Portals 3.3 on the Sandia/Cray Red Storm System

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Outline

- Portals history
- Portals objects
- Portals implementation
- Portals for Red Storm
- Performance on Red Storm
- Conclusions

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Portals Timeline

- Portals 0.0 - 1991
  - SUNMOS (Sandia/UNM OS)
  - nCUBE, Intel Paragon
  - Direct access to network FIFOs
  - Message co-processor
- Portals 1.0 - 1993
  - Data structures in user-space
  - Kernel-managed and user-managed memory descriptors
  - Published but never implemented
- Portals 2.0 - 1994
  - Puma/Cougar
  - Message selection (match lists)
  - Four types of memory descriptors (three implemented)
- Portals 3.0 - 1998
  - Cplant/Linux
  - Functional API
  - Target intelligent/programmable network interfaces

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Portals 3.3 Features

- Best effort, in-order delivery
- Well-defined transport failure semantics
- Based on expected messages
- One-sided operations
  - Put, Get, Atomic swap
- Zero-copy
- OS-bypass
- Application offload
  - No polling or threads to move data
  - No host CPU overhead
- Runtime system independent

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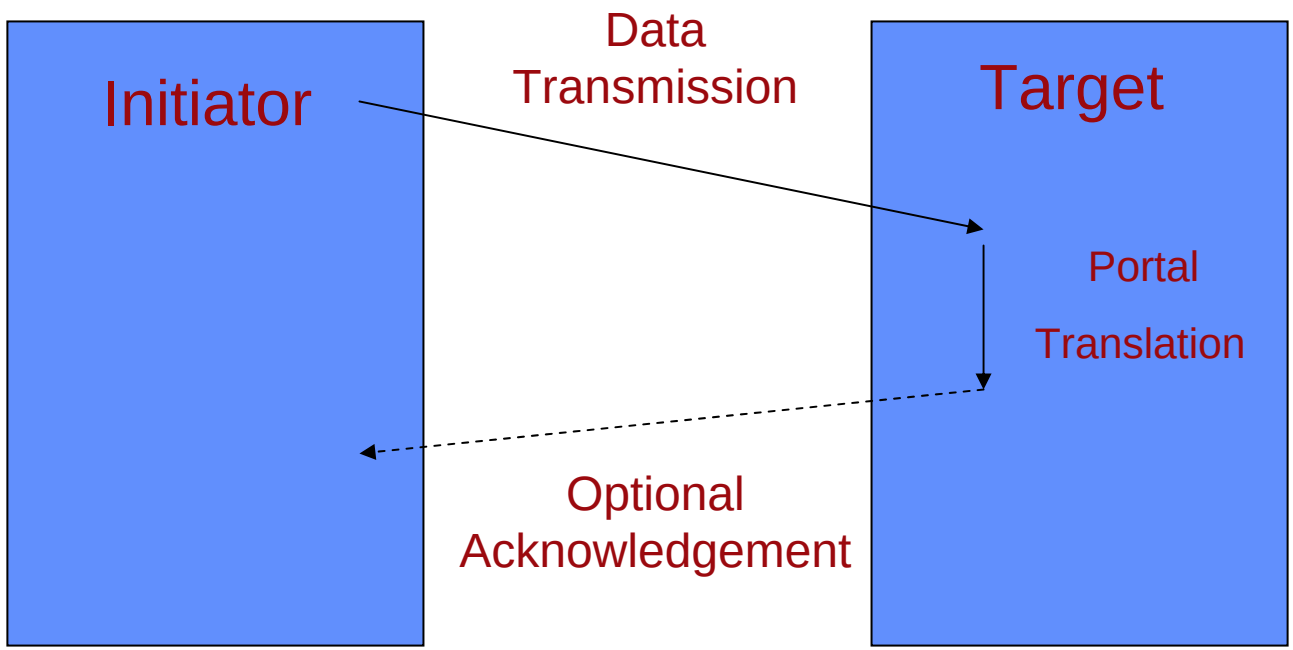
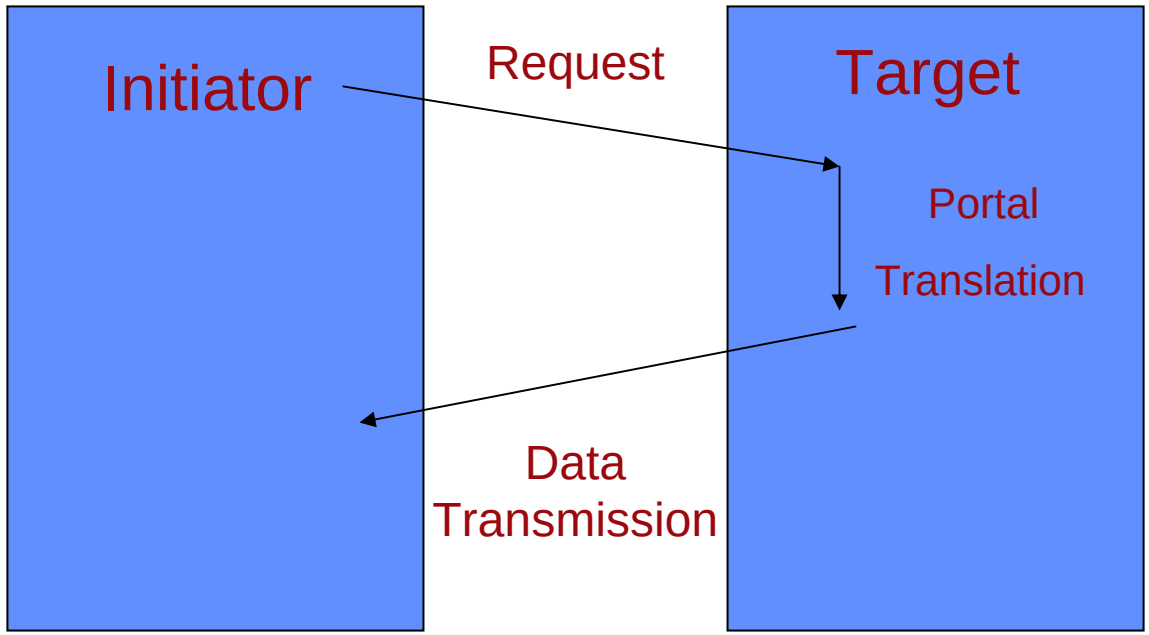
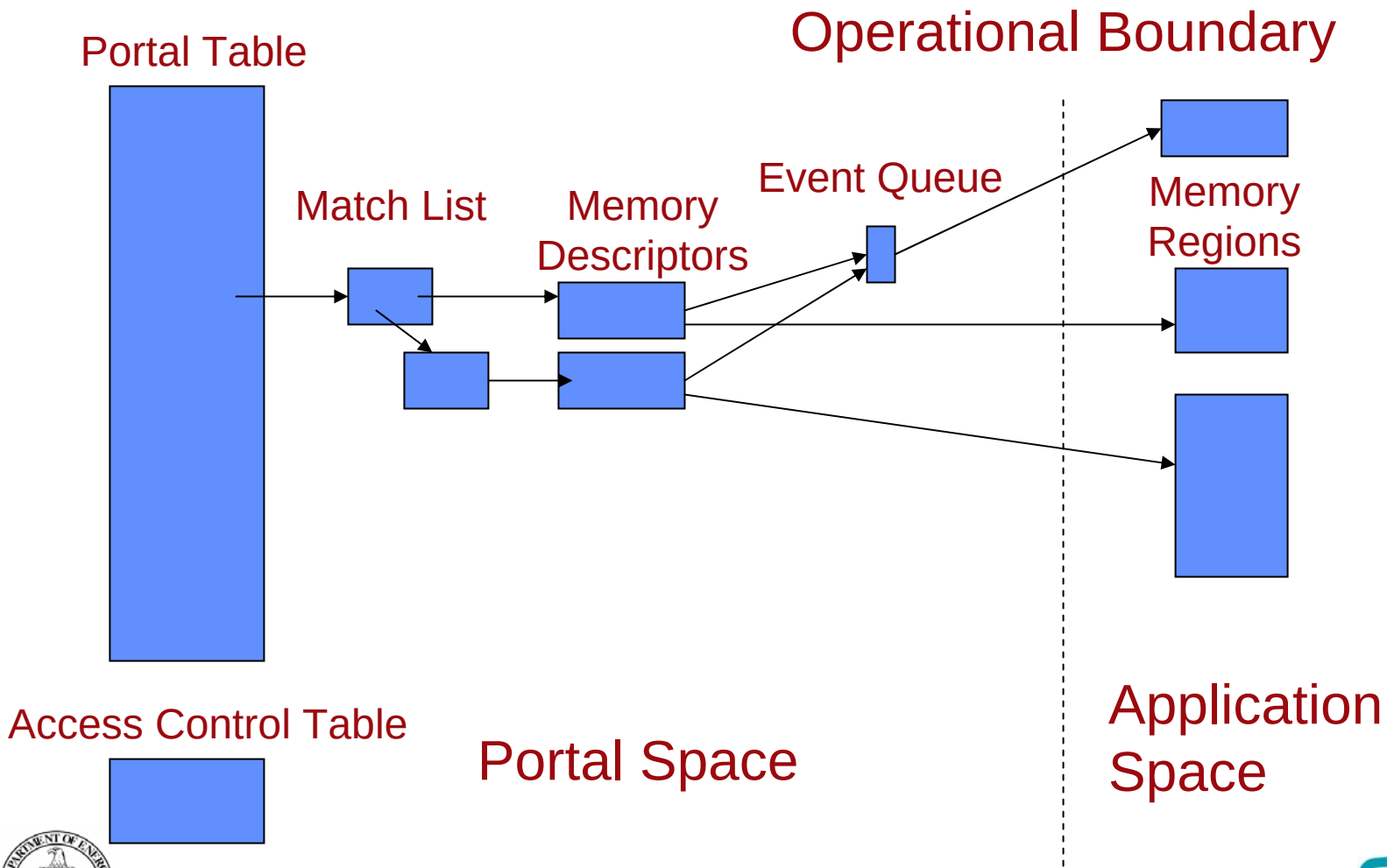
Portal Put



