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# NEW FEATURES AND CAPABILITIES OF PSM2

Ravi Murty
Intel

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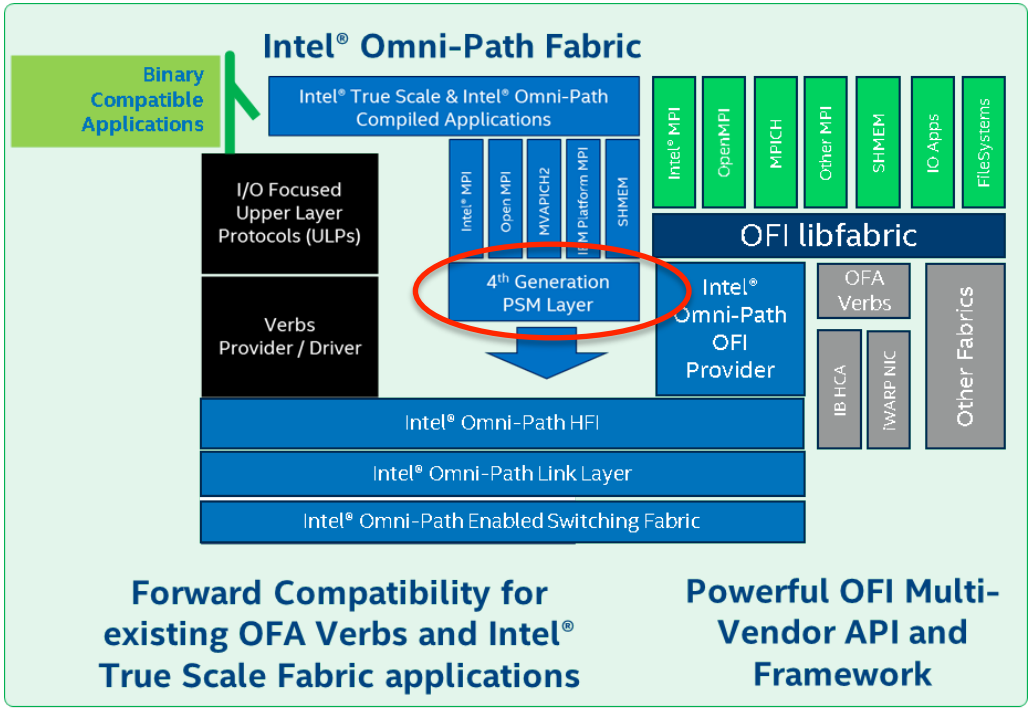
# OUTLINE

- What is Performance Scaled Messaging (PSM)?
- New Features in PSM2
- Compatibility with PSM1
- PSM Architecture
- PSM and OFI
- PSM Open Source Strategy

# INTEL® OMNI-PATH ARCHITECTURE

## OPTIMIZED HOST IMPLEMENTATION




- **Host Strategy: Leverage OpenFabrics Alliance* (OFA)**
  - **Host Strategy: Leverage OpenFabrics Alliance* (OFA)**
  - OpenFabrics Alliance compliant: Off-the-shelf application compatibility
  - Provides an extensive set of mature upper layer protocols
  - Integrates 4th generation proven, scalable PSM capability for HPC
- OpenFabrics Interface (OFI) API aligned with application requirements
  - **Access: Open Source Key Elements**
    - Intel® Omni-Path Fast Fabric Tools, Fabric Manager, and GUI
    - Host software stack via OFA
- **Channels: Integrate into Linux* Distributions**
  - Intel® Omni-Path Architecture support included in standard distributions


# PSM – A QUICK OVERVIEW

# WHAT IS PSM?

- **A scalable messaging library for large clusters and millions of ranks**
  - PSM is carefully designed to match the semantics needed by compute middlewares such as MPI
- **End-point communication model**
  - Manage flow state for reliability with support for dynamic addition of end-points
- **Matched Queue (MQ) component**
  - Semantically matched to the needs of MPI using tag matching
  - Provides calls for communication progress guarantees
  - MQ completion semantics (standard vs. synchronized)
- **Data transfer strategies optimized for latency and bandwidth**
  - Adaptively takes advantage of on-load and off-load mechanisms in HFI, transparent to library user
- **Optimized inter and intra node communications encapsulated in the API**
- **Error handling scheme**
  - Per Endpoint and Global error handler and user-defined error handlers.

