Process Management Interface – Exascale

Agenda

- Since we last met…
  - Address some common questions
  - Outline PMIx standards process
- PMIx v1.x release series
  - What has been included and planned
  - Review launch performance status
- Roadmap
  - Features in the pipeline
  - Potential future features
- Questions/comments/discussion

Charter?

- **Define**
  - set of agnostic APIs (not affiliated with specific model code base) to support application ⇔ system mgmt software (SMS) interactions
- **Develop**
  - an open source (non-copy-left licensed) standalone “convenience” library to facilitate adoption
- **Retain**
  - transparent compatibility across all PMI/PMIx versions
- **Support**
  - the *Instant On* initiative
- **Work**
  - to define/implement new APIs for evolving programming models.

What Is PMIx?

- Standardized APIs
  - Four header files (client, server, common, tool)
  - Enable portability across environments
  - Support interactions between applications and system management stack
- Convenience library
  - Facilitate adoption
  - Serves as validation platform for standard
- Community

What Is PMIx?

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Not Required!

Required: Caveat

- Containerized operations
  - Require cross-boundary compatibility
  - Wireup library of containerized app must be compatible with the local resource manager
- Issues occur when migrating
  - Build under one environment using custom implementation
  - Move to another environment using different implementation
- Convenience library mitigates the problem

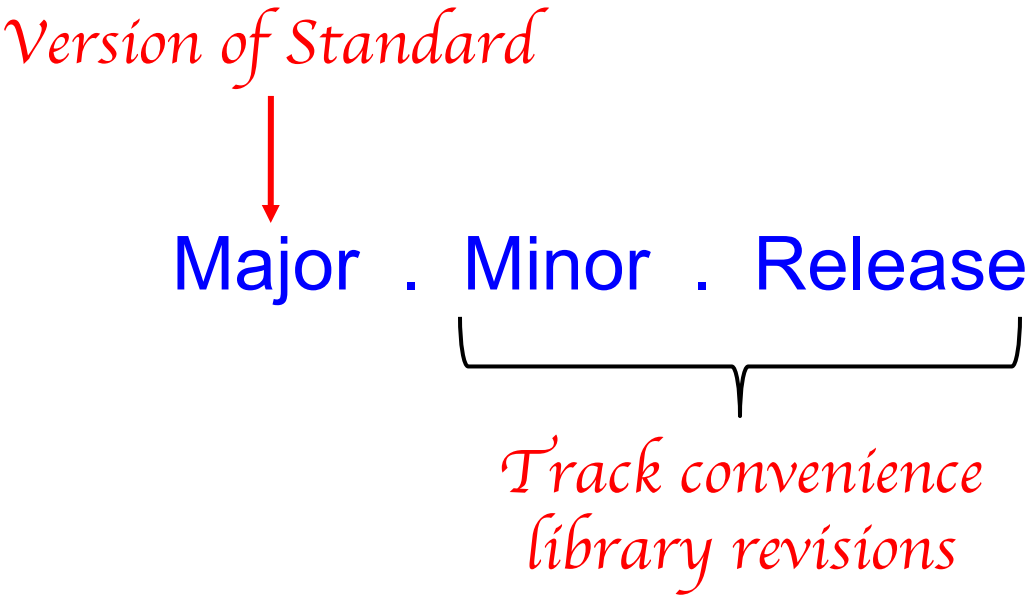
Why Not Part of MPI Forum?

- PMIx is agnostic
  - No concept of “communicator”
  - No understanding of MPI
  - Used by non-MPI libraries
- Discussions underway
  - Bring it into Forum process in some appropriate fashion

PMIx "Standards" Process

- Modifications/additions
  - Proposed as RFC
  - Include prototype implementation
    - Pull request to convenience library
  - Notification sent to mailing list
- Reviews conducted
  - RFC and implementation
  - Continues until consensus emerges
- Approval given
  - Developer telecon (2x/week)

PMIx Numbering



Regression Testing?

- Limited direct capability
  - Run basic API tests on each PR
- Extensive embedded testing
  - Open MPI includes PMIx master, regularly updated
  - 20k+ tests run every night
    - Tests all spawn, wireup, publish/lookup, connect/disconnect APIs
    - Not 100% code coverage

Adoption?