Portal Get



Portals Addressing



Match Entry Contents

- Source node id
- Source process id
- 64 match bits
- 64 ignore bits

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Memory Descriptor

- Start address
  - Optionally supports gather/scatter list
- Length in bytes
- Threshold
  - Number of operations allowed
- Max size
  - Low-water mark
- Options
  - Put/get
  - Receiver/sender managed offset
  - Truncate
  - Ack/no ack
  - Ignore start/end events
- 64 bits of user data
- Event queue handle
- Auto-unlink option

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Event Queue

- Circular queue that records operations on MDs
- Types of events
  - Get (PTL_EVENT_GET_{START,END})
    - MD has received a get request
  - Put (PTL_EVENT_PUT_{START,END})
    - MD has received a put request
  - Reply (PTL_EVENT_REPLY_{START,END})
    - MD has received a reply to a get request
  - Send (PTL_EVENT_SEND_{START,END})
    - Put request has been processed
  - Ack (PTL_EVENT_ACK)
    - MD has received an ack to a put request

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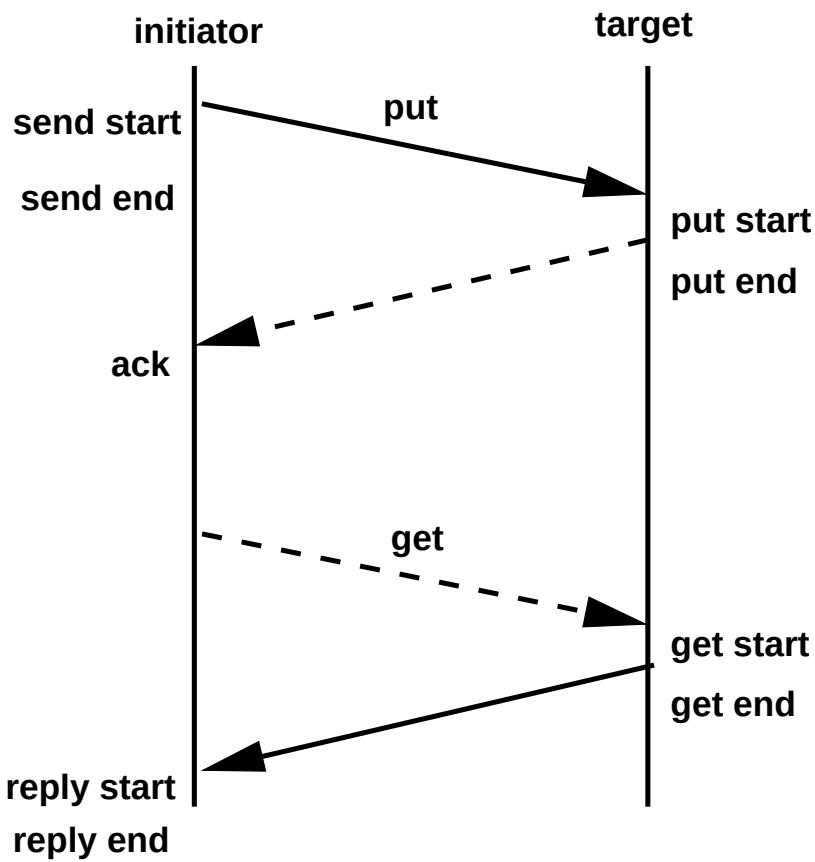
Event Scenarios



