improvements
    - New netmod hooks

OFI Netmod

- Network Initialization
  - Address discovery/exchange
- Data movement
  - Send/Recv
- Control messages
  - Also involves data movement

OFI Netmod

- Initialization
  - Provider selection
    - Tag matching (FI_TAGGED)
    - Dynamic memory region spanning all memory (FI_DYNAMIC_MR)
  - Endpoint creation
    - Reliable Datagram
    - Address exchange over PMI to populate AV
      - Stored in MPICH virtual connection table

OFI Netmod

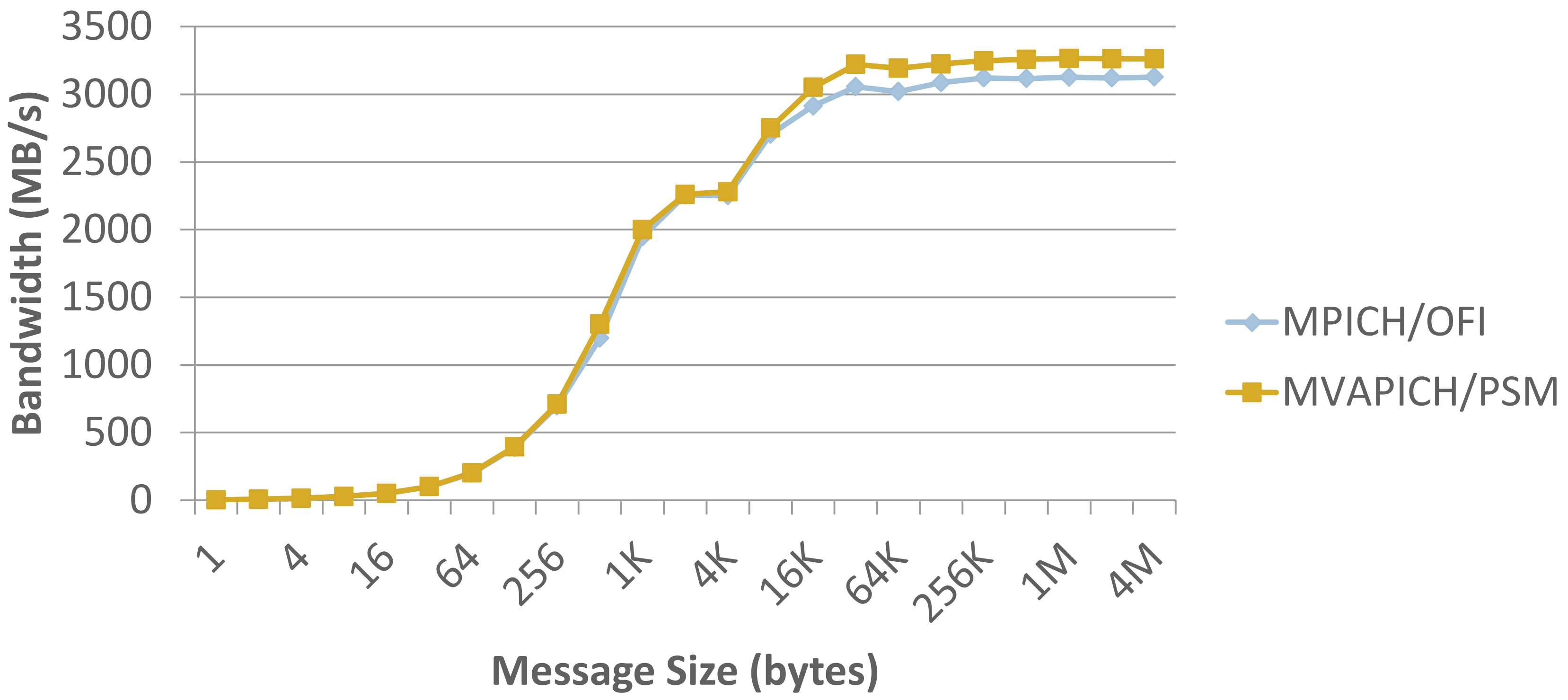
- Point-to-point data movement
  - Closely maps to fi_tsend/trecv functionality

```
MPI_Send(buf, count, datatype, dest, tag, comm)

fi_tsend(gl_data.endpoint,            /* Endpoint */
         send_buffer,                 /* Packed or user */
         data_sz,                     /* Size of the send */
         gl_data.mr,                  /* Dynamic memory region */
         VC_OFI(vc)->direct_addr,     /* VC address */
         match_bits,                  /* Match bits */
         &(REQ_OFI(sreq)->ofi_context));
```

Pt2Pt Benchmarks (Blues cluster @ ANL)

