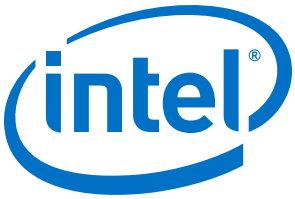


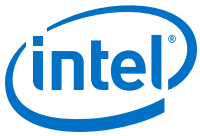
Intel® Omni-Path Fabric

Staging Guide

Rev. 4.0

December 2016

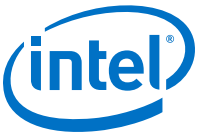
Order No.: J27600-4.0



Revision History

For the latest documentation, go to: http://www.intel.com/omnipath/FabricSoftwarePublications.

Date	Revision	Description
December 2016	4.0	Updates to this document include: • Updated Take State Dump of a Switch procedure. • Globally, updated the following filepaths: — from `/opt/opa` to `/usr/lib/opa` — from `/var/opt/opa` to `/var/usr/lib/opa` — from `/opt/opafm` to `/usr/lib/opa-fm` — from `/var/opt/opafm` to `/var/usr/lib/opa-fm` • Added Cluster Configurator for Intel® Omni-Path Fabric to Preface.
October 2016	3.0	Document has been updated to add the following sections: • Perform Initial Fabric Verification. • Edit Hosts and Allhosts Files. • Defining Type in the Topology Spreadsheet. • Configure Intel® OP Director Class Switch 100 Series. • Configure Host Setup. • Fabric Manager Routing Algorithm.
August 2016	2.0	Updates to this document include: • Updated Generate Cable Map Topology Files to include Intel® Omni-Path Director Class Switch 100 Series information.
May 2016	1.0	Initial release.



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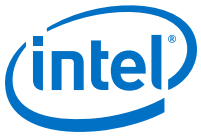

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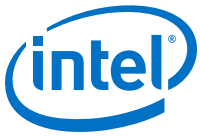


Preface

This manual is part of the documentation set for the Intel® Omni-Path Fabric (Intel® OP Fabric), which is an end-to-end solution consisting of Intel® Omni-Path Host Fabric Interfaces (HFIs), Intel® Omni-Path switches, and fabric management and development tools.

The Intel® OP Fabric delivers a platform for the next generation of High-Performance Computing (HPC) systems that is designed to cost-effectively meet the scale, density, and reliability requirements of large-scale HPC clusters.

Both the Intel® OP Fabric and standard InfiniBand* are able to send Internet Protocol (IP) traffic over the fabric, or *IPoFabric*. In this document, however, it is referred to as *IP over IB* or *IPoIB*. From a software point of view, IPoFabric and IPoIB behave the same way and, in fact, use the same `ib_ipoib` driver to send IP traffic over the ib0 and/or ib1 ports.

Intended Audience

The intended audience for the Intel® Omni-Path (Intel® OP) document set is network administrators and other qualified personnel.

Documentation Set

The complete end user publications set for the Intel® Omni-Path product includes the following items.

- Hardware Documents:
  - *Intel® Omni-Path Fabric Switches Hardware Installation Guide*
  - *Intel® Omni-Path Fabric Switches GUI User Guide*
  - *Intel® Omni-Path Fabric Switches Command Line Interface Reference Guide*
  - *Intel® Omni-Path Edge Switch Platform Configuration Reference Guide*
  - *Intel® Omni-Path Fabric Managed Switches Release Notes*
  - *Intel® Omni-Path Fabric Externally-Managed Switches Release Notes*
  - *Intel® Omni-Path Host Fabric Interface Installation Guide*
- Software Documents:
  - *Intel® Omni-Path Fabric Software Installation Guide*
  - *Intel® Omni-Path Fabric Suite Fabric Manager User Guide*
  - *Intel® Omni-Path Fabric Suite FastFabric User Guide*
  - *Intel® Omni-Path Fabric Host Software User Guide*
  - *Intel® Omni-Path Fabric Suite Fabric Manager GUI Online Help*
  - *Intel® Omni-Path Fabric Suite Fabric Manager GUI User Guide*

- *Intel® Omni-Path Fabric Suite FastFabric Command Line Interface Reference Guide*
- *Intel® Performance Scaled Messaging 2 (PSM2) Programmer's Guide*
- *Intel® Omni-Path Fabric Performance Tuning User Guide*
- *Intel® Omni-Path Host Fabric Interface Platform Configuration Reference Guide*
- *Intel® Omni-Path Fabric Software Release Notes*
- *Intel® Omni-Path Fabric Manager GUI Release Notes*
- *Intel® Omni-Path Storage Router Design Guide*
- *Building Lustre* Servers with Intel® Omni-Path Architecture Application Note*
- *Intel® Omni-Path Fabric Staging Guide*

Documents are available at the following URLs:

- Intel® Omni-Path Switches Installation, User, and Reference Guides

  http://www.intel.com/omnipath/SwitchPublications
- Intel® Omni-Path Host Fabric Interface Installation, User, and Reference Guides (includes software documents)

  http://www.intel.com/omnipath/FabricSoftwarePublications
- Drivers and Software (including Release Notes)

  http://www.intel.com/omnipath/Downloads

Cluster Configurator for Intel® Omni-Path Fabric

The Cluster Configurator for Intel® Omni-Path Fabric is available at: http://www.intel.com/content/www/us/en/high-performance-computing-fabrics/omni-path-configurator.html.