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Event Entry Contents

- Event type
- Initiator of event (nid,pid)
- Portal index
- Match bits
- Requested length
- Manipulated length
- Offset
- MD
- 64 bits of out-of-band data
- Link
- Sequence number

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What Makes Portals Different?

- Provides elementary building blocks for supporting higher-level protocols well
- Allows structures to be placed in user-space, kernel-space, or NIC-space
- Receiver-managed offset allows for efficient and scalable buffering of “unexpected” messages
- Supports multiple protocols within a process

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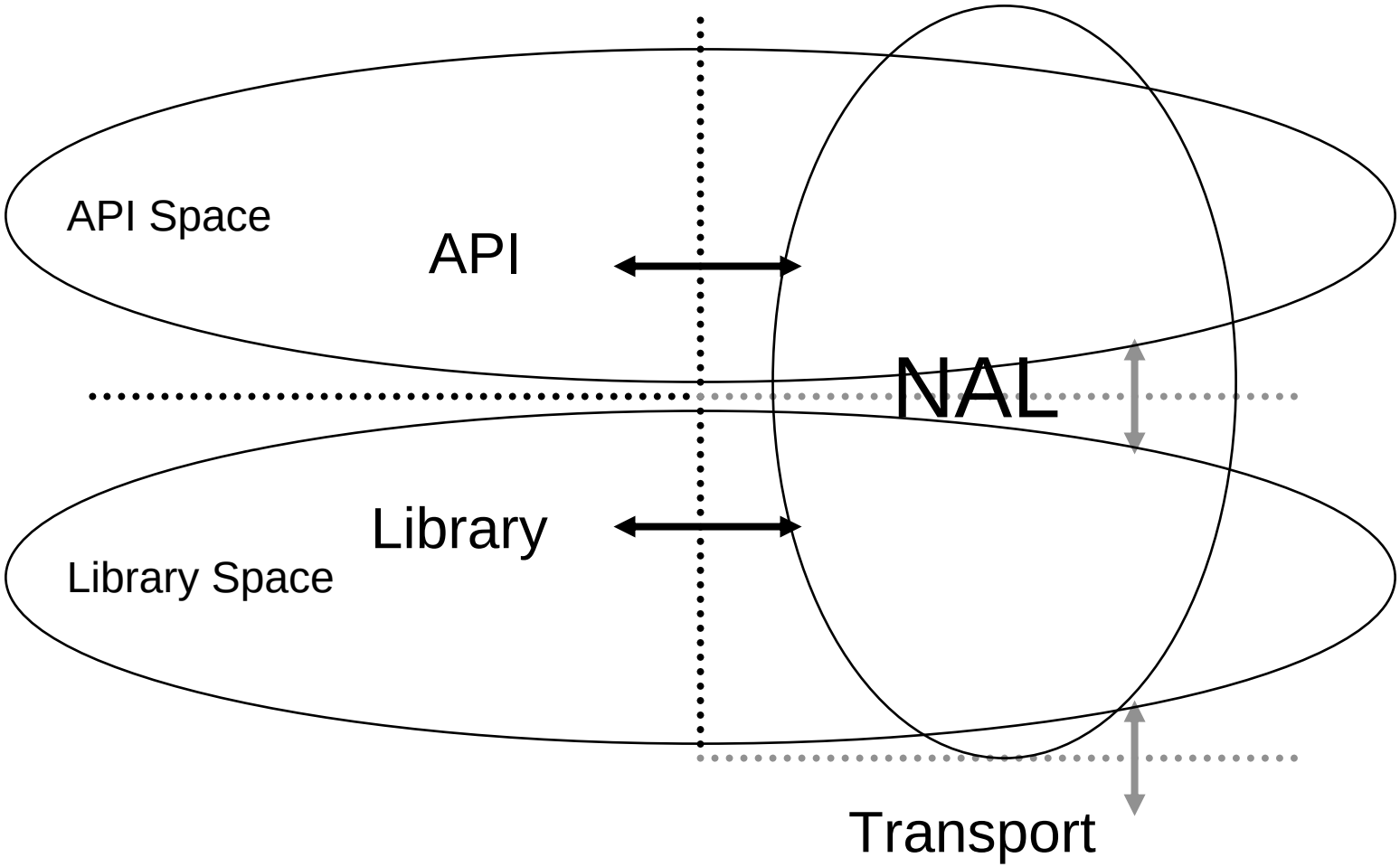
Portals Reference Implementation Design



