Argonne NATIONAL LABORATORY

Chapel over MPI-3

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MPI: A Philosophical Perspective

- Debate in the community that MPI is too hard to program
  - We don't disagree ; it was never meant to be easy to program ☺
- A programming model has to pick a tradeoff between programmability, portability, and performance
  - MPI has chosen to be a high-performance and portable programming model
  - If we have to pick between losing performance/portability vs. losing programmability, we typically pick the latter
  - Focus has been on completeness and ability to help real and complex applications meet their computational needs
- ***MPI's goal is not to make simple programs easy to write, rather it is to make complex programs possible to write***

MPI as a Common Runtime System

- We want to encourage high-level libraries/languages on top of MPI to meet productivity goals or domain-specific optimizations
- MPI was traditionally considered to be too "two-sided" in nature to be suitable to be a PGAS or HPCS runtime system
- MPI-2 introduced one-sided communication, but the semantics were too restrictive to take advantage of modern hardware
  - Cache-coherent systems
  - PUT/GET hardware
- MPI-3 introduced a significantly revamped one-sided communication interface
  - Better support for cache-coherent hardware
  - Better communication and synchronization primitives
- The standard was released in September 2012
- MPICH released a (full) implementation at SC 2012

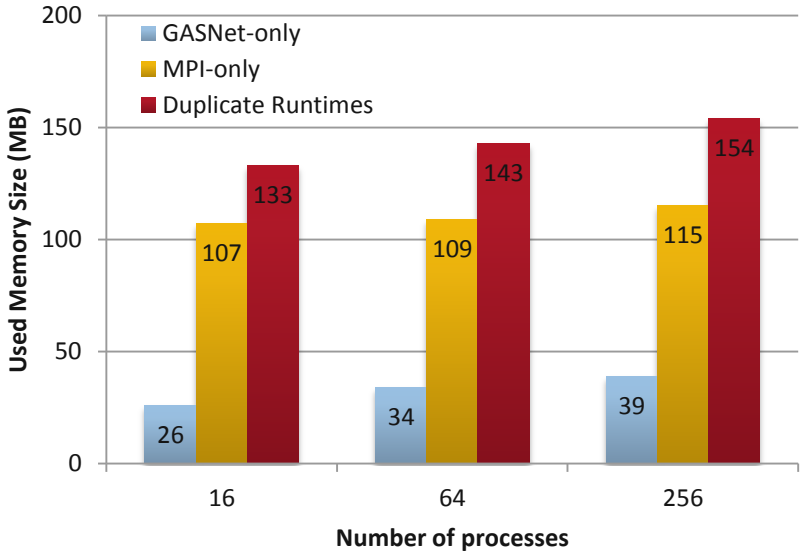
Status of MPI-3 Implementations (as of 11/20/2013)

	MPICH	MVAPICH	Cray	Tianhe	Intel	IBM PE	IBM Platform	Open MPI	SGI	Fujitsu	MS
NB collectives	✔	✔	✔	✔	✔	Q1 '14	✔	✔	✔		
Neighborhood collectives	✔	✔	✔	✔	✔	Q1 '14	Q3 '14	Q4 '13 (in nightly snapshots)	Q1 '14		
RMA	✔	✔	✔	✔	✔	Q1 '14	Q3 '14	Q1 '14	Q4 '13		
Shared memory	✔	✔	✔	✔	✔	Q1 '14	Q2 '15	Q1 '14	Q4 '13		
Tools Interface	✔	Q1 '14	Q2 '14	Q1 '14	Q1 '14	Q1 '14	Q2 '15	✔	Q1 '14		
Non-collective comm. create	✔	✔	✔	✔	✔	Q1 '14	Q2 '15	Q4 '13 (in nightly snapshots)	✔		
F08 Bindings (MPI-3 + errata)	(Q1 '14)	(Q2 '14)	(Q2 '14)	(Q1 '14)	(Q1 '14)	(Q1 '14)	(Q3 '14)	(✔)	(Q1 '14)		
New Datatypes	✔	✔	✔	✔	✔	Q1 '14	Q2 '15	✔	✔		
Large Counts	✔	✔	✔	✔	✔	Q1 '14	Q2 '15	✔	Q1 '14		
Matched Probe	✔	✔	✔	✔	✔	Q1 '14	Q3 '14	✔	✔		

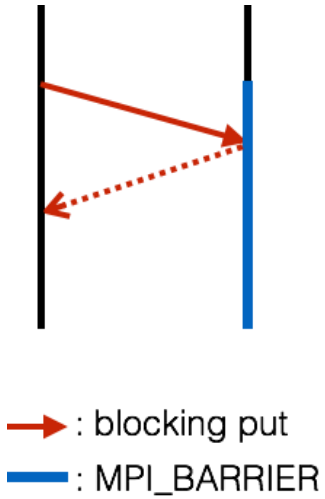
Release dates are estimates and are subject to change at any time.