# PSM API

- **Global tag matching API with 64-bit tags**
- **Scale up to 64K processes per job**
- **MQ APIs provide point-to-point message passing between endpoints**
  - e.g. psm_mq_send, psm_mq_irecv
- **No “recvfrom” functionality – needed by some applications**

# PSM2 API

- **4th generation mature API with forward compatible extensions to existing PSM API**
- **Tag matching improvement**
  - Increased tag size to 96 bits
  - Fundamentally ((stag ^ rtag) & rtagsel) == 0
  - Supports wildcards such as MPI_ANY_SOURCE or MPI_ANY_TAG using zero bits in rtagsel
- **Allows for practically unlimited scalability**
  - Up to 64M processes per job
- **Added "recvfrom" API**
  - Allows caller to specify the *source* from which to receive message
  - e.g. difference between

**PSM2 API**
- **4th generation mature API with forward compatible extensions to existing**
- **Tag matching improvement**
  - Increased tag size to 96 bits

# PSM2 TAG MATCHING

```
#define PSM_MQ_TAG_ELEMENTS 3
typedef struct psm2_mq_tag {
    union {
        uint32_t tag[PSM_MQ_TAG_ELEMENTS] __attribute__((aligned(16)));
        struct {
            uint32_t tag0;
            uint32_t tag1;
            uint32_t tag2;
        };
    };
} psm2_mq_tag_t;
```

- **Application fills ‘tag’ array or ‘tag0/tag1/tag2’ and passes to PSM**
- **Both tag and tag *mask* use the same 96 bit tag type**

# PSM2 SEND SIDE FUNCTIONS

```
psm_error_t
psm2_mq_isend2(psm2_mq_t mq, psm2_epaddr_t dest,
        uint32_t flags,  psm2_mq_tag_t *stag,
        const void *buf, uint32_t len, void *context,
        psm2_mq_req_t *req);

psm_error_t
psm2_mq_send2(psm2_mq_t mq, psm2_epaddr_t dest,
        uint32_t flags, psm2_mq_tag_t *stag,
        const void *buf, uint32_t len);
```

- **Non-blocking and blocking send PSM API extended to support 96-bit tag**

# PSM2 RECEIVE SIDE STATUS

```
typedef struct psm2_mq_status2 {
    psm2_epaddr_t  msg_peer;
    psm2_mq_tag_t  msg_tag;
    uint32_t  msg_length;
    uint32_t  nbytes;
    psm_error_t  error_code;
    void   *context;
} psm2_mq_status2_t;
```

- **psm2_mq_status2_t is derived from psm2_mq_status_t**
  - msg_tag field changed from 64-bits to the new 96-bit tag
- **Additionally, a new field msg_peer added**
  - Provide the source of the message
  - Eliminates application burden to maintain relationship between message and source of message

# PSM2 RECEIVE SIDE FUNCTIONS

```
psm_error_t
psm2_mq_irecv2(psm2_mq_t  mq, psm2_epaddr_t  src, psm2_mq_tag_t  *rtag,
      psm2_mq_tag_t  *rtagsel, uint32_t  flags, void  *buf, uint32_t len,
      void *context, psm2_mq_req_t  *req);

psm2_error_iprobe2
psm_mq_iprobe2(psm2_mq_t  mq, psm2_epaddr_t src, psm2_mq_tag_t *rtag,
      psm2_mq_tag_t *rtagsel, psm2_mq_status2_t *status);

psm2_error_t
psm_mq_improbe2(psm2_mq_t mq, psm2_epaddr_t src, psm2_mq_tag_t *rtag,
      psm2_mq_tag_t *rtagsel, psm_mq_req_t *req, psm2_mq_status2_t *status);
```