- Already released
  - SLURM 16.05 (PMIx v1.1.5)
- Planned
  - IBM, Fujitsu, Adaptive Solutions, Altair, Microsoft
- Reference server
  - Provides surrogate support until native support becomes available
  - Supports full PMIx standard, limited by RM capabilities
  - Launches network of PMIx servers across allocation

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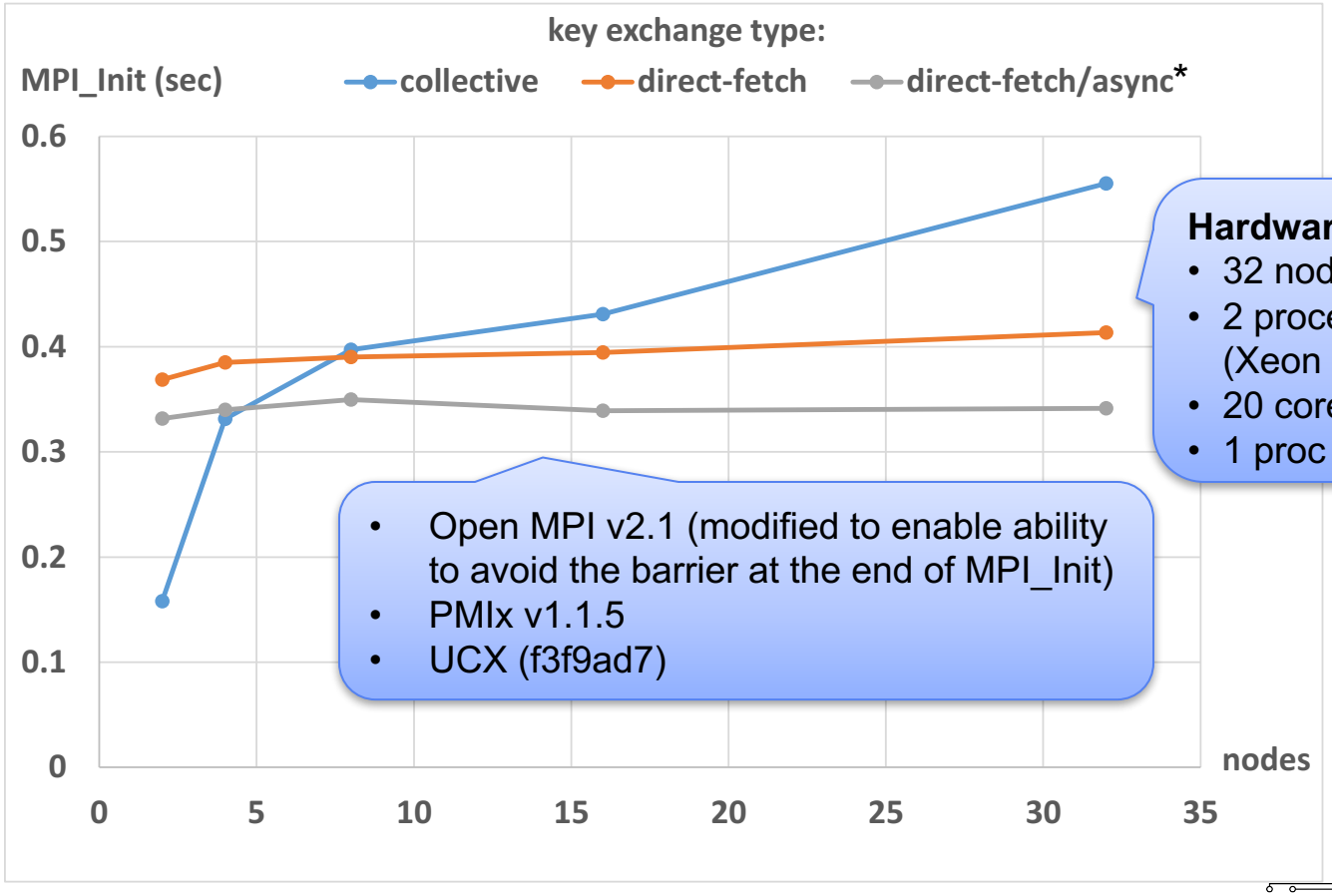
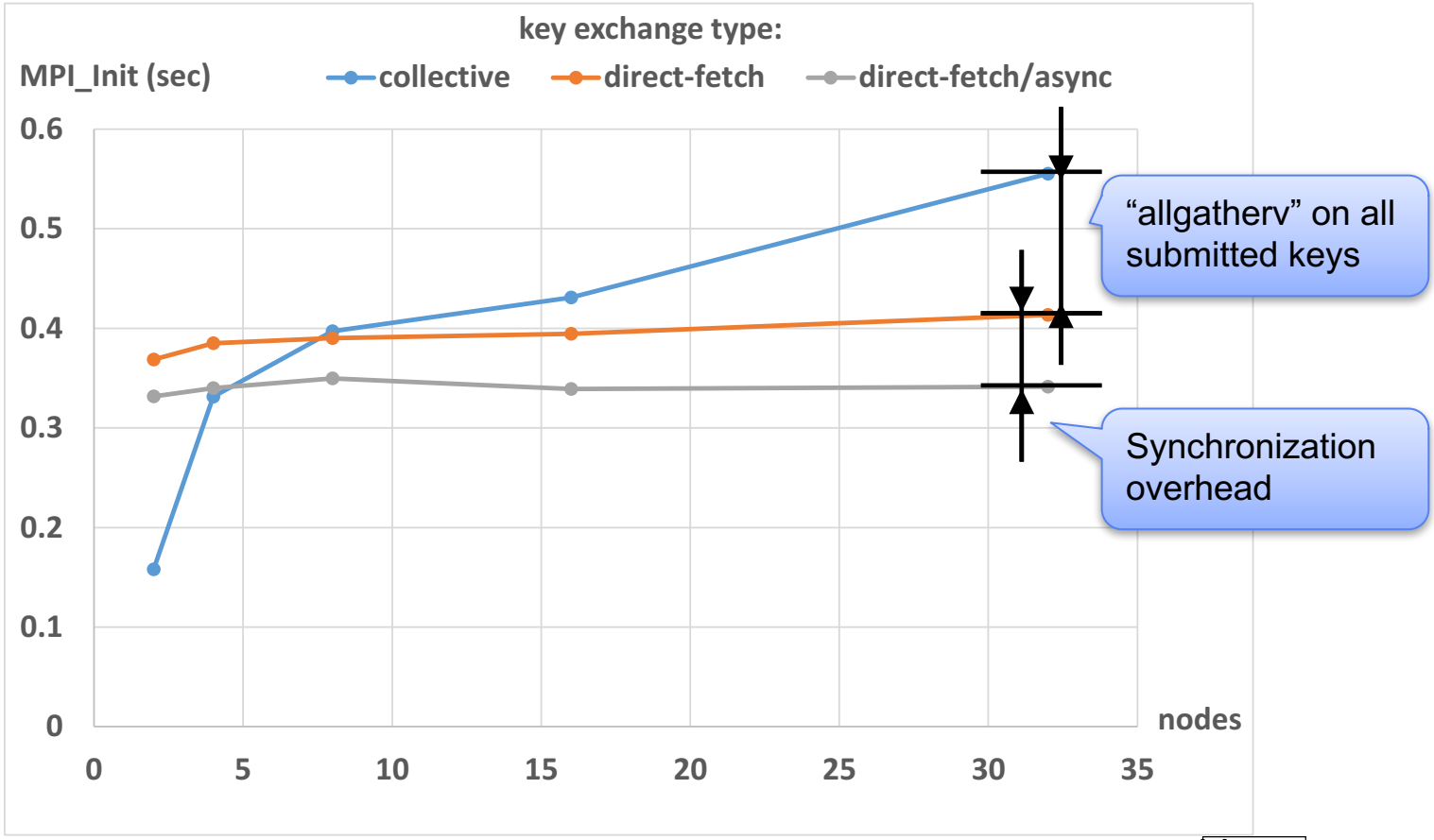
PMIx/UCX job-start use case