This tool generates sample cluster configurations based on key cluster attributes, including a side-by-side comparison of up to four cluster configurations. The tool also generates parts lists and cluster diagrams.

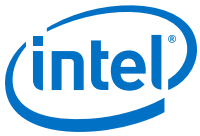
Documentation Conventions

The following conventions are standard for Intel® Omni-Path documentation:

- *Note:* provides additional information.
- ***Caution:*** indicates the presence of a hazard that has the potential of causing damage to data or equipment.
- ***Warning:*** indicates the presence of a hazard that has the potential of causing personal injury.
- Text in blue font indicates a hyperlink (jump) to a figure, table, or section in this guide. Links to websites are also shown in blue. For example:

  See License Agreements on page 9 for more information.

  For more information, visit www.intel.com.
- Text in **bold** font indicates user interface elements such as menu items, buttons, check boxes, key names, key strokes, or column headings. For example:



Click the **Start** button, point to **Programs**, point to **Accessories**, and then click **Command Prompt**.

Press **CTRL+P** and then press the **UP ARROW** key.

- Text in `Courier` font indicates a file name, directory path, or command line text. For example:

  Enter the following command: `sh ./install.bin`

- Text in *italics* indicates terms, emphasis, variables, or document titles. For example:

  Refer to *Intel® Omni-Path Fabric Software Installation Guide* for details.

  In this document, the term *chassis* refers to a managed switch.

Procedures and information may be marked with one of the following qualifications:

- **(Linux)** – Tasks are only applicable when Linux* is being used.
- **(Host)** – Tasks are only applicable when Intel® Omni-Path Fabric Host Software or Intel® Omni-Path Fabric Suite is being used on the hosts.
- **(Switch)** – Tasks are applicable only when Intel® Omni-Path Switches or Chassis are being used.
- Tasks that are generally applicable to all environments are not marked.

License Agreements

This software is provided under one or more license agreements. Please refer to the license agreement(s) provided with the software for specific detail. Do not install or use the software until you have carefully read and agree to the terms and conditions of the license agreement(s). By loading or using the software, you agree to the terms of the license agreement(s). If you do not wish to so agree, do not install or use the software.

Technical Support

Technical support for Intel® Omni-Path products is available 24 hours a day, 365 days a year. Please contact Intel Customer Support or visit www.intel.com for additional detail.

1.0 Introduction

This document provides a high level overview of the steps required to stage a customer-based installation of the Intel® Omni-Path Fabric. Procedures and key reference documents, such as Intel® Omni-Path user guides and installation guides are provided to clarify the process. Additional commands and BKMs are defined to facilitate the installation process and troubleshooting.

Intel recommends that you use the Intel® Omni-Path FastFabric (FF) Textual User Interface (TUI) as the initial tool suite for installation, configuration, and validation of the fabric. This tool includes a set of automated features that are specifically used for standalone host, Ethernet*, and Intel® Omni-Path Fabric connectivity validation.

This document includes recommendations for processes and procedures that complement the FF tools to reduce the time required to install and configure the customer's fabric.

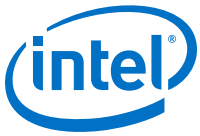
You should check applicable release notes and technical advisories for key information that could influence installation steps outlined in this document.

Note: Before the onsite installation, Intel requires that you generate a `topology.csv` file in the format specified for `opaxlattopology` as described in Generate Cable Map Topology Files on page 16 in this document.

Assumptions:

- Reference Documentation: Intel® Omni-Path End User Publications.
- Operating System (OS) Software: RHEL* 7.1 or later.
- Single Management Node (with Fabric Manager running) configured with the Intel® Omni-Path Fabric Suite Software, also known as IntelOPA-IFS.
- Intel® Omni-Path Fabric Manager enabled on management nodes.
- Compute Nodes configured with the Intel® Omni-Path Fabric Host Software, also known as IntelOPA-Basic.
- Password-less access enabled for all hosts and switches.

Note: Before you run top500 HPL (High Performance Linpack) runs or customer acceptance tests, Intel recommends that you follow all steps outlined in this staging guide.



2.0 Installation Prerequisites

The recommended fabric installation prerequisites are defined in the *Intel® Omni-Path Fabric Software Installation Guide*, Installation Prerequisites section.

The RPMs required for the operating system you are using are defined in the *Intel® Omni-Path Fabric Software Installation Guide*, OS RPMs Installation Prerequisites section.

Complete the following steps before starting software installation:

1. Install Intel® Omni-Path Host Fabric Interface (HFI) Gen3 PCIe Card(s) in servers.
2. Verify server boots OS from local disk or PXE remote boot server with no hardware errors.
3. Verify node executes a warm reset and boots to OS.

2.1 Configure BIOS Settings

Intel recommends that you pre-configure servers with the appropriate BIOS settings (UEFI) before you configure Intel® Omni-Path software. For details, refer to the *Intel® Omni-Path Fabric Performance Tuning User Guide*, BIOS Settings sections for the following processors:

- Intel® Xeon® Processor E5 v3 Family and Intel® Xeon® Processor E5 v4 Family
- Intel® Xeon Phi™ Product Family x200 (codenamed Knights Landing)

Note: For Intel® Xeon Phi™ Product Family x200, set the Snoop Holdoff Count to 9 as recommended in the *Intel® Omni-Path Fabric Performance Tuning User Guide*.

