Endpoints Plenary

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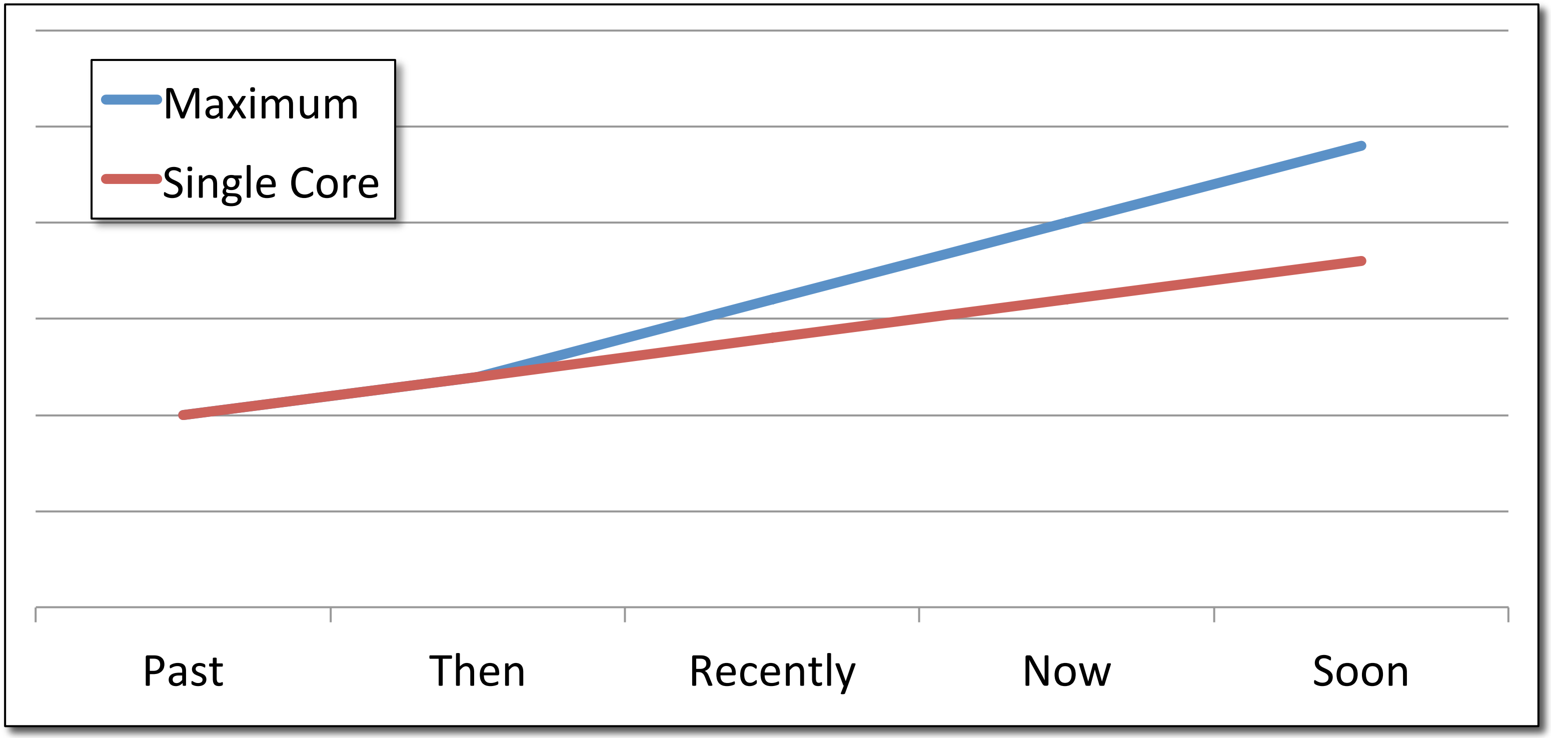
Status of Endpoints

1. Proposal text #380 ready
2. Explored interoperability story [EuroMPI ‘13]
3. Exploring performance story [IJHPCA in prep]
4. Working on implementation in MPICH
   - Will be open source
5. Target: Formal reading in March