* **direct-fetch/async** assumes no synchronization barrier inside MPI_Init.

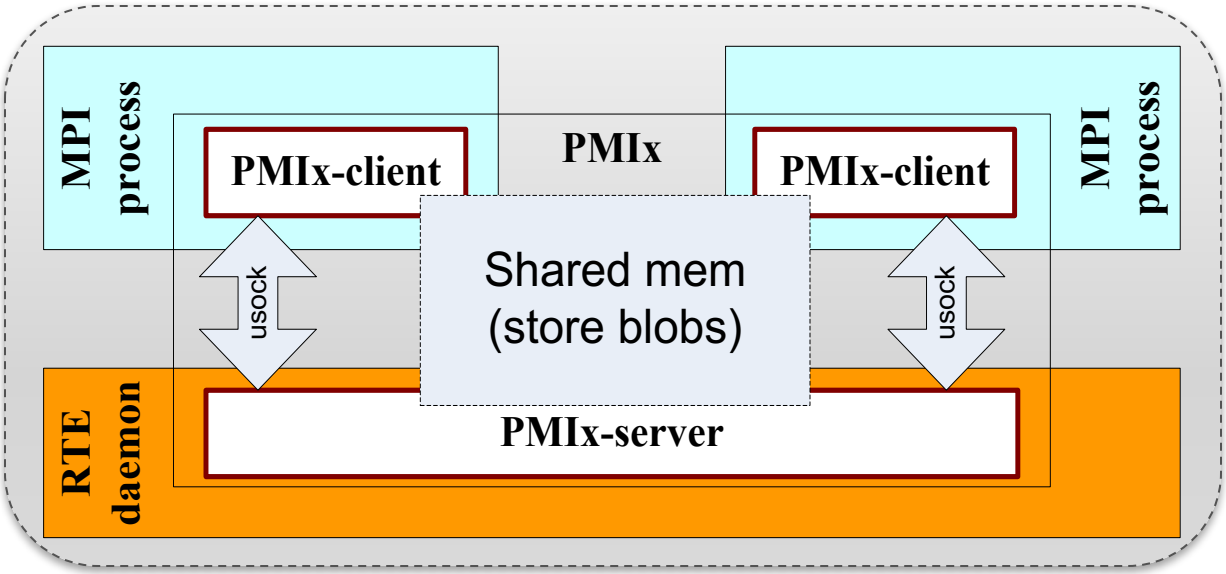
PMIx/UCX job-start usecase



v1.2.0

- Extension of v1.1.5
  - v1.1.5
    - Each proc stores own copy of data
  - v1.2
    - Data stored in shared memory owned by PMIx server
    - Each proc has read-only access
- Benefits
  - Minimizes memory footprint
  - Faster launch times

Shared memory data storage (architecture)



- Server provides all the data through the shared memory
- Each process can fetch all the data with **0 server-side CPU cycles!**
- In the case of direct key fetching if a key is not found in the shared memory – a process will request it from the server using regular messaging mechanism.

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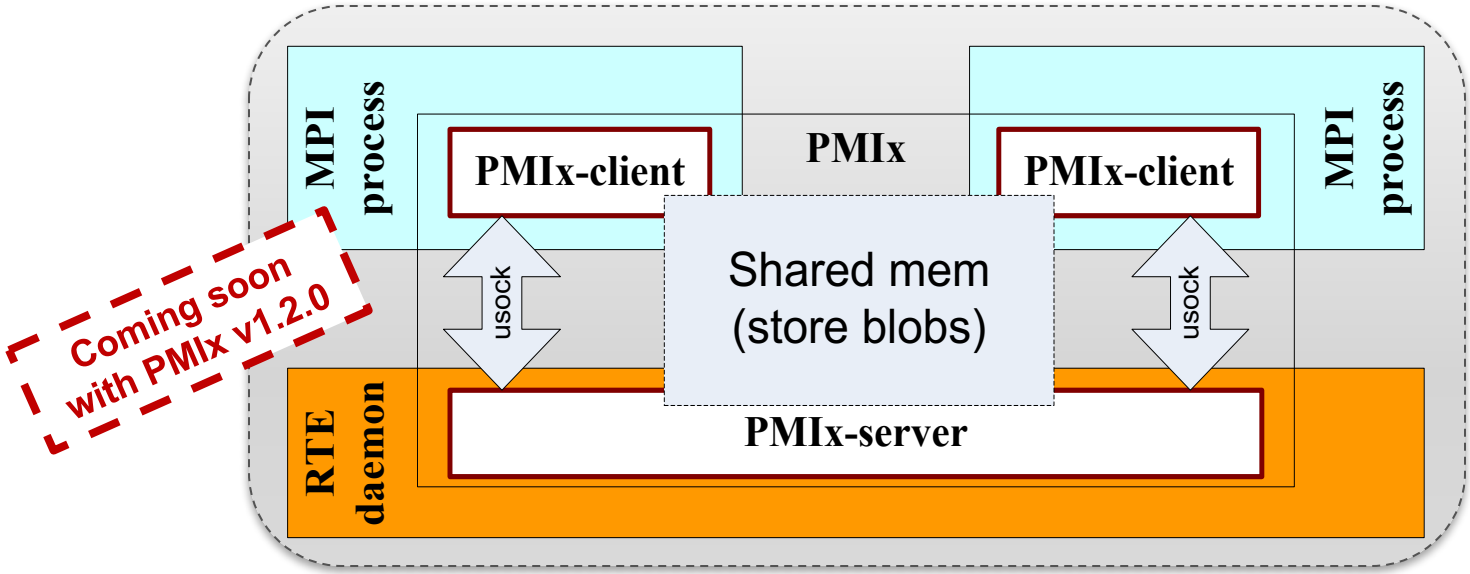