2.2 Configure OS Settings

Intel recommends that you pre-configure servers with the appropriate OS configuration settings before you start Intel® Omni-Path software installation, thus reducing installation time.

The recommended OS settings to optimize performance are defined in the *Intel® Omni-Path Fabric Performance Tuning User Guide*, Linux* Settings section.

2.2.1 CPU Frequency Settings

These settings are used to optimize CPU performance for benchmarks and may not be required for a production environment.

CPU frequency default Intel pstate driver in RHEL* 7 can result in changing CPU frequencies and unpredictable performance. The following change allows cpupower to set a consistent and steady CPU clock rate on all cores.

1. Disable `intel_pstate` in the kernel command line:

Edit /etc/default/grub by adding intel_pstate=disable to GRUB_CMDLINE_LINUX.

2. Apply the change: grub2-mkconfig -o /boot/grub2/grub.cfg
3. Reboot.

Platform Settings

To reduce run-to-run performance variations, Intel recommends that you pin the CPU clock frequency to a specific value and use the performance setting of the CPU power governor.

For example, the following command sets the frequency of all cores to a value of 2.6 GHz and sets the performance governor, when using acpi-cpufreq driver:

```
sudo cpupower -c all frequency-set -min 2.6 GHz -max 2.6 GHz -g performance
```

2.2.2 OS Tuning

These settings are used to optimize OS performance and are recommended for both benchmark and production environments.

1. The ACPI processor aggregator driver handles high core count processor power management. However, the driver can cause the system to run acpi_pad and consume 100% of each core. To work around this issue, add the following line to the /etc/modprobe.d/blacklist.conf file:

   ```
   blacklist acpi_pad
   ```

2. For optimum verbs and IPoIB performance and stability, add the following to the /etc/sysconfig/irqbalance file:

   ```
   IRQBALANCE_ARGS=--hintpolicy=exact
   ```

   Restart the irqbalance service after HFI1 driver loads, by rebooting or using the following command:

   ```
   /bin/systemctl restart irqbalance.service
   ```

3. Set IPoFabric to MTU size of 65520 and set connected mode in the /etc/sysconfig/network-scripts/ifcfg-ib0 file.

All servers in the fabric should have the identical BIOS and OS configuration.

3.0 TCP/IP Host Name Resolution

For details on resolving TCP/IP Host Names, see the *Intel® Omni-Path Fabric Software Installation Guide*, Installation Prerequisites section. The following notes provide an example of the contents of the `/etc/hosts` file.

Create a `/etc/hosts` file before starting Intel® Omni-Path software installation to simplify the process. In a typical installation, the server and switch names follow a local convention to indicate physical location or purpose of the node.

- If using `/etc/hosts`, update the `/etc/hosts` file on the Management Node (the head node with IFS installed) and copy to all hosts.
- If using DNS, all Management Network and IPoIB hostnames must be added to DNS `/etc/resolve.conf` and configured on the Management Node.
- The `/etc/hosts` file should contain:
  - Local host, required for subsequent single host verification using FastFabric TUI
  - Ethernet and IPoIB addresses and names for all hosts
  - Ethernet addresses and names of switches
  - Ethernet addresses of IPMI or remote management modules
  - Ethernet addresses of power domain

  An example of these recommendations follows:

```
# /etc/hosts example
# localhost (required)
127.0.0.1 localhost localhost.localdomain localhost4 localhost4.localdomain
# Ethernet Addresses of hosts 10.128.196.14    node1
10.128.196.15    node2
10.128.196.16    node3
#IPoIB Address of hosts should be outside Ethernet network 10.128.200.14
node1-opa
10.128.200.15    node2-opa
10.128.200.16    node3-opa
#RMM IP Addresses
10.127.240.121    node1-rmm
10.127.240.122    node2-rmm
# Chassis IP Address
10.128.198.250    opaedge1
10.128.198.249    opaedge2
# OPA director switch IP Address
10.128.198.251 opadirector1
10.128.198.252 opadirector2
```

Other files that may need adjustment according to specific site requirements include:

`/etc/hostname`, `/etc/resolv.conf`, `/etc/sysconfig/network`,

and `/etc/sysconfig/network-scripts/ifcfg-enp5s0f0`

4.0 Install Intel® Omni-Path Software

You should configure at least one node to run the Intel® Omni-Path Management Software including Fabric Manager (FM). This node is used to configure and validate all of the other hosts, switches, and chassis fabric devices. You must install the Intel® Omni-Path Fabric Suite software on this node.

Overview

- Install IntelOPA-IFS on head node(s) usually designated to run Subnet Manager (SM) and FastFabric Tools (including MPI applications) by changing directory to `/IntelOPA-IFS.DISTRO.VERSION` and using the `./INSTALL` command.
- Intel recommends that you enable servers with IPMI interfaces to support ACPI or equivalent remote power management and reset control via an Ethernet network.
- Apply Technical Advisories as needed.