- 0-byte PingPong
  - 1.90 µs MPICH/OFI vs 1.44 µs MVAPICH/PSM

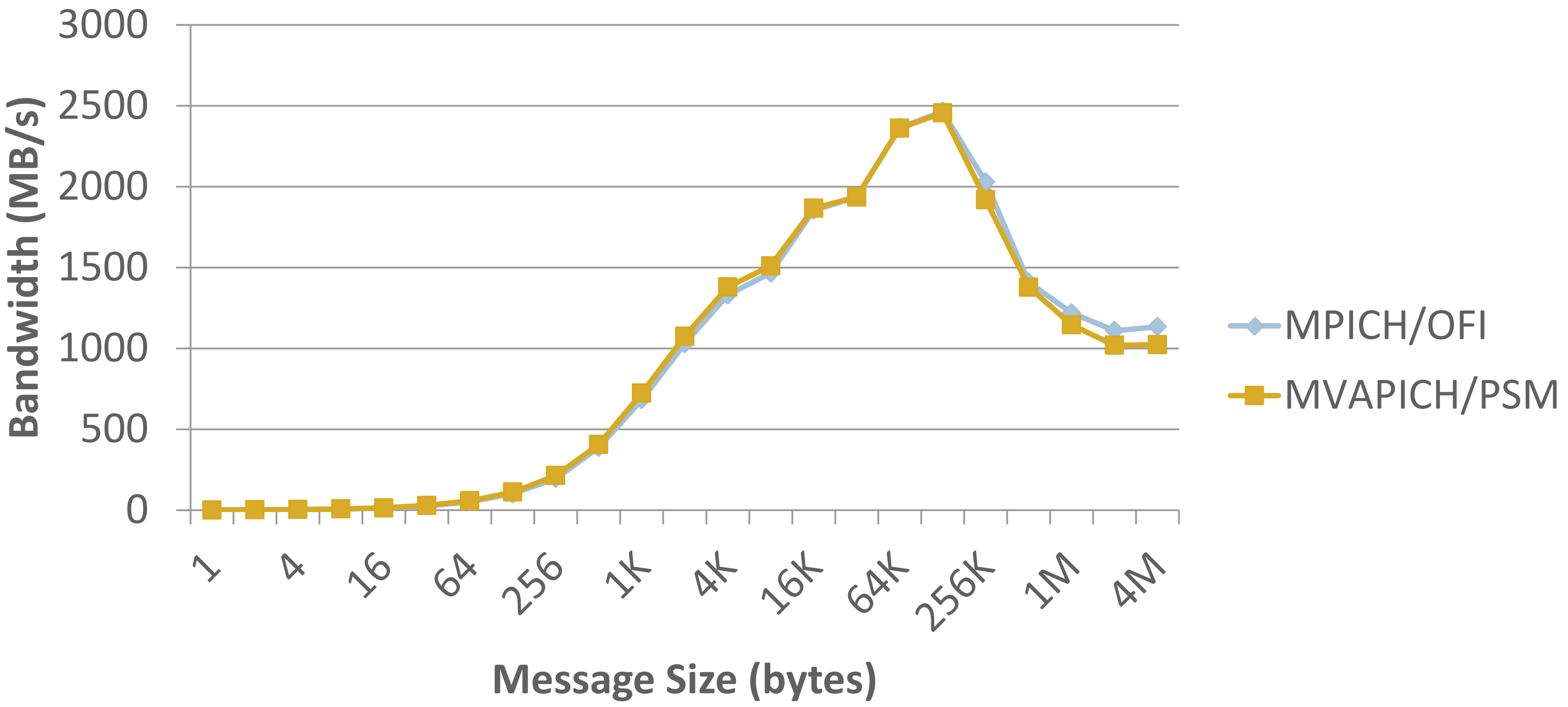


OFI Netmod

- Control Messages and RMA
  - MPICH CH3 implementation based on active messages
    - Use of persistent request to accept incoming CH3 packets + eager data
    - Received into temporary buffer, then copied to user buffer
    - Ongoing work in MPICH 3.2 to provide put/get overrides in netmod

Put Benchmarks

- 1-byte Put Latency
  - 11.52 µs (MPICH/OFI) vs. 8.92 µs (MVAPICH/PSM)
- Bandwidth



OFI/Portals 4 Comparison

- Similarities
  - Shared, connection-less endpoints
  - Both one-sided and two-sided primitives
  - Hardware matching
  - Network hardware independent
- Differences
  - Queue management
    - Portals 4 – explicit unexpected queue management
    - OFI – single persistent request
  - Flow-control
    - Portals 4 - leaves recovery to the upper layer
    - OFI – enabled or disabled

Additional Complexity

Future Work

- How can we improve our OFI support?
  - Finish CH3/Nemesis improvements
  - Support providers with different sets of functionality?
  - Triggered operations?

Thank you

- Questions?