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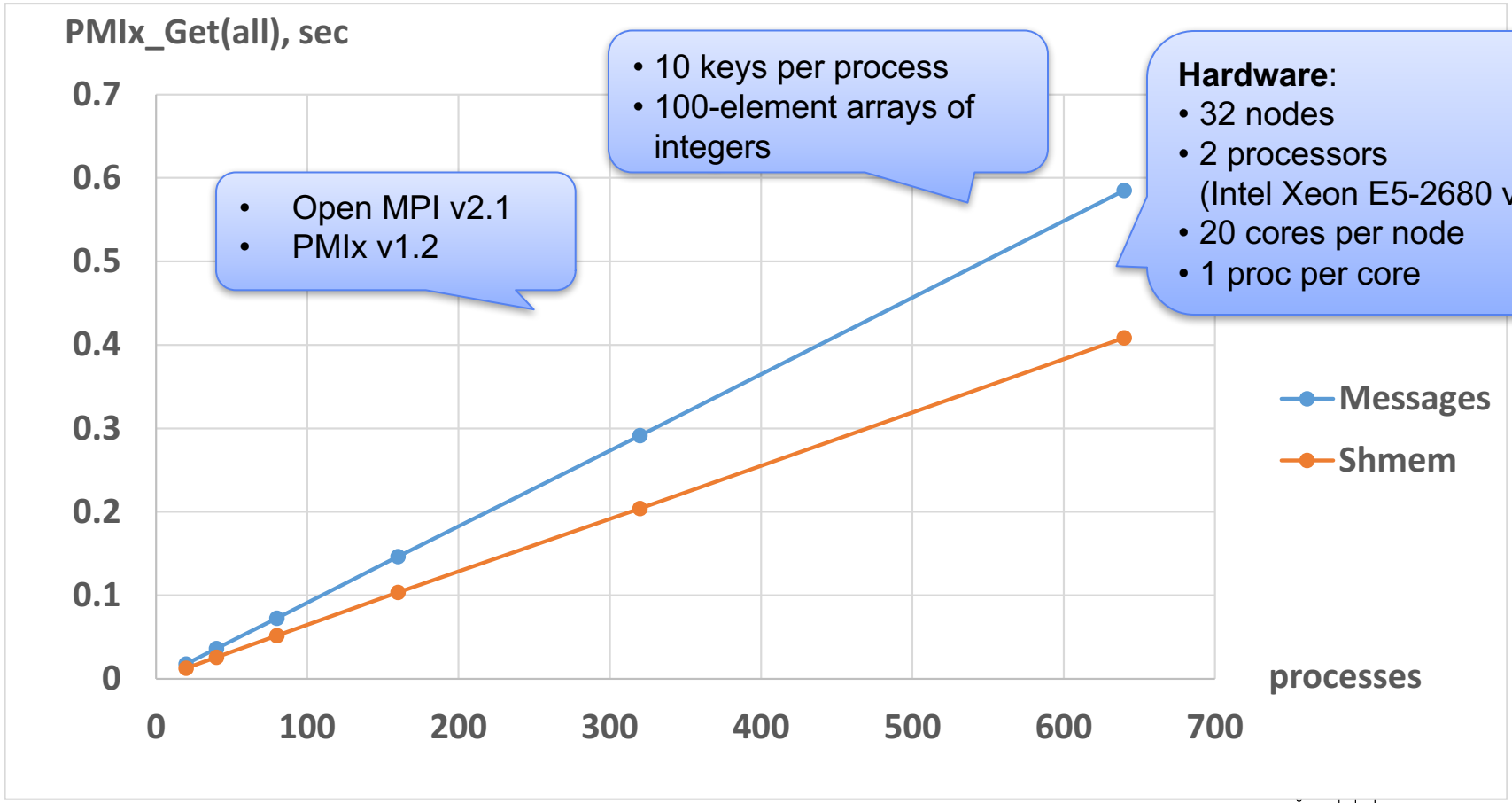
Shared memory data storage (synthetic performance test)



https://github.com/pmix/master/tree/master/contrib/perf_tools

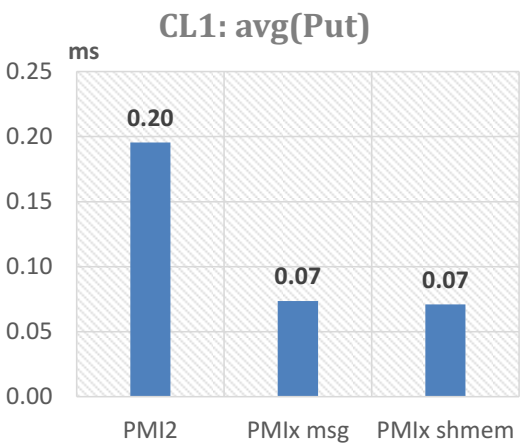
Shared memory data storage (synthetic performance test) [2]