- **Functions psm2_mq_irecv2 and psm2_mq_iprobe2**
  - Tag and tag mask are 96-bit wide. Also src argument allows receiver to specify the source from which to receive the message
- **psm2_mq_improbe2 is a new function for MPI3 support**

# PSM2 PROGRESSION API

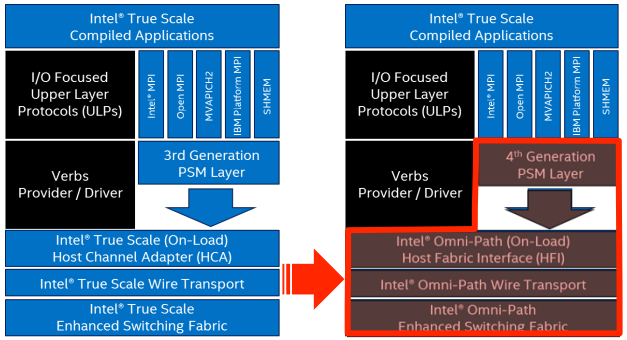
```
psm_error_t psm2_mq_ipeek2(psm2_mq_t mq, psm_mq_req_t *req,
psm2_mq_status2_t *status);

psm_error_t psm2_mq_wait2(psm2_mq_req_t *request, psm2_mq_status2_t
*status);

psm_error_t psm2_mq_test2(psm2_mq_req_t *request, psm2_mq_status2_t
*status);
```

- **Change in status argument from previous PSM API**


# PSM1/PSM2 FORWARD COMPATIBILITY AND CO-EXISTENCE

# PSM1/PSM2 FORWARD COMPATIBILITY

- **Both PSM and PSM2 are supported on Intel® OPA**
  - On Intel® OPA PSM1 64-bit tag is zero-extended to 96-bits
  - A PSM function only returns the first 64 bits of tag
  - A PSM2 function returns all 96 bits of tag
  - For a PSM2 receive function, if ‘src’ argument is NULL, PSM uses only the 96b *tag* to match a message from any source
  - status2 will always return the message source epaddr ‘msg_src’, independent of the ‘src’ argument in receiving function