Empty cells indicate no *publicly announced* plan to implement/support that feature.

Chapel over MPI-3

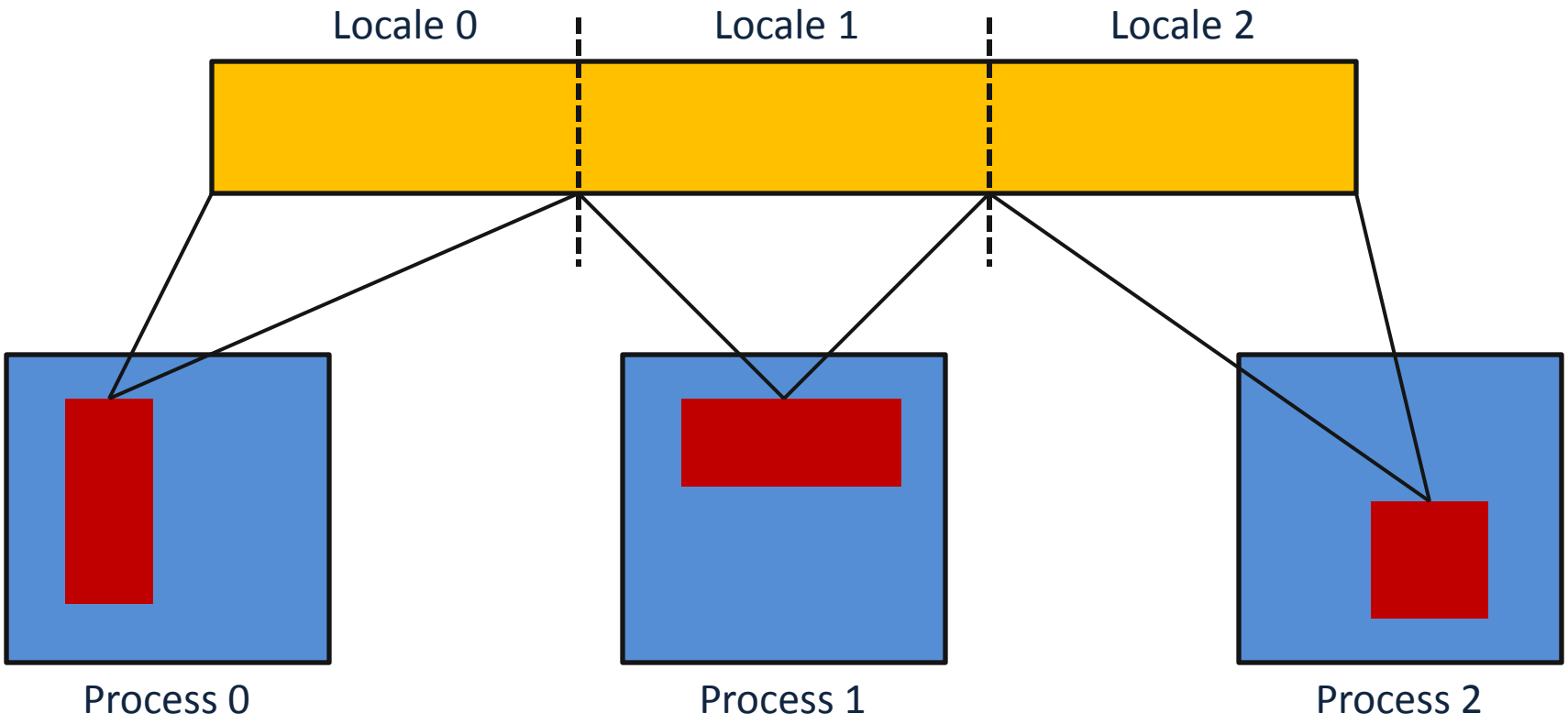


- Combine strengths of different runtime systems
  - Performance of MPI
  - Usability of PGAS languages
- Ability to leverage external, MPI-based libraries
  - Easy to program a Jacobi iteration in CHAPEL
  - Write one from scratch, or make use of PETSc, elemental, etc.
- Adopting a new language like CHAPEL is not easy for real-world applications
  - Many applications have an MPI dependence
  - Users slow to adopt if performance hinges on new runtime systems
- Chapel over MPI-3
  - Reduces duplication of runtime resources
  - MPI-3 provides a much better match to Chapel's needs than MPI-1



MPI-3 Features in CHAPEL

- MPI Windows
  - Allocation handled by MPI Implementation
  - Exposed memory shared by all processes in a communicator



Chapel Tasks

- Traditionally done with Active Messages in GASNet
- No active messages in MPI (yet)
- Our model is to use a remote queuing model using MPI RMA atomic operations
  - Lock remote target
  - Enqueue task and arguments
  - Unlock target
- Partial asynchronous progress in this model
  - Enqueue operation can be asynchronous on a good MPI RMA implementation
  - The actual execution of the task requires the target process to see the enqueued operations and execute them