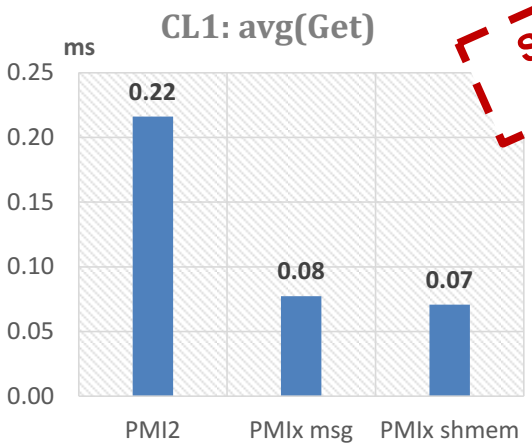
Nodes	procs	Messages (us)		Shmem (us)	
		local key	remote key	local key	remote key
1	20	8.8		6.4	
2	40	8.9	9.2	6.5	6.5
4	80	8.8	9.2	6.5	6.5
8	160	8.7	9.2	6.4	6.4
16	320	8.4	9.2	6.5	6.5
32	640	8.2	9.2	6.5	6.5

Advantages:

- Stable timings for a separate key access(no difference between local and remote key access)
- Up to 30% improvement for the remote key fetch
- Significant CPU offload on the SMP systems with large core count.

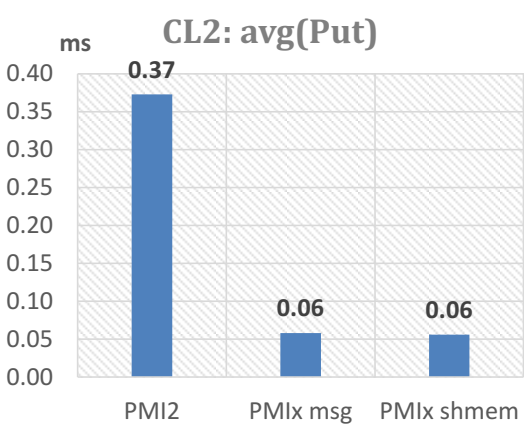
Shared memory data storage (synthetic performance test) [3]

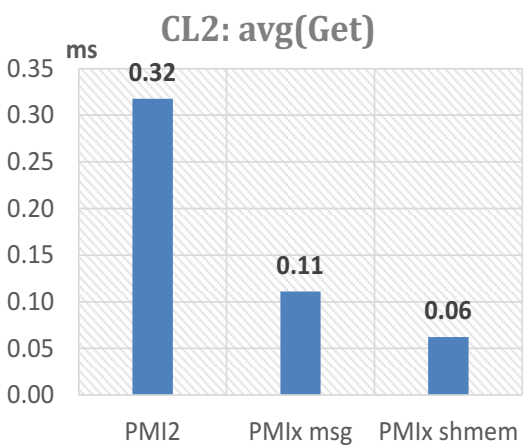




SLURM plugins

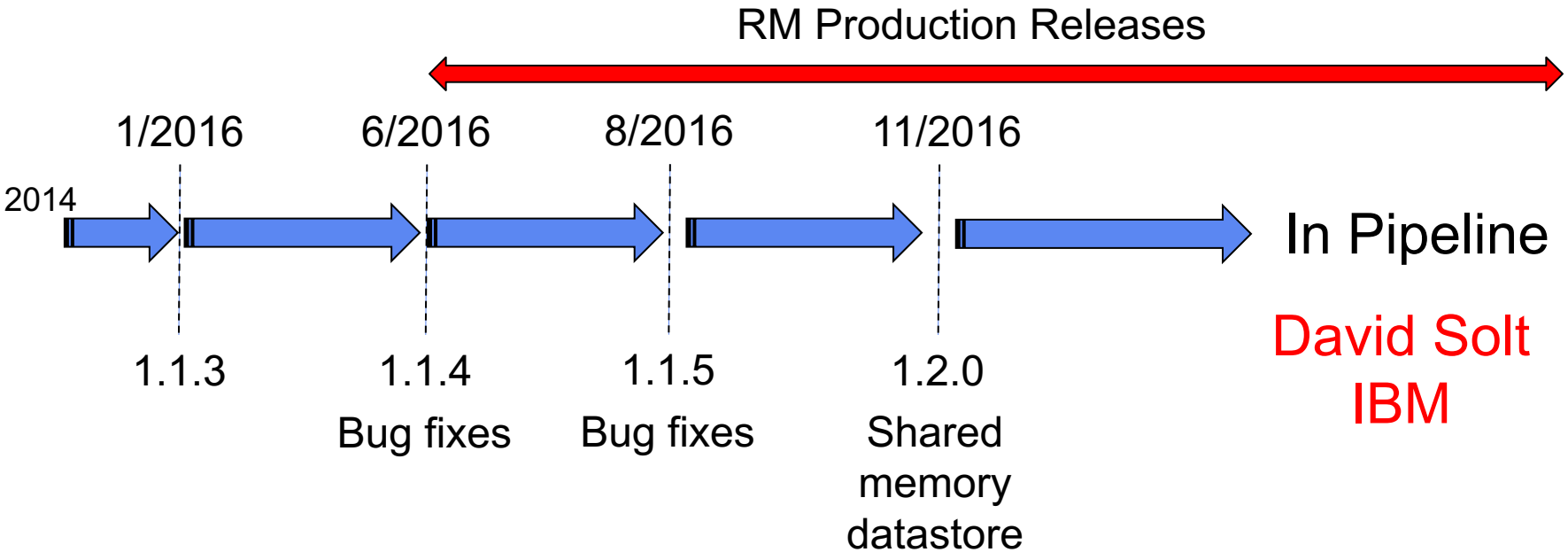
CL1 Hardware:
- 15 nodes
- 2 processors (Intel Xeon X5570)
- 8 cores per node
- 1 proc per core