No software application changes

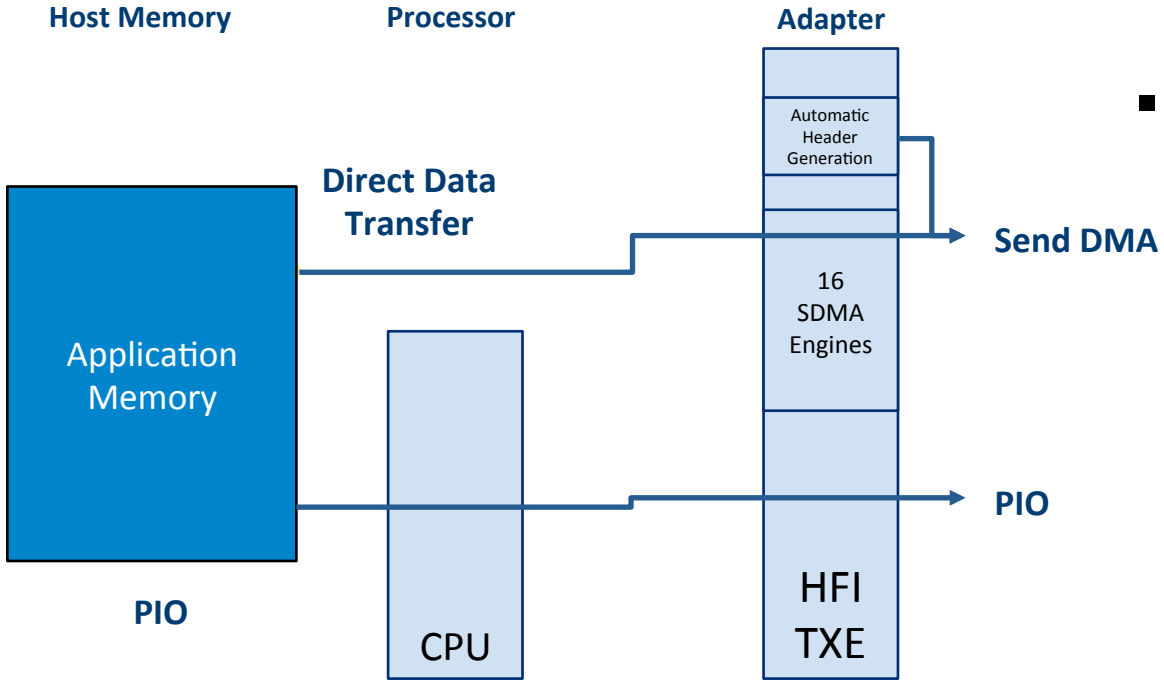
# PSM1/PSM2 CO-EXISTENCE

- **Co-existence between Intel® True Scale and Intel® Omni-Path Architecture**
  - PSM2 renamed the symbol names but …
- **Forward compatibility is provided by psm2-compat RPM:**
  - Provides binary compatibility for PSM1 based
  - Set LD_LIBRARY_PATH=/usr/lib64/psm2-compat/ prior to application launch.
  - /usr/lib64/psm2-compat/libpsm_infinipath.so.1, is a very thin wrapper exporting PSM APIs, but uses PSM2 library. Minimal performance impact from native PSM2


# PSM2 OPTIMIZED ON INTEL® OMNI-PATH ARCHITECTURE

# INTEL® OPA: SEND OPTIONS

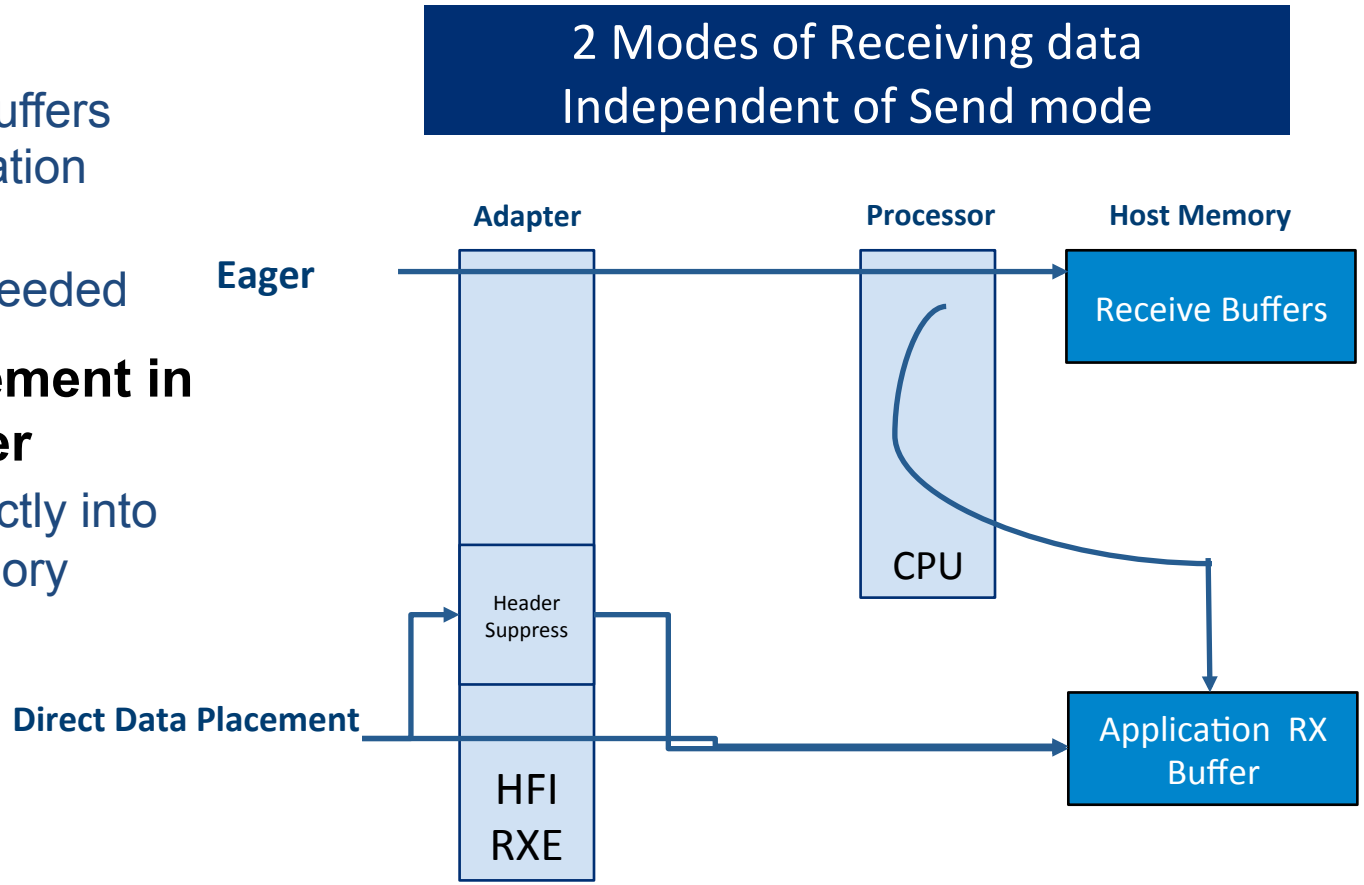
2 Modes of Sending data Independent of Receive mode