References

The following document and sections describe the install procedures:

- *Intel® Omni-Path Fabric Software Installation Guide*, Download and Extract Installation Packages section
- *Intel® Omni-Path Fabric Software Installation Guide*, Install the Intel® Omni-Path Fabric Software section

Verify HFI speed and bus width using lspci

After the IFS installation, verify the Intel® OP HFI card is configured and visible to the host OS as Gen3 x16 slot speed (values are in **bold** text):

```
lspci -d 8086:24f0 -vv |grep Width
LnkCap: Port #0, Speed 8GT/s, Width x16, ASPM L1, Exit Latency L0s
<4us, L1 <64us
LnkSta: Speed 8GT/s, Width x16, TrErr- Train- SlotClk+ DLActive- BWMgmt- ABWMgmt-
```

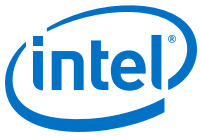
4.1 Disable Linux* Firewall

Use the commands:

```
# systemctl status firewalled
# systemctl stop firewalled
# systemctl disable firewalled
# systemctl status firewalled
```

4.2 Perform Initial Fabric Verification

Perform the following steps:



- Verify the port state of host is Active by running `opainfo`. If the command fails or returns other port state than Active, verify that the SM is running using `systemctl status opafm`.
- Verify the OPA software version on all nodes using `opaconfig -V`. All nodes should be running the same version.
- Verify all nodes, switches, SM, and ISLs are up using `opafabricinfo` as shown in the following example.

```
opafabricinfo
Fabric 0:0 Information:
SM: node1 hfi1_0 Guid: 0x001175010165b116 State: Master
Number of HFIs: 126
Number of Switches: 9
Number of Links: 252
Number of HFI Links: 126            (Internal: 0   External: 126)
Number of ISLs: 126                 (Internal: 0   External: 126)
Number of Degraded Links: 0         (HFI Links: 0   ISLs: 0)
Number of Omitted Links: 0          (HFI Links: 0   ISLs: 0)
```

- Review the number of HFIs, number of switches, and external ISLs and confirm that they match the fabric design. The number of HFIs and external ISLs provide a fabric-blocking factor. If there are any degraded links, further troubleshooting is required.

4.3 Edit Hosts and Allhosts Files

Edit the following files, which are used by the `opafastfabric.conf` file.

- Edit `/etc/sysconfig/opa/hosts`

  This file contains all hosts except the management node running IFS.

- Edit `/etc/sysconfig/opa/allhosts`

  This file contains the statement `include /etc/sysconfig/opa/hosts`. Edit the file to add the node(s) running IFS.

5.0 Generate Cable Map Topology Files

For complete details on `topology.xlsx`, see the *Intel® Omni-Path Fabric Suite FastFabric Command Line Interface Reference Guide*, topology.xlsx Overview section.

- `topology.xlsx` is a spreadsheet with 3 tabs:

  Note: You should **not** modify tab 2 and 3.

  — Tab 1 Fabric is for the end user to define EXTERNAL links.

  — Tab 2 swd06 contains the internal links for an Intel® OP Edge Switch 100 Series.

  — Tab 3 swd24 contains the internal links for an Intel® OP Director Class Switch 100 Series.

- `README.topology` and `README.xlat_topology` describe best practices for editing the `topology.xlsx` file.

For descriptions of other sample files provided in the package, see the *Intel® Omni-Path Fabric Suite FastFabric Command Line Interface Reference Guide*.

5.1 Generate Cable Map Topology Files

Defining Type in the Topology Spreadsheet

All host nodes should be defined Type = FI in column F of the spreadsheet. All Edge switches should be defined as Type = SW in column L (destination from host to Edge) and column F (source for Edge to core that is also Edge switch). The following example shows links between host and Edge switch.

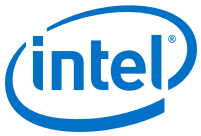
```
R19 opahost1  1 FI  R19 opaedge1  13 SW opahost1_opae1p13 1m Cable CU
```

All links between Edge switch to core that is also an Edge switch should be defined Type = SW as shown in the following example:

```
row1 rack01 opaedge1  1 SW row1 rack04 opaedgecore1 2 SW opae1p1_opac1p2 5M Cable
Fiber
```

All Director switches should be defined as Type = CL in column L (destination from Edge switch to Director switch). Column J (Name-2) should have the destination leaf and column K should have the port number on that leaf. The following example shows a link between an Edge switch to core that is a Director switch.

```
R19 opaedge1  5 SW  R72 opadirector1 01 L105B 11 CL opae1p5opad1L105Bp11 30m Fiber
```



All 24-leaf chassis Director switches should be defined as shown in the following example:

```
Core Name:opadirector1 Core Group:row1 Core Rack:rack72 Core Size:1152 Core Full:0
```

Set Core Full to 0 if the Director switch is not fully populated with all the leafs and spines. If it is fully populated, set Core Full to 1.

For complete details on `topology.xlsx`, see the *Intel® Omni-Path Fabric Suite FastFabric Command Line Interface Reference Guide*.