CL2 Hardware:
- 64 nodes
- 2 processors (Intel Xeon E5-2697 v3)
- 28 cores per node
- 1 proc per core

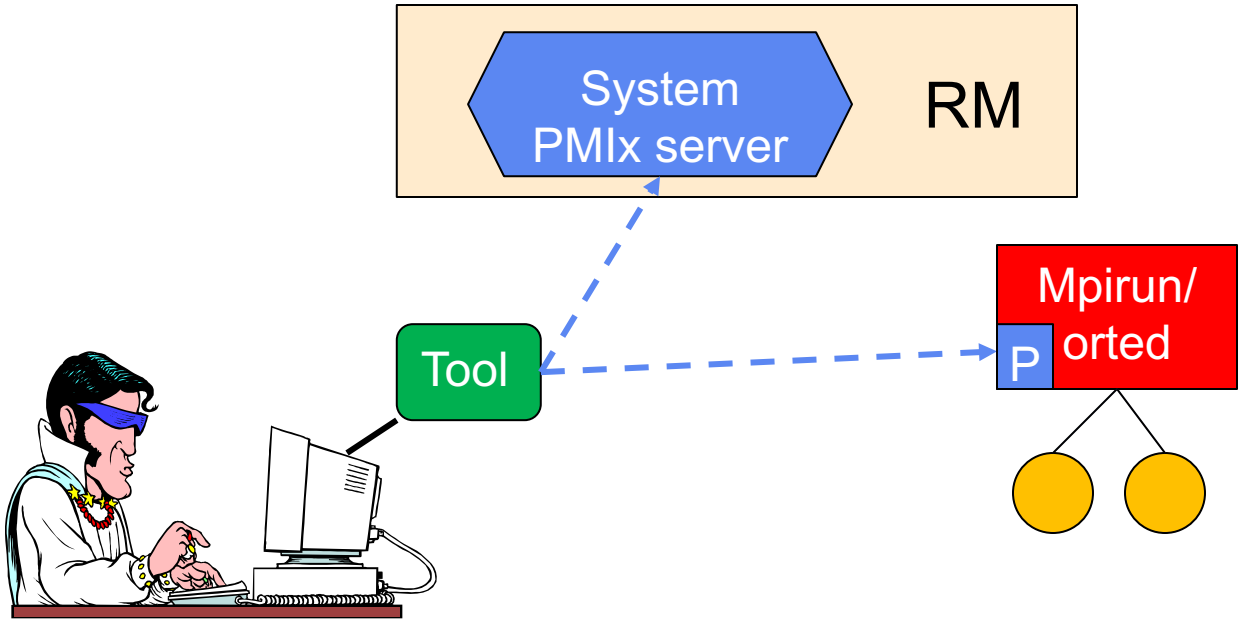
PMIx Roadmap



David Solt
IBM

Tool Support

- Tool connection support
  - Allow tools to connect to local PMIx server
  - Specify system vs application



Tool Support

- Query
  - Network topology
    - Array of proc network-relative locations
    - Overall topology (e.g., “dragonfly”)
  - Running jobs
    - Currently executing job namespaces
    - Array of proc location, status, PID
  - Resources
    - Available system resources
    - Array of proc location, resource utilization (ala “top”)
  - Queue status
    - Current scheduler queue backlog

Examples

Debuggers?

New Flexibility

- Plugin architecture
  - DLL-based system
  - Supports proprietary binary components
  - Allows multiple implementations of common functionality
    - Buffer pack/unpack operations
    - Communications (TCP, shared memory,…)
    - Security

Obsolescence Protection

- Plugin architecture
- Cross-version support
  - Automatic detection of client/server version
  - Properly adjust for changes in structures, protocols
  - Ensure clients always get what they can understand
  - Backward support to the v1.1.5 level