- **Send DMA (SDMA)**
  - Optimizes Bandwidth for Large messages
  - 16 SDMA Engines for CPU Offload
- **Programmed I/O (PIO)**
  - Optimizes Latency and Message Rate for small messages

# INTEL® OPA: RECEIVE OPTIONS

- **Eager-Receive**
  - Received data buffers copied to Application Buffer
  - No handshake needed
- **Direct Data placement in Application Buffer**
  - Data placed directly into Application Memory



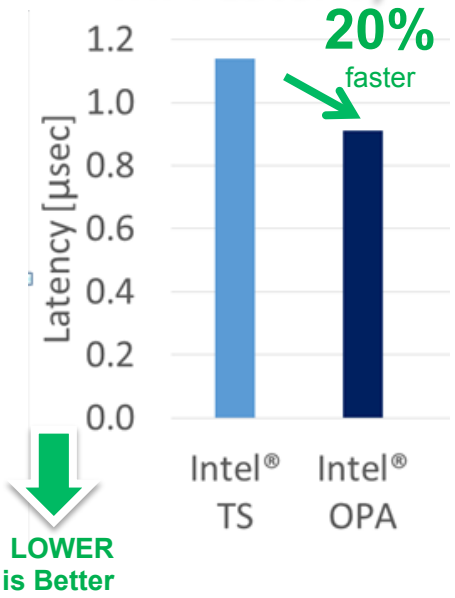
# INTEL® OPA PROVIDES EFFICIENT DATA TRANSFER MECHANISMS

| Message Size | Send Side | Receive Side |
|---|---|---|
| Up to 8KB | PIO Send | Eager Receive |
| > 8KB and < 64KB | SDMA | Eager Receive |
| 64KB or more | SDMA | Expected Receive |

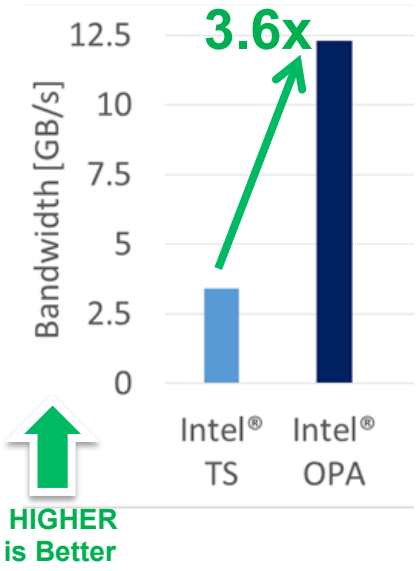
- **Most efficient data movement method automatically chosen based on message size**

