A Fault Tolerant MPI Standard for HPC Applications and Libraries

Dr. Joshua Hursey

Oak Ridge National Laboratory

http://users.nccs.gov/~jjhursey

Fault Tolerance: The approaching storm

As the number of components in an HPC system increase the overall system reliability diminishes.

- **HPC system reliability is a problem for:**
  - Long running applications running at any scale, and
  - Any application running at large scale
- **International Exascale Software Project:**
  - Failures will no longer be *rare events*, but *normal events* that the application must be prepared to handle.
  - Projected Mean Time To Failure (MTTF):
    - Petascale: O(days)  Exascale: O(minutes)
  - Fault Tolerant MPI needed by 2012 – 2013 timeframe

Cappello, Geist, Gropp, Kale, Kramer, and Snir, "Toward exascale resilience," 2009.
Exascale Roadmap: http://www.exascale.org/iesp/IESP:Documents

MPI Forum Fault Tolerance Working Group

MPI Standard does not address interface semantics after process failure.
"After an error is detected, the state of MPI is undefined."

- **Our Mission:**
  - Define a set of semantics and interfaces to *enable* fault tolerant applications and libraries to be portably constructed on top of MPI.
- **Application Involved Fault Tolerance (not transparent)**
  - Algorithm Based Fault Tolerance (ABFT)
  - Natural Fault Tolerance
  - Middleware libraries that provide applications with various fault tolerant services
- **Some driving goals:**
  - Scalability, performance, localized recovery, and layered library support.

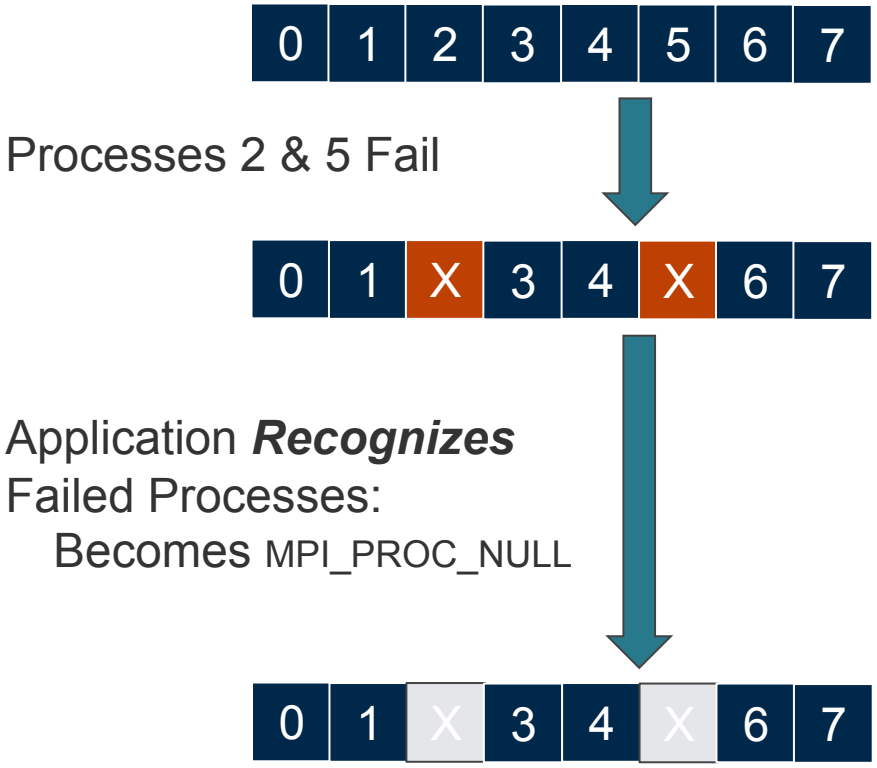
Proposal & Prototype Co-Development

- **Fail-stop failures:**
  - Process is permanently stopped, often due to crash.
- **Development stages:**

	Proposal	Prototype (Open MPI)
1. Run-through stabilization	MPI-1 (complete) MPI-2 (in development)	MPI-1 (complete) ---
2. Process recovery	In-development	---

- **Concurrently working with applications and libraries**
  - Helps to ground the proposal, and provide real-world examples for new developers
  - We can always use more use-cases, libraries, and applications

Stage 1: Run-through Stabilization



Process Failure Semantics

MPI_Send(rank=**2**) // MPI_ERR_RANK_FAIL_STOP
MPI_Send(rank=3) // MPI_SUCCESS
MPI_Recv(rank=6) // MPI_SUCCESS
MPI_Bcast() // MPI_ERR_RANK_FAIL_STOP

Local Failure Recognition

MPI_Comm_validate_rank(comm, rank, state)
MPI_Comm_validate(comm, incnt, outcnt, states)

Collective Failure Recognition

MPI_Comm_validate_all(comm, count)

Post-Recognition Semantics

MPI_Send(rank=**2**) // MPI_SUCCESS
MPI_Send(rank=3) // MPI_SUCCESS
MPI_Recv(rank=6) // MPI_SUCCESS
MPI_Bcast() // MPI_SUCCESS*

How to learn more & get involved

- **Looking for application and library developers**
  - More use cases, and early adopter feedback
  - Watch for the Open MPI prototype in early 2011
- **MPI Forum Meetings:**

  Website: http://meetings.mpi-forum.org
- **MPI Forum Fault Tolerance Working Group:**

  Website: http://meetings.mpi-forum.org/mpi3.0_ft.php

  Mailing List: http://lists.mpi-forum.org/mailman/listinfo.cgi/mpi3-ft

  Proposal: http://svn.mpi-forum.org/trac/mpi-forum-web/wiki/FaultToleranceWikiPage