Motivation for Endpoints

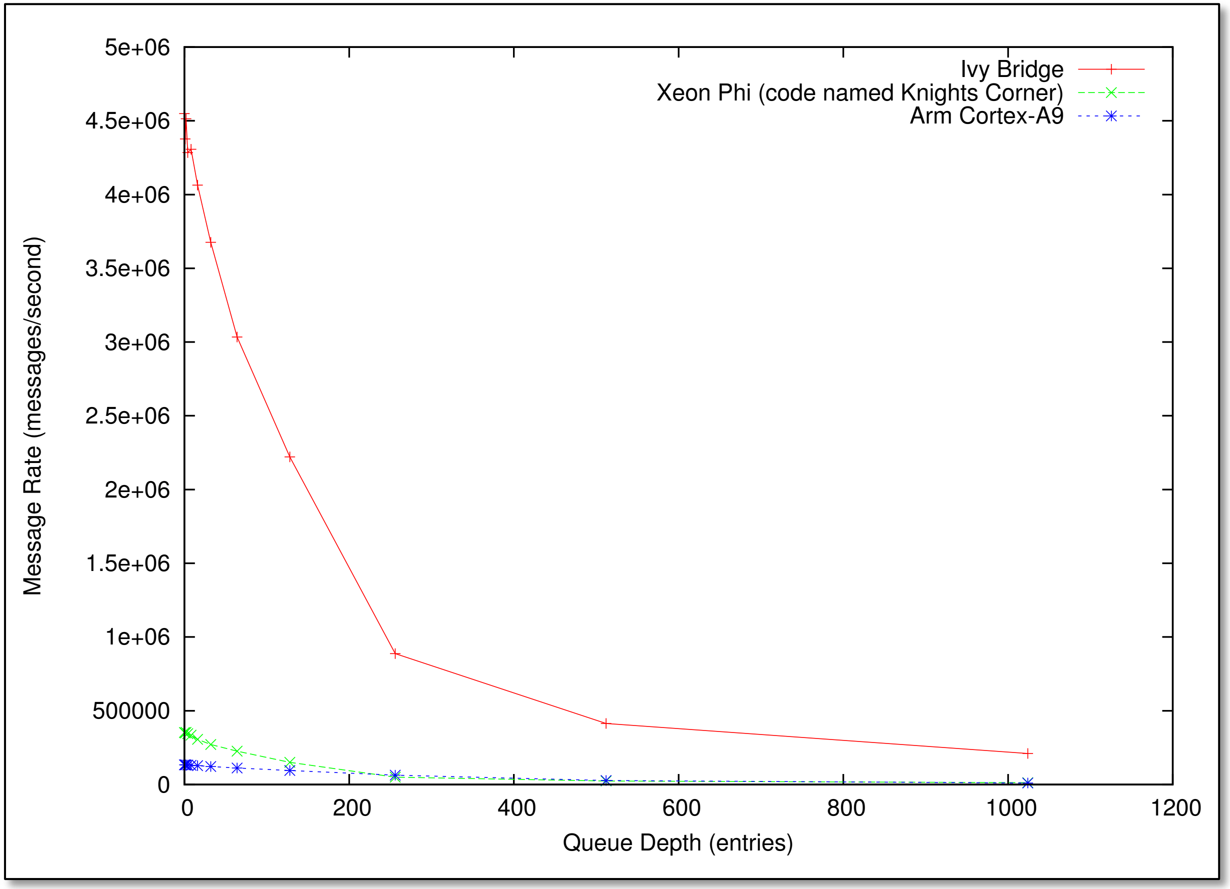
1. Interoperability argument
   - On-node programming model
   - Multi-node models that use threads
2. Performance argument
   - Increase communication concurrency
     - Preserve shared memory/node-level programming
     - Make number of VA spaces free parameter
   - Reduce synchronization penalties
     - Privatize thread communication state and resources

Achievable Network Performance (Dramatization)



