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Omni-Path Evolution

→2021

Middleware

Provider

Hardware

New Software
Significant functionality and performance enhancements via Libfabric over Omni-Path Express

New Hardware
Optimized performance via Premier OFI Adapter

H1‘2022

H1‘2023

Middleware

Provider

Hardware

PSM: Performance Scaled Messaging
OPX: Libfabric over Omni-Path Express

*Simplification for concept illustration. Future features/options are subject to change without notice.
Introducing Omni-Path Express Libfabric Provider
Enabling Dramatic Performance Improvements

- Optimized for high-performance converged infrastructures
  - Host architecture based on OpenFabrics Interfaces (OFI)
  - Access to industry standard frameworks and ongoing open-source development
  - Significant application performance gains resulting from accelerated fabric performance
    - Improved time-to-solution and return on investment
  - Foundational for next generation Omni-Path fabric architecture
    - Seamless transition to future Omni-Path platforms
  - Broad support coming for application-critical technologies
    - All popular MPIs, AI frameworks, Object Storage file systems like DAOS, and all popular GPUs
Clearing Up Library Confusion

- **PSM2**
  - Native OPA Provider, has a history
  - The original way of supporting MPIs on Omni-Path
  - Support continues in OPA100

- **Libfabric Through PSM2**
  - Libfabric uses PSM2
  - Two layers of APIs (not optimal)

- **PSM3**
  - Fork of PSM2 to support Ethernet by Intel

- **Omni-Path Express often referred to as: OPX (this talk)**
  - Native Omni-Path support for Libfabric
  - Replaces PSM2 eventually
  - All the benefits of Libfabric with optimized performance
Omni-Path Express Host Software Stack
Accelerating the Next Level of Application Performance

- Fully open-sourced messaging software stack
- Leveraging libfabric with lightweight OFI Provider
- Facilitating rapid adoption of optimized communication libraries
- Foundational hardware/software co-design driving innovation

*Simplification for concept illustration. Future features/options are subject to change without notice.
Omni-Path Express Design Philosophy

- **PSM2**
  - Support applications with well-engineered, durable API
  - Handle HW access to achieve performance (provider)

- **OPX**
  - Leave application support/API to upper layer Libfabric (and the community)
  - Focus on the part that really matters for performance: The Provider

- **OPX designed from ground up to be performance optimal**
  - Must be as good as PSM2....turns out it gets even better!
  - Instruction count and cache line footprint are a major goal

- **Bottom line**
  - Performance rules
**Significant Performance Improvements**  
*Intel Xeon Icelake Platform*

- **Latency**  
  Up to 20% latency improvement

- **Message Rate**  
  Up to 2.4X messages/sec per core

- **Scalability**  
  Linear Scalability at double the throughput

---

**Test Configuration:**

2-socket Intel® 3rd Generation Xeon® Scalable (Icelake) Platinum 8358, Dual Rail OPA100, BIOS: Snoop Hold-off Response Timer=11, Energy Efficient Turbo=DISABLED, C-States=DISABLED  
Rocky Linux 8.4 (Green Obsidian), Kernel 4.18.0-305.19.1.el8_4.x86_64, IntelMPI 2019.6, IMB 2019.6, IFS 10.11.1.1.1, OPX Build 225

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Significant Performance Improvements
AMD EPYC Milan Platform

- **Latency**: Up to 25% latency improvement
- **Message Rate**: Up to 2.6X messages/sec per core
- **Scalability**: Linear Scalability at double the throughput

Test Configuration:
2-socket AMD EPYC (Milan) 7713, Dual Rail OPA100, xGMI Frequency Locked, xGMI Link Width Locked, P-State Disabled, PCIe Slot Frequency Locked
CentOS Linux 8.3, IntelMPI 2019.6, IMB 2019.6, IFS 10.11.1.1.1, OPX Build 223

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Omni-Path Express vs PSM2

Processing a Packet

- Optimized incoming packet processing (Do a single MPI_Recv(...))
  - Intel SDE testing shows tremendous improvement in instruction count
  - Significant improvements in cache line footprint

<table>
<thead>
<tr>
<th></th>
<th>PSM2</th>
<th>OPX</th>
<th>Improvement</th>
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</thead>
<tbody>
<tr>
<td>Instruction count</td>
<td>3064</td>
<td>1170</td>
<td>62%</td>
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<tr>
<td>Cache lines for code</td>
<td>205</td>
<td>124</td>
<td>40%</td>
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<tr>
<td>Cache line loads</td>
<td>93</td>
<td>55</td>
<td>41%</td>
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<tr>
<td>New cache line access</td>
<td>354</td>
<td>209</td>
<td>41%</td>
</tr>
</tbody>
</table>

- Every commit is checked to ensure no regressions
Early Customer Adoption

- Zuse Institute Berlin
- “Lise” System
  - 1270 Nodes with Omni-Path Interconnect
  - Test runs with OPX up to 100+ nodes
    - 6 real-world applications
    - 2 synthetic benchmarks
    - 10-20% improvements!

See 2022 Hyperion HPC Forum for more details from NHR@ZIB!
Omni-Path Express: Current Status

- Beta: Upstream and accepted into Libfabric:main,
  - Will be in Libfabric release v1.15
  - Focused on small messages and latency improvements first
  - More updates coming to main, OPX under active development

- Breakthrough performance characteristics on current generation platforms
  - AMD Milan and Intel Ice Lake

- Working to upstream provider defaults for MPICH and Open MPI

- DAOS support under development and in testing

- Full GA Coming Soon!
  - Included in Cornelis OPXS software suite (formerly IFS)
  - Dedicated to upstream first development to Libfabric
    - Active and engaged in community
    - Get Involved: Happy to take patches via GitHub!
Support Targeted by Omni-Path Libfabric Provider

<table>
<thead>
<tr>
<th>Communication APIs</th>
<th>Storage</th>
<th>AI/ML</th>
<th>GPU</th>
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<tbody>
<tr>
<td>Open MPI</td>
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2022 OFA Virtual Workshop

THANK YOU

Tim Thompson & Dennis Dalessandro
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