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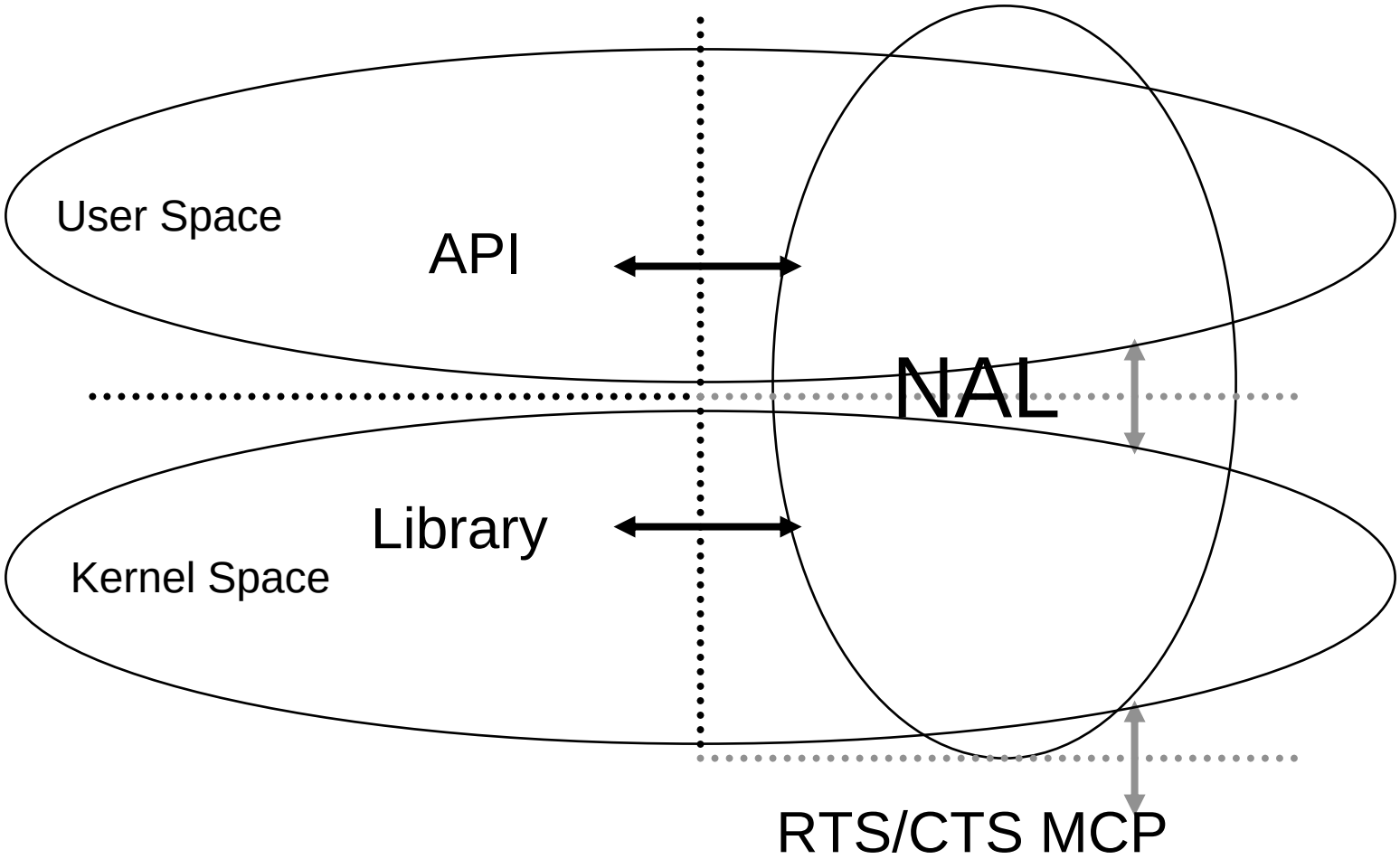
Myrinet Kernel Implementation



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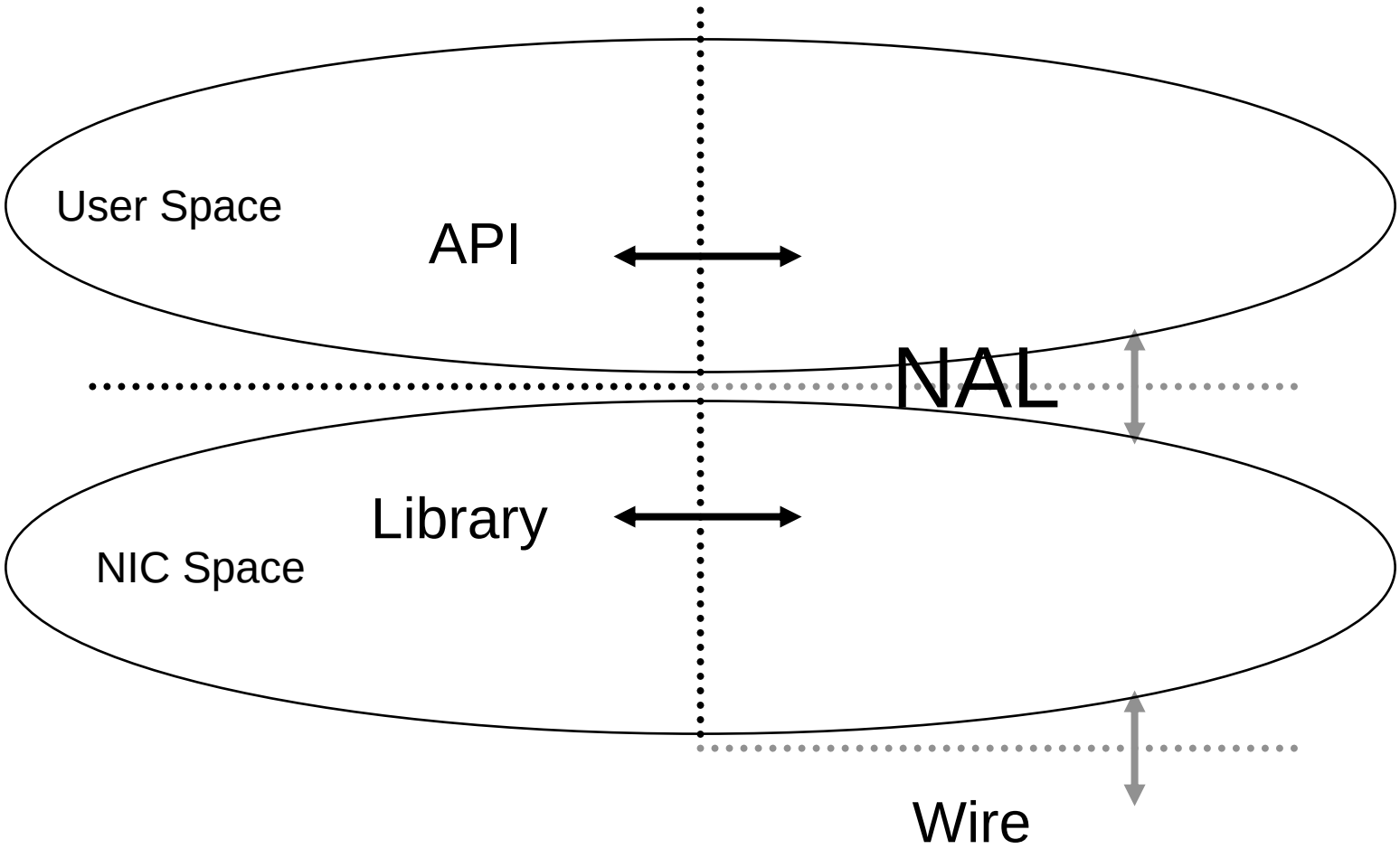
Myrinet MCP Implementation