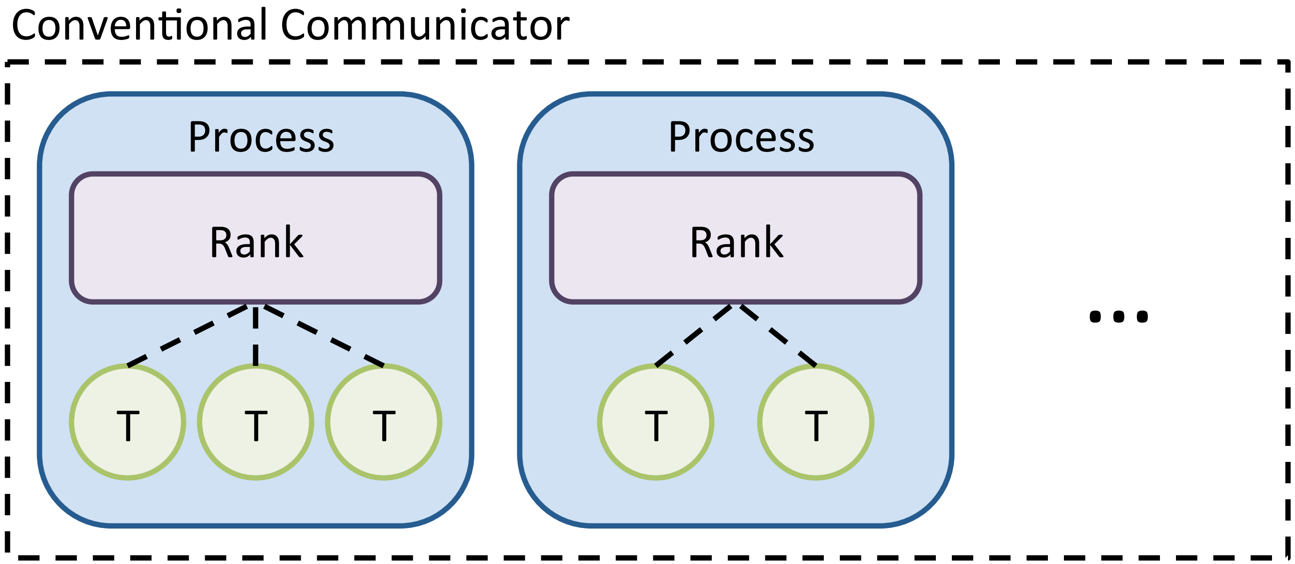
- Network endpoint design evolving to support many cores
- ***Not real data, represents my personal views***
- Gathering real data for paper, will present at next meeting

Impact of Queue Depth on Message Rate



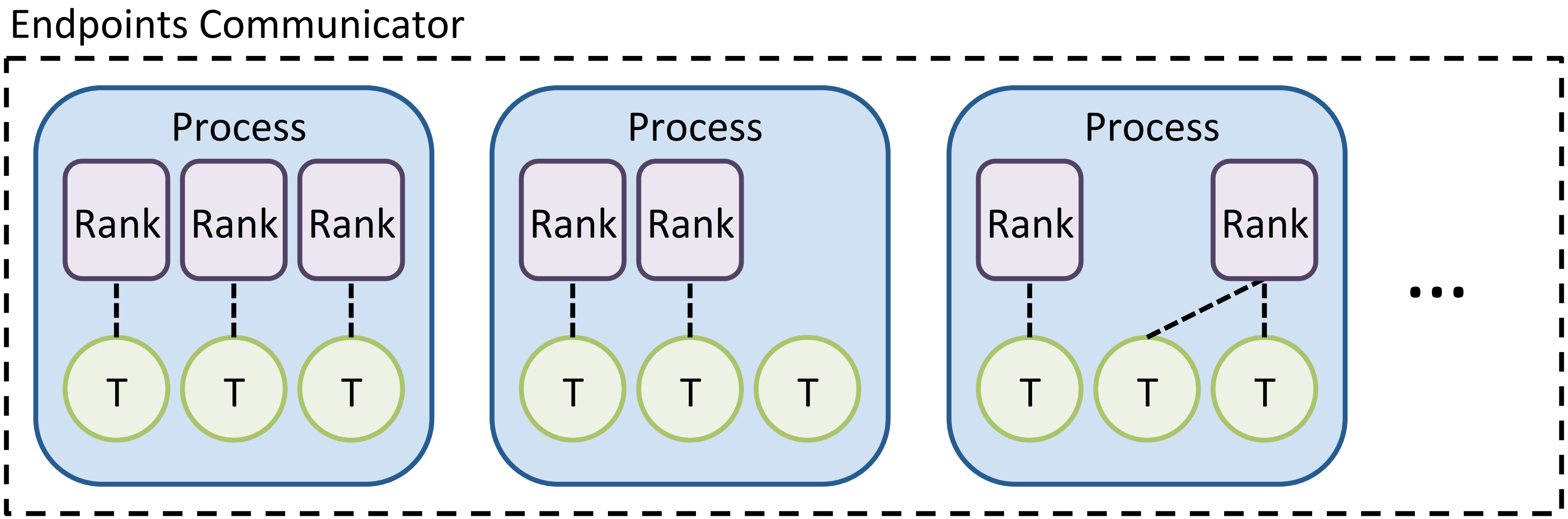
- Brian Barrett, et al. [EuroMPI '13]
- Threads sharing a rank increase posted receive queue depth (x-axis)