Creating the Topology File

1. Copy and save the `/opt/opa/samples/topology.xlsx` file from the Fabric Manager node to your local PC for editing in Microsoft* Excel.
2. Edit tab 1 in the spreadsheet to reflect your specific installation details as described previously. Save tab 1 as `<topologyfile>.csv` and copy this `.csv` file back to the Fabric Manager node.

   Note: In release 10.3 and later, the `topology.csv` cable label field can be up to 57 characters.
3. Generate the topology file in `.xml` format using the following command and the `topology.csv` file as the source:

   ```
   # opaxlattopology <topologyfile>.csv <topologyfile>.xml
   ```

If there are Director switches defined in the `.csv` file, then `opaxlattopology` includes all the ISL (internal chassis links between leafs and spines) in the `.xml` file.

Known Issues

The following known issue is present in release 10.3 and earlier:

- Core Full functionality for Director switches does not work. If the command `opareport -o verifyall -T <topologyfile>.xml` is run, then ISL errors are reported. (ISLs are internal links in a Director switch between leafs and spines.)

6.0 Configure FastFabric

The list of configuration files that are used by FastFabric are contained in the *Intel® Omni-Path Fabric Suite FastFabric User Guide*, Configuration Files for FastFabric section.

The `opafastfabric.conf` file provides default settings for most of the FastFabric command line options.

6.1 Format for IPoIB Host Names

By default, FastFabric uses the suffix OPA for the IPoIB host name. You can change this to a prefix and you can also change from opa to another convention such as ib, as the customer requires in `/etc/sysconfig/opa/opafastfabric.conf`.

The following examples show how to change opa to ib as a prefix or suffix.

For suffix:

```
export FF_IPOIB_SUFFIX=${FF_IPOIB_SUFFIX:--opa to export FF_IPOIB_SUFFIX=$
{FF_IPOIB_SUFFIX:--ib
```

For prefix:

```
export FF_IPOIB_PREFIX=${FF_IPOIB_PREFIX:-opa- to export FF_IPOIB_PREFIX=$
{FF_IPOIB_PREFIX:-ib-
```

6.2 Specify Test Areas for opaallanalysis

By default, `opaallanalysis` includes the fabric and chassis. These can be modified to include host SM, embedded SM, and externally-managed switches in `/etc/sysconfig/opa/opafastfabric.conf` as follows:

```
# pick appropriate type of SM to analyze
#export FF_ALL_ANALYSIS=${FF_ALL_ANALYSIS:-fabric chassis hostsm esm}
export FF_ALL_ANALYSIS=${FF_ALL_ANALYSIS:-fabric chassis hostsm}
```

6.3 Location of mpi_apps Directory

By default, `opafastfabric` uses `mpi_apps` located in `/usr/lib/opa/src/mpi_apps`. If a different path is set up for `mpi_apps`, then modify the following in `/etc/sysconfig/opa/opafastfabric.conf`:

```
export FF_MPI_APPS_DIR=${FF_MPI_APPS_DIR:-/usr/lib/opa/src/mpi_apps}
```

7.0 Configure Internally-Managed Switches

For a complete description of the configuration process, refer to the *Intel® Omni-Path Fabric Software Installation Guide*, Configure Intel® Omni-Path Chassis section.

The following steps provide a summary:

1. Download and install the driver file CDM v2.12.00 WHQL Certified.exe from: http://www.ftdichip.com/Drivers/VCP.htm
2. Set up USB serial port terminal emulator using the following serial options:
   - Speed: 115200
   - Data Bits: 8
   - Stop Bits: 1
   - Parity: None
   - Flow Control: None
3. Set up the switch TCP/IP address, gateway, netmask, and other options using a terminal emulator.
   a. Set the chassis IP address:

   ```
   setChassisIpAddr -h ipaddress -m netMask
   ```

   where *ipaddress* is the new IP address in dotted decimal format (xxx.xxx.xxx.xxx), and *netMask* is the new subnet mask in dotted decimal format.

   b. Change the chassis default gateway IPaddress:

   ```
   setDefaultRoute -h ipaddress
   ```

   where *ipaddress* is the new default gateway IP address in dotted decimal format.

   The changes are effective immediately.

   For details, refer to the *Intel® Omni-Path Fabric Switches Hardware Installation Guide*.
4. Edit the chassis file using the command:

   ```
   opagenchassis >> /etc/sysconfig/opa/chassis
   ```

   The chassis file contains the node name of managed switches corresponding to TCP/IP addresses as defined in the `/etc/hosts` file.
5. Run the `opafastfabric` TUI (Textual User Interface).
6. Select `1) Chassis Setup/Admin`.
7. Select items `0-6` and press `P` to **Perform**.

a. Item 0: Edit Config and Select/Edit Chassis File.
   i. Skip `opafastfabric.conf`, no changes needed.
   ii. Skip `ports`, no changes needed.
   iii. For `chassis` file, in the editor, review the list of chassis selected. The setup of this file should have occurred above when setting up the Management Node by editing `/etc/sysconfig/opa/chassis` with the name corresponding to the Ethernet IP address of the chassis.
b. Item 1: Verify Chassis via Ethernet Ping, should pass without error.
c. Item 2: Update Chassis Firmware.

   Specify the location for the firmware file to use.
d. Item 3: Set Up Chassis Basic Configuration.