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Cray Portals Bridge

- Needed single version of NIC firmware that supports all combinations of
  - User-level and kernel-level API
  - NIC-space and kernel-space library
- Cray added bridge layer to reference implementation to allow NAL to interface multiple API NALs and multiple library NALs
  - qkbridge for Catamount applications
  - ukbridge for Linux user-level applications
  - kbridge for Linux kernel-level applications

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SeaStar NAL

- Kevin already told you this ☺
- Portals library currently in kernel-space
  - Interrupt-driven
  - “generic”
- Portals library moving to NIC-space
  - No interrupts
  - “accelerated”

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Standard Red Storm/XT3 Performance Disclaimer

- Performance results are from a snapshot of a developer code base
- Sandia C firmware stack
- Some features that may impact performance are not implemented
  - End-to-end reliability protocol

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Micro-Benchmarks

- **PtlPerf**
  - **Ping-pong latency and bandwidth (uni- and bi-directional)**
  - **Single, persistent ME, MD, EQ**
  - **Best-case performance for Portals**
- **NetPIPE 3.6.2**
  - **Ping-pong latency and bandwidth (uni- and bi-directional)**
  - **Streaming bandwidth**
  - **Implemented Portals module**

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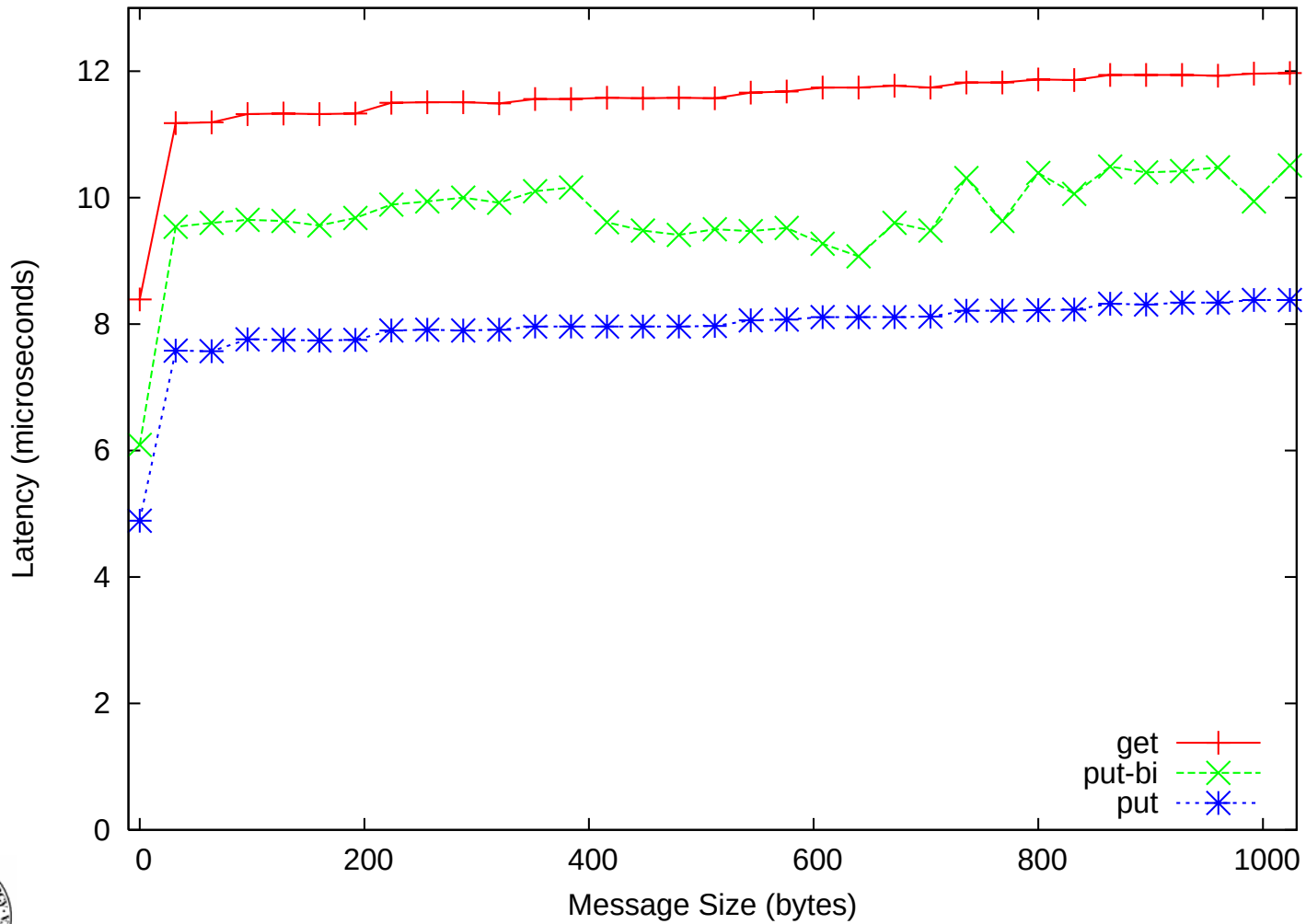
PtlPerf Latency