Mapping of Ranks to Processes



- MPI provides a 1-to-1 mapping of ranks to processes
- This was good in the past
- Usage models and systems have evolved
  - Hybrid MPI+Threads programming
  - Ratio of core to network endpoint performance decreasing

Endpoints Model



- Many-to-one mapping of ranks to processes
  - Threads act as first-class participants in MPI operations
  - Improve programmability of MPI + X
  - Threads drive independent network endpoints
- Endpoint: Set of resources that supports the independent execution of MPI communications
  - Endpoints have process semantics

Current THREAD_MULTIPLE Usage

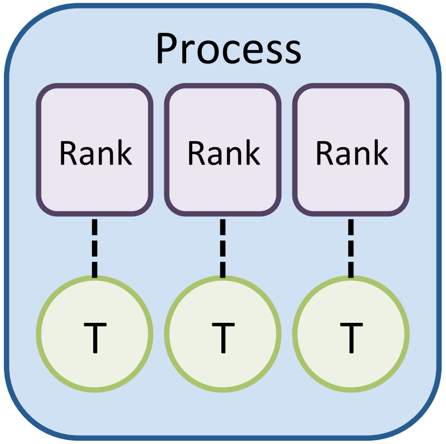
- MPI message matching space: `<communicator, sender, tag>`
- Two approaches to using THREAD_MULTIPLE

1. Match specific thread using the tag:
   - Partition the tag space to address individual threads
   - Limitations:
     - Collectives – Multiple threads at a process can't participate concurrently
     - Wildcards – Multiple threads concurrently requires care

2. Match specific thread using the communicator:
   - Split threads across different communicators (e.g. Dup and assign)
   - Can use wildcards and collectives
   - However, limits connectivity of threads with each other

Implementation of Endpoints

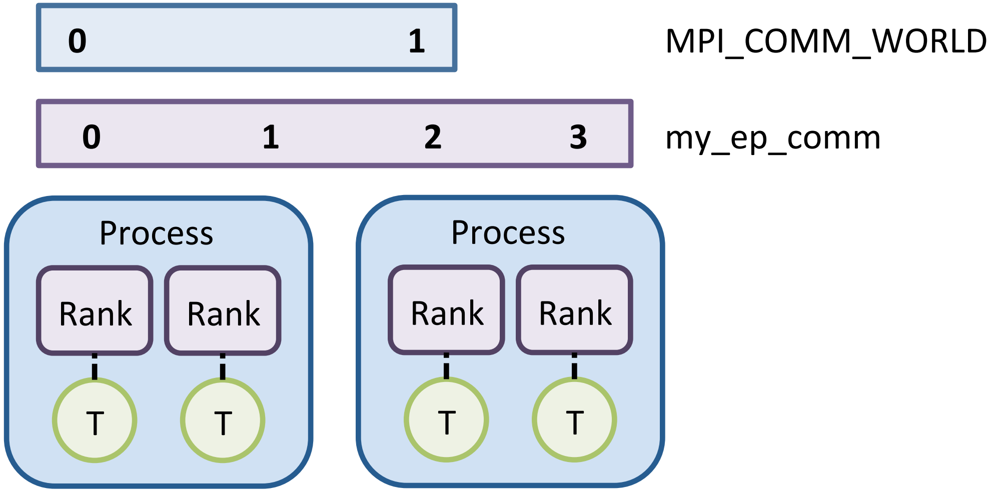
- Two implementation strategies
  1. Each rank is a network endpoint
  2. Ranks are multiplexed on endpoints
     - Effectively adds destination rank to matching
  3. Combination of the above



- Potential to reduce threading overheads
  - Separate resources per thread
    - Rank can represent distinct network resources
    - Increase HFI/NIC concurrency
  - Separate software state per thread
    - Per-endpoint message queues/matching
    - Enable per-communicator threading levels

- FG-MPI implements “static” endpoints
  - A little different, still demonstrates implementation and performance benefits

Endpoints Interface



0 1 MPI_COMM_WORLD

0 1 2 3 my_ep_comm

Process

Rank Rank

T T

Process

Rank Rank

T T

```
int MPI_Comm_create_endpoints(
   MPI_Comm parent_comm, int my_num_ep,
   MPI_Info info, MPI_Comm *out_comm_hdls[])
```

- – Out handle array takes TLS out of the implementation and off the critical path
- – Each process requests an independent number of endpoints
- – MPI_ERR_ENDPOINTS – Endpoints could not be created

Endpoints Proposal

https://svn.mpi-forum.org/trac/mpi-forum-web/ticket/380