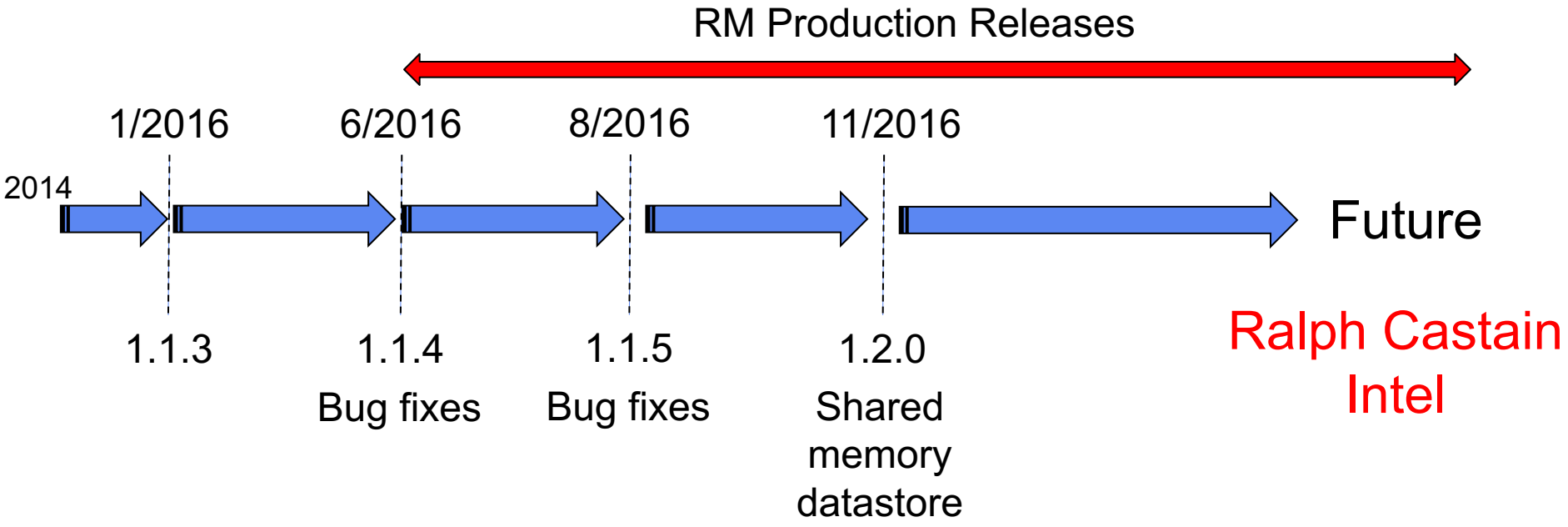
Notification

- Plugin architecture
- Cross-version support
- Event notification
  - System generated, app generated
  - Resolves issues in original API, implementation
  - Register for broad range of events
    - Constrained by availability of backend support

Logging

- Plugin architecture
- Cross-version support
- Event notification
- Log data
  - Store desired data in system data store(s)
    - Specify hot/warm/cold, local/remote, database and type of database, …
  - Log output to stdout/err
  - Supports binary and non-binary data
    - Heterogeneity taken care of for you

PMIx Roadmap



Ralph Castain
Intel

Future Features

Reference Server

- Initial version: DVM
  - Interconnected PMIx servers
  - High-speed, resilient collectives
    - bcast, allgather/barrier
- Future updates: ”fill” mode
  - Servers proxy clients to host RM
  - Complete missing host functionality

Winter 2017

Future Features

Debugger Support

- Ongoing discussions with MPI Forum Tools WG
  - Implement proposed MPIR2 interface
  - Enhance scalability
- Exploit tool connection
  - Obtain proctable info
  - Use PMIx_Spawn to launch daemons, auto-wireup, localize proctable retrieval
- Extend available supporting info
  - Network topology, bandwidth utilization
  - Event notification

Winter 2017

Future Features

Network Support Framework

- Interface to 3rd party libraries
- Enable support for network features
  - Precondition of network security keys
  - Retrieval of endpoint assignments, topology
- Data made available
  - In initial job info returned at proc start
  - Retrieved by Query

Spring 2017

Future Features

IO Support

- Reduce launch time
  - Current practices
    - Reactive cache/forward
    - Static builds
  - Proactive pre-positioning
    - Examine provided job/script
    - Return array of binaries and libraries required for execution
- Enhance execution
  - Request async file positioning
    - Callback when ready
  - Specify persistence options

Summer 2017

Future Features

Generalized Data Store (GDS)

- Abstracted view of data store
  - Multiple plugins for different implementations
    - Local (hot) storage
    - Distributed (warm) models
    - Database (cold) storage
- Explore alternative paradigms
  - Job info, wireup data
  - Publish/lookup
  - Log

Fall 2017

Open Discussion

We now have an interface library the RMs will support for application-directed requests

Need to collaboratively define what we want to do with it

Project: https://pmix.github.io/master
Code: https://github.com/pmix