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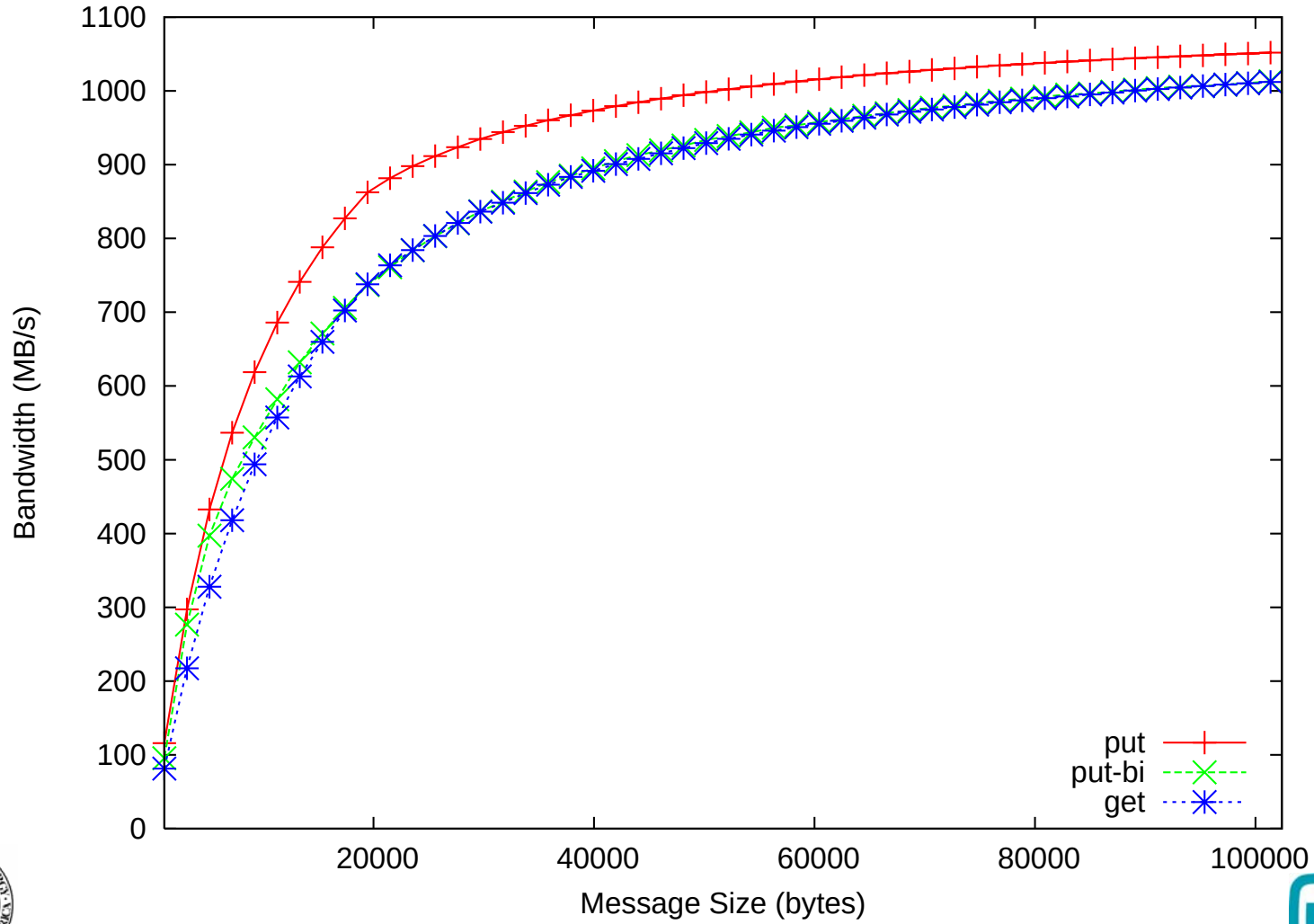
PtlPerf Bandwidth (10KB-100KB)



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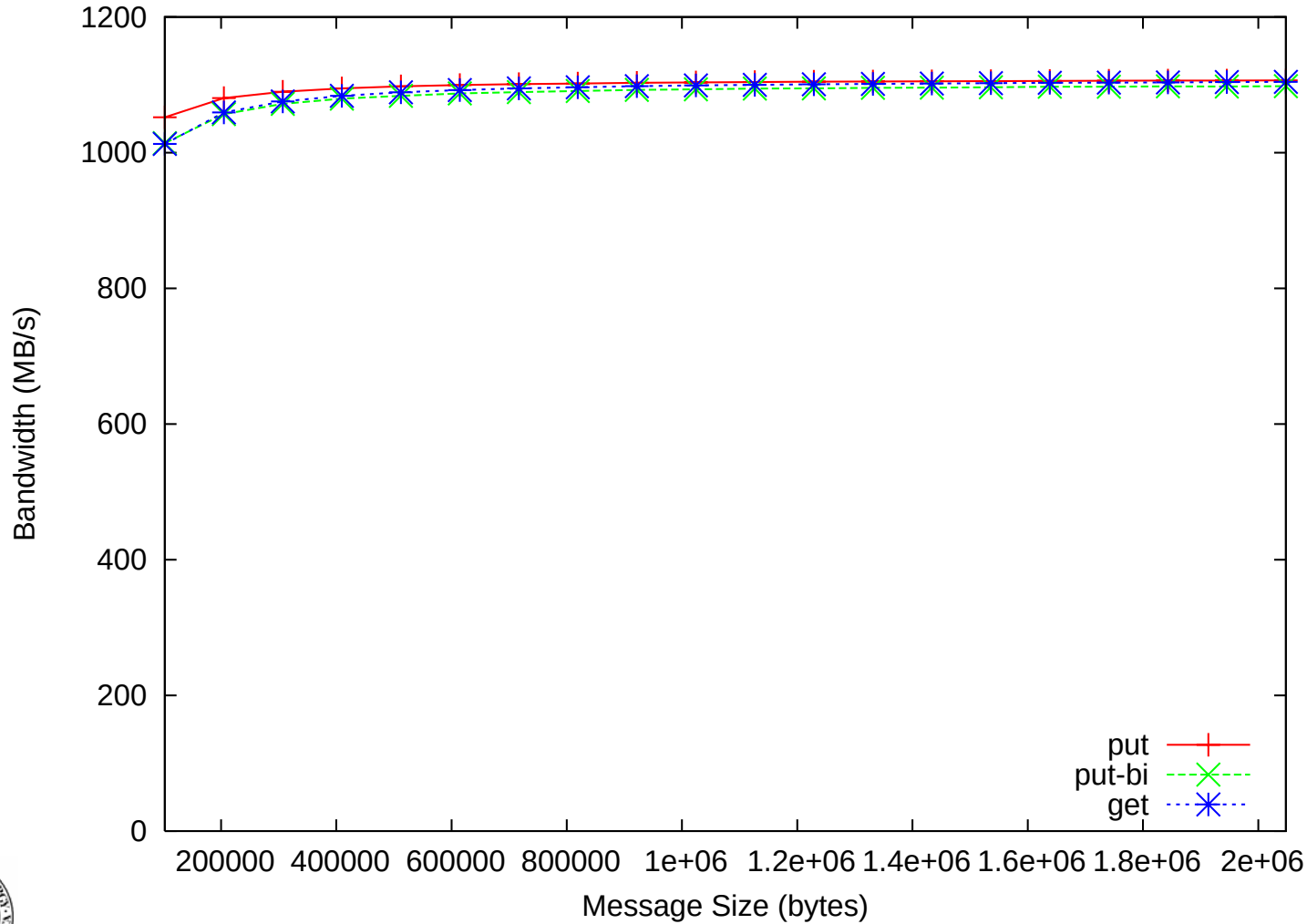
PtlPerf Bandwidth (100KB-2MB)