# MPI PERFORMANCE ON INTEL® OPA

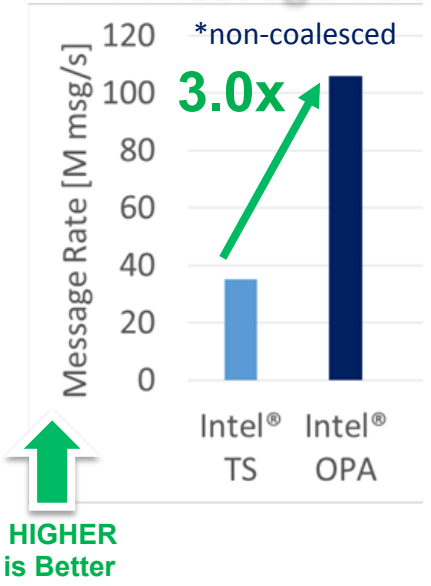
## MPI Latency[1]




## MPI Bandwidth[2]




## MPI Message Rate[3]




Tests performed on Intel® Xeon® Processor E5-2697v3 dual-socket servers with 2133 MHz DDR4 memory. Turbo mode enabled and hyper-threading disabled. Ohio State Micro Benchmarks v. 4.4.1. Intel OPA: Open MPI 1.10.0 with PSM2. Intel Corporation Device 24f0 – Series 100 HFI ASIC. OPA Switch: Series 100 Edge Switch – 48 port. IOU Non-posted Prefetch disabled in BIOS. Intel® True Scale: Open MPI. QLG-QLE-7342(A), 288 port True Scale switch. 1. osu_latency 8 B message. 2. osu_bw 1 MB message. 3. osu_mbw_mr, 8 B message (uni-directional), 28 MPI rank pairs


# PSM AND OFI

# PSM PROVIDERS FOR OFI

- **In addition to a *standalone* library, OFI supports providers for both versions of PSM**
- **OFI provider for PSM and PSM2: https://github.com/ofiwg/libfabric**
  - The psm provider runs over PSM1.x interface supported by Intel® True Scale
  - The psm2 provider runs over PSM2.x interface supported by Intel® OPA
  - The psm2 provider supports a richer set of capabilities due to the additional functionality provided by the PSM2 library described earlier.
- **The PSM2 provider allows creation of multiple OFI endpoints without limitations**
  - PSM provider has limitations on endpoint capability settings when multiple endpoints are opened.
- **The fi_psm and fi_psm2 man pages provide additional information including capabilities supported by these providers**
  - **https://github.com/ofiwg/libfabric/wiki/Provider-Feature-Matrix-v1.3.0**
- **Status: Both providers are in stable state. On-going work will be mainly bug fixes/code refactoring**

# PSM IS OPEN SOURCE

- **PSM1 has been part of OFED for a very long time.**
  - PSM2 is still in the works
- **PSM2 sources: https://github.com/01org/opa-psm2**
- **Distros: PSM2 is accepted to go into RHEL 7.2 and SLES SP2**
- **Documentation: Additional details on PSM2 and its API are available: http://www.intel.com/content/dam/support/us/en/documents/network/omni-adptr/sb/Intel_PSM2_PG_H76473_v1_0.pdf**

# CONCLUSIONS

- PSM2 is an optimized user-space library designed to meet the requirements of MPI
- MQ component of PSM2 supports tag matching with 96-bit tags and “recvfrom” functionality, among other improvements
- Existing applications written to the PSM1 API should run on Intel® OPA via the compat library
- PSM support two send mechanism and two receive mechanisms that allow for very efficient messaging from a latency and BW perspective.
- OFI has providers for PSM1 and PSM2
- Finally, PSM2 is open source

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Ravi Murty

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