   Provide answers as follows:
   i. Password: - Press **Enter** (no password).
   ii. Syslog (`y`)
      1. Syslog server (`n`)
      2. TCP/UDP port number (`n`) - Use default.
      3. Syslog facility (`n`) - Use default.
   iii. NTP (`n`) - Customer to assign
   iv. Timezone and DST (`y`)

      Use local timezone of server (`y`).
   v. Do you wish to configure OPA Node Desc to match Ethernet chassis name? (`y`) - Enter `y`.
   vi. Do you wish to configure the Link CRC Mode? (`n`)
e. Item 4: Set Up Password-Less SSH/SCP.
f. Item 5: Reboot Chassis should pass without error.
g. Item 6: Get Basic Chassis Configuration.

   Expected Summary output at end is shown below. Note that count should match the number of Edge switches.

```
Edgeswitch1:
Firmware Active          : 10.x.x.x.x
Firmware Primary         : 10.x.x.x.x
Syslog Configuration     : Syslog host set to: 0.0.0.0 port 514 facility
22
NTP                      : Configured to use the local clock
Time Zone                : Current time zone offset is: -5
LinkWidth Support        : 4X
Node Description         : switch1
Link CRC Mode            : 48b_or_14b_or_16b
```

To review the results, use an editor to view the files:

`/root/test.res` and `/root/test.log`

For more information, refer to the *Intel® Omni-Path Fabric Switches Hardware Installation Guide* and *Intel® Omni-Path Fabric Managed Switches Release Notes*.

8.0 Configure Intel® OP Director Class Switch 100 Series

Most Intel® OP Director switches are supplied with two Management Modules (MMs) for redundancy. In addition, Intel® OP Director switches have the following additional features:

- The switch has two Ethernet ports (one for each MM) and requires two Ethernet cables.
- The switch requires three IP addresses: one for each MM and one for the chassis, which is bound to the MM that is currently Master.
- It is useful to understand all reboot modes: `reboot all|-s|-m [slot #]` and how that causes failover.
- Default IP addresses of the Management Modules are:

  Chassis IP address: `192.168.100.9`

  Management Module M201: `192.168.100.10`

  Management Module M202: `192.168.100.11`

The chassis file, located in `/etc/sysconfig/opa/chassis`, contains the node name of Intel® OP Director switches corresponding to TCP/IP addresses as defined in the `/etc/hosts` file. The chassis IP address is configured using the procedure for configuring internally-managed switches, as described in Configure Internally-Managed Switches.

The MM IP addresses must be configured using a serial connection as described in the following procedure:

1. Ensure that the module is connected to a COM port on a serial terminal device through the USB port.
2. Get to a `[boot]:` prompt by following either step a or b:
   a. If the management module is running and displays `->` prompt, type the following command at the console: `reboot now` and press **ENTER**.
   b. If the management module is not running, power on the switch.
3. When the system displays `image1`, press the spacebar to interrupt the autoload sequence before the counter expires (within 5 seconds).
4. At the prompt, enter the command: `moduleip <ip_address>`

   The module reboots itself within 5 seconds and comes back with the new IP assigned to it. This module becomes the slave and the other MM becomes the master.

Repeat these steps for the second management module.

For more information, refer to the *Intel® Omni-Path Fabric Switches Hardware Installation Guide* and *Intel® Omni-Path Fabric Managed Switches Release Notes*.

9.0 Configure Externally-Managed Switches

For a complete description of the install process, refer to the *Intel® Omni-Path Fabric Software Installation Guide*, Configure Firmware on the Externally-Managed Intel® Omni-Path Switches section.

The 100SWE48QF Edge switches do not have an Ethernet* interface. Setup of these switches is performed using FastFabric via in-band commands.

Preferred approach:

1. Edit the switches file for externally-managed switches using the command: `opagenswitches >> /etc/sysconfig/opa/switches`

   The switches file contains a list of all the externally-managed switches in the fabric.

   Edit the switches file to replace the default switch name with the actual name that corresponds to the GUID for each switch. For example:

   Default: `0x00117501026a5683:0:0,`**`OmniPth00117501ff6a5602,`**`2`

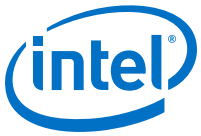
   Edited: `0x00117501026a5683:0:0,`**`opaextmanagededge1,`**`2`

2. Run `opafastfabric`.
3. Select `2) Externally Managed Switch Setup/Admin`.
4. Select items `0-9` and press `P` to **Perform**.
   a. Item 0: Edit Config and Select/Edit Switch File
      i. Skip `opafastfabric.conf`. No changes needed.
      ii. Skip `ports`. No changes needed.
      iii. Edit the file `/etc/sysconfig/opa/switches` and review the list of chassis selected. The `switches` file specifies:
      - switches by node GUID
      - (optional) hfi:port
      - (optional) Node Description (nodename) to be assigned to the switch
      - (optional) distance value indicating the relative distance from the FastFabric node for each switch

      The following snippet shows the switches file format and an example:

```
nodeguid:hfi:port,nodename,distance
0x00117501026a5683:0:0,opaextmanagededge1,2
```

   b. Item 1: Generate or Update Switch File.
      i. Regenerate - Answer `n` if it was generated in step 1. Answer `y` if this is the first time or additional externally-managed switches have been added or replaced.



ii. Update switch names - Answer `y`. Note that this step may take a few minutes.

c. Item 2, 3:

Should pass without error.

d. Item 4: Specify the location for the FW file (`.emfw`) to use.

e. Item 5: Set up switch basic configuration and set the node description.

```
Performing Switch Admin: Setup Switch basic configuration
Executing: /usr/sbin/opaswitchadmin -L
/etc/sysconfig/opa/switches configure
Do you wish to configure the switch Link Width Options? [n]:
Do you wish to configure the switch Node Description as it is set in the
switches file? [n]: y
Do you wish to configure the switch FM Enabled option? [n]: Do you wish
to configure the switch Link CRC Mode? [n]: Executing configure Test
Suite (configure) Fri Jan 15 11:11:12 EST 2016 ...
Executing TEST SUITE configure CASE (configure.
0x00117501026a5683:0:0,OmniPth00117501ff6a5602.i2c
.extmgd.switchconfigure) configure switch
0x00117501026a5683:0:0,OmniPth00117501ff6a5602 ...
TEST SUITE configure CASE (configure.
0x00117501026a5683:0:0,OmniPth00117501ff6a5602.i2c
.extmgd.switchconfigure) configure switch
0x00117501026a5683:0:0,OmniPth00117501ff6a5602 PASSED
TEST SUITE configure: 1 Cases; 1 PASSED
```

f. Item 6: Reboot should pass without error.

g. Item 7: Review results for redundant power and FAN status.

Expected summary output at end should be similar to the following (count should match number of externally-managed Edge switches):

```
0x00117501026a5683:0:0,opaextmanagededge1:
F/W ver:10.x.x.x.x    H/W ver:003-01    H/W pt num:H89344-003-
01    Fan status:Normal/Normal/Normal/Normal/Normal/Normal    PS1
Status:ONLINE    PS2 Status: ONLINE    Temperature
status:LTC2974:33C/MAX_QSFP:40C/PRR_ASIC:40C
```

Any non-redundant or failed fans or power supplies found during this step are also reported in `/root/punchlist.csv`.

h. Item 8: Get Basic Switch Configuration.

Expected summary output at end should be similar to the following (count should match number of externally-managed Edge switches):

```
Link Width                  :    1,2,3,4
Link Speed                  :    25Gb
FM Enabled                  :    No
Link CRC Mode               :    None
vCU                         :    0
External Loopback Allowed   :    Yes
Node Description            : Edgeswitch1
```

i. Item 9: Save the `test.res` output for future reference.

To review results, view the `/root/test.res` and `/root/test.log` files.

For more information, refer to the *Intel® Omni-Path Fabric Switches Hardware Installation Guide* and *Intel® Omni-Path Fabric Externally-Managed Switches Release Notes*.

10.0 Configure Host Setup

Perform the following steps:

1. Make sure all hosts are booted; this is required to identify switch names. If hosts are not available, you can perform all configuration steps except setting the switch names.
2. Run `opafastfabric`.
3. Select `3) Host Setup`.
4. Select items `0-4` and press `P` to **Perform**.
5. Select item `5` and press `P` to **Perform**.

   This installs IntelOPA-Basic on all compute nodes defined in `/etc/sysconfig/opa/hosts`. Be sure to exclude head node(s) with IFS installed and the node where you are running `opafastfabric`.

   a. Provide the path to `IntelOPA-Basic.DISTRO.VERSION.tgz` when prompted.

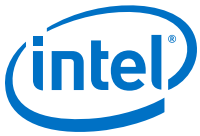
   b. Enter directory to get `IntelOPA-Basic.DISTRO.VERSION.tgz` from (or none) :`/root`.
6. Select item `6` and press `P` to **Perform**. This performs the IPoIB ping test.
7. Select item `7` and press `P` to **Perform**. This Builds Test Apps and Copy to Hosts.

   a. Choose an MPI when prompted: `Please Select MPI Directory`

   b. Select an MPI with -hfi extension, so it will build with PSM2. For example: `/usr/mpi/gcc/openmpi-1.10.2-hfi`.

   c. When prompted to build base sample applications, select `yes`.

For more information, refer to the *Intel® Omni-Path Fabric Software Installation Guide* and *Intel® Omni-Path Fabric Software Release Notes*.



11.0 Verify Cable Map Topology

This section describes how to use the fabric `topology.xml` file created in Generate Cable Map Topology Files to verify that fabric topology (cabling) is consistent with the cable map.

The command `opareport -o verify* -T <topologyfilename>.xml` compares the live fabric interconnect against the topology file created based on the cable map. These commands test links, switches, and SM topology. If successful, the output reports a total of 0 Incorrect Links found, 0 Missing, 0 Unexpected, 0 Misconnected, 0 Duplicate, and 0 Different.

```
# opareport -o verifyfis -T <topologyfilename>.xml
# opareport -o verifyextlinks -T <topologyfilename>.xml
# opareport -o verifyall -T <topologyfilename>.xml
```

In most cases, links reported with errors are either due to incorrect cabling to the wrong port or the `topology.csv` file has incorrect source and port destinations. Verify the physical interconnect against the cable map using `opaextractsellinks` as in the following examples:

- List all the links in the fabric: `opaextractsellinks`
- List all the links to a switch named `OmniPth00117501ffffffff`: `opaextractsellinks -F "node:OmniPth00117501ffffffff"`
- List all the connections to end-nodes: `opaextractsellinks -F "nodetype:FI"`
- List all the links on the second HFI's fabric of a multi-plane fabric: `opaextractsellinks -h 2`

After all topology issues have been resolved, copy the `topologyfile.xml` from the local working directory to `cat /etc/sysconfig/opa/topology.0\:0.xml`.

Refer to the *Intel® Omni-Path Fabric Suite FastFabric Command Line Interface Reference Guide* for more information about using `opareport` in general, and using `opareport` for Advanced Topology Verification.

12.0 Verify Server and Fabric

Validation of servers and the fabric is initiated from the Management Node using the FastFabric TUI using `opafastfabric` on hosts defined in `/etc/sysconfig/opa/allhosts`.

Perform the following steps:

1. Choose item `4) Host Verification/Admin` and run through all steps.
2. Perform `3) Perform Single Host Verification`.

   When prompted "`Would you like to specify tests to run? [n]:`" enter `y` for HPL test.

   When prompted "`View Load on hosts prior to verification? [y]:`" enter `y`. This option checks CPU load by running `/usr/sbin/opacheckload -f /etc/sysconfig/opa/allhosts`.

   Edit `hostverify.res` for results.
3. Perform `4) Verify OPA Fabric Status and Topology`. This option goes through a fabric error and topology verification.

   Choose the default for all prompts.

   Edit `/root/linkanalysis.res` to view results.
4. Perform `6) Verify Hosts Ping via IPoIB`. This option pings all IPoIB interfaces.
5. Perform `8) Check MPI Performance`. This option tests Latency and Bandwidth deviation between all hosts.

   Choose defaults for all prompts.

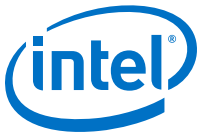
   Edit `/root/test.log` for results.

For more information, refer to the *Intel® Omni-Path Fabric Software Installation Guide*.

12.1 punchlist.csv

A punchlist file is generated during execution of the FastFabric TUI and CLI commands and can be used to track issues identified by the Intel® OPA tools. The punchlist file is located in `$FF_RESULT_DIR /punchlist.csv`, typically `/root/punchlist.csv`.

Two additional files, `/root/test.res` and `/root/test.log`, are created during OPA test commands and are useful for tracking test failures and issues.



13.0 Best Known Methods (BKMs) for Site Installation

This section contains commands useful for configuring and debugging issues during fabric installation.

13.1 Enable Intel® Omni-Path Fabric Manager GUI for Early Debug

By default, the Intel® Omni-Path Fabric Suite Fabric Manager GUI is disabled after installation of the IFS software. To quickly enable for early debug, use the following steps. For complete details, refer to the *Intel® Omni-Path Fabric Suite Fabric Manager GUI User Guide*.

Note: This method bypasses the SSH key authorization and is not intended for end customer installs.

1. Edit `/etc/sysconfig/opafm.xml` file on the Management Node. Make the two changes shown in **bold** for SslSecurityEnabled and default FE startup:

```
<SslSecurityEnabled>0</SslSecurityEnabled>

<!-- Common FE (Fabric Executive) attributes -->
<Fe>
<!-- The FE is required by the Intel Omni-Path FM GUI. -->
<!-- To enable the FE, configure the SslSecurity parameters in this file -->
<!-- as desired. -->
<!-- For Host FM then set Start to 1. -->
<!-- For Embedded FM the Start parameter in this file is not used;    -->
<!-- enable the FE via the smConfig and smPmStart chassis CLI commands. -->
<Start>1</Start> <!-- default FE startup for all instances -->
<!-- Overrides of the Common.Shared parameters if desired -->
<!-- <SyslogFacility>Local6</SyslogFacility> -->
```

2. Restart the Fabric Manager to enable the changes and start the FE process required by the Fabric Manager GUI.

```
# systemctl restart opafm
```

3. Download and install the Fabric Manager GUI application to a Windows* PC or Linux* system.
4. Start the Fabric Manager GUI application.
5. Open the **Configuration** tab and enter the hostname or IP address of the Management Node running the Fabric Manager in your system into the FE Connection.
6. Uncheck the Secure tab.
7. Select **Apply** to run the connection test and then **Run** to start the Fabric Manager GUI application.

Note: The Fabric Manager GUI does not operate through network proxies. Network firewall access may also need to be disabled. For a quick go/no-go verification, complete the connection test in the configuration tab as previously described.

13.2 Review Server and Fabric Verification Test Results

During fabric validation, unexpected loads on Host CPUs may result in inconsistent performance results. As a debug step, isolate the issue using the following:

Use the OPA tool to verify CPU host load. By default, it captures the top ten most heavily loaded hosts.

```
# /usr/sbin/opacheckload -f /etc/sysconfig/opa/allhosts
```

After the high load hosts have been identified, the next step is to root cause the issues.

Perform the following steps:

1. Check for HFI PCIe width or speed issues