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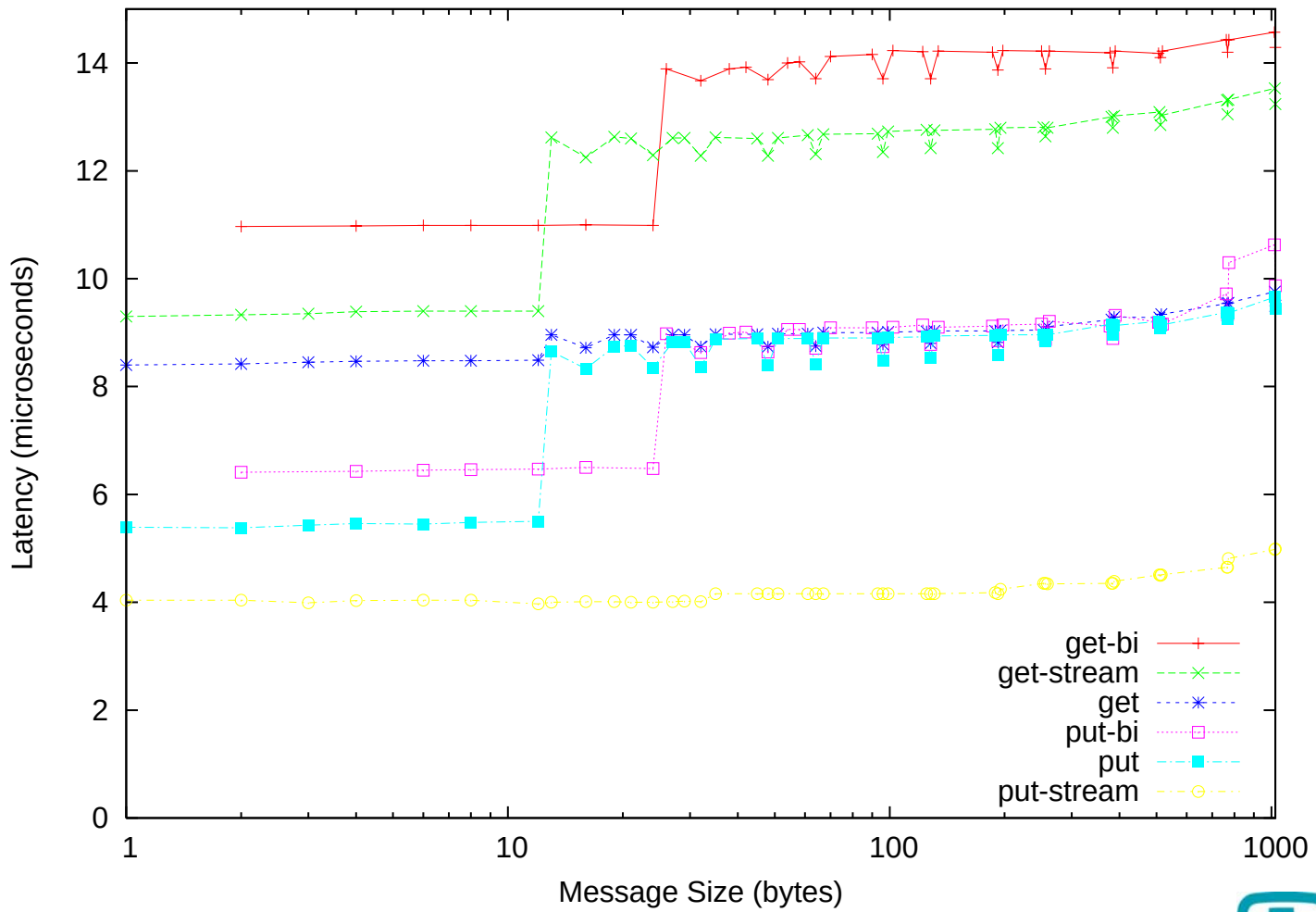
NetPIPE Latency



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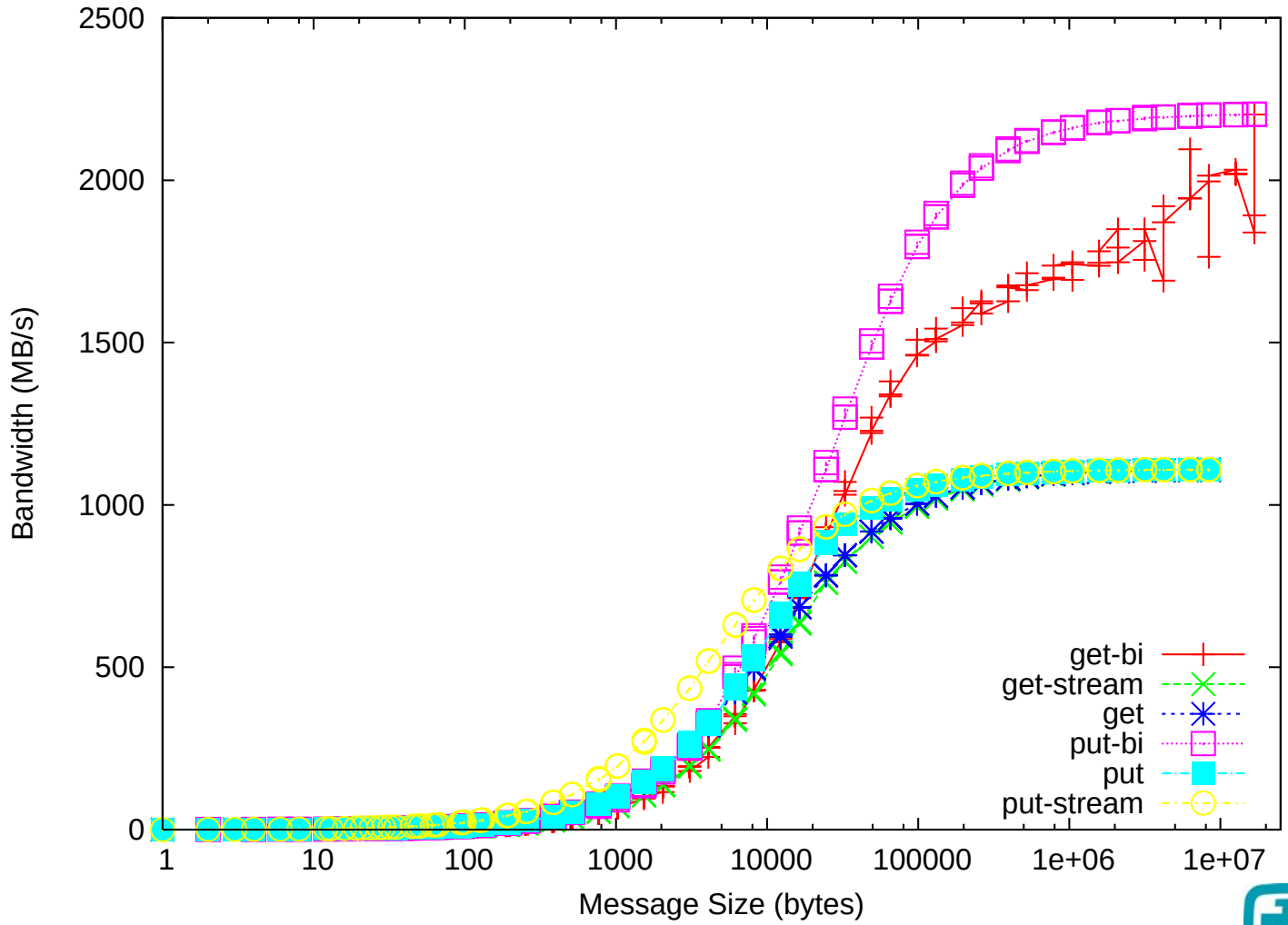
NetPIPE Bandwidth



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Conclusions

- Portals 3.3 is the lowest-level network programming interface on Red Storm
- Cray bridge abstraction allows single instance of firmware to support multiple API and Library paths
- Interrupt-driven kernel-space Library implementation achieves ~4.8 µs
- Expect NIC-space Library implementation to do better

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Questions?

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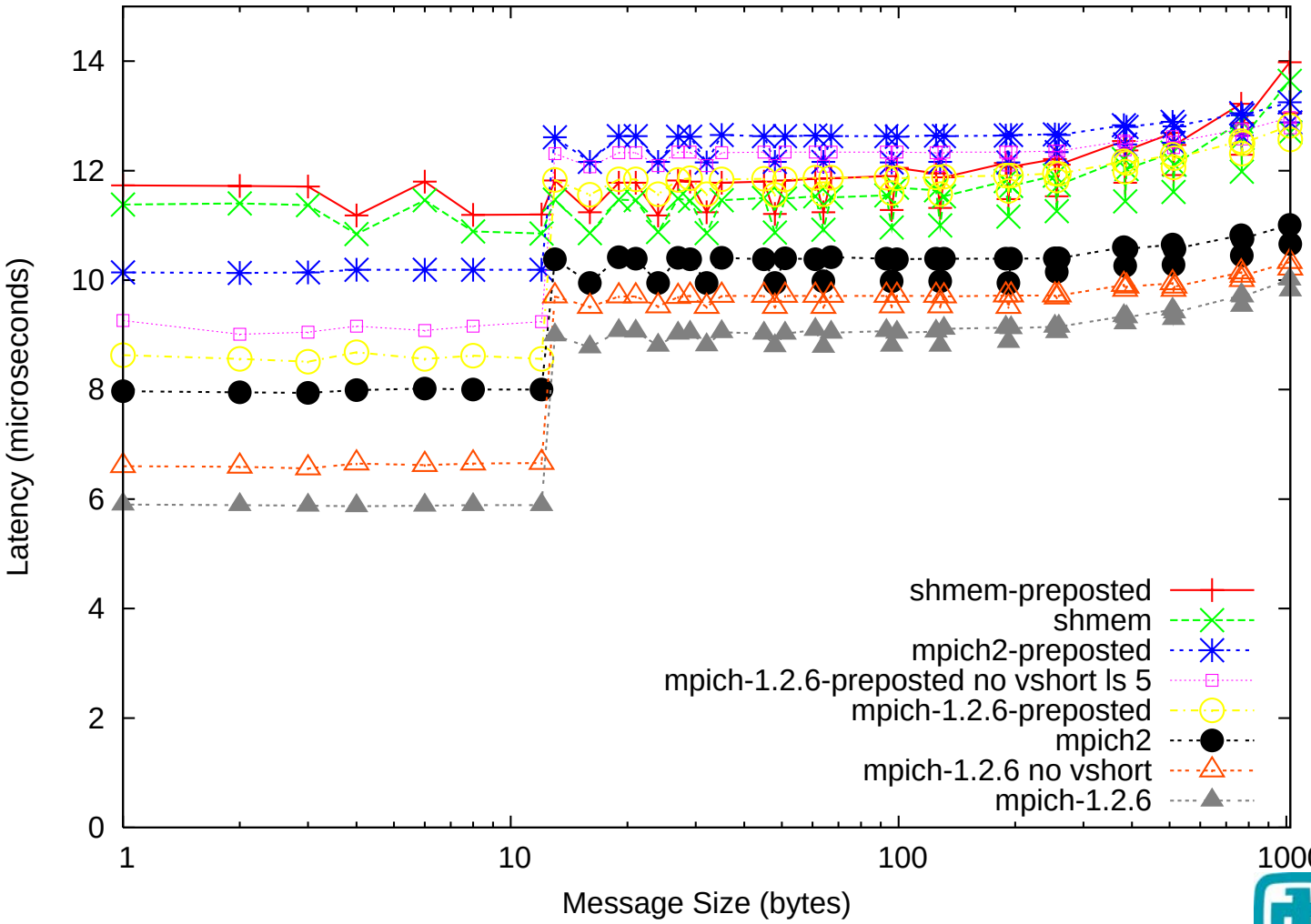
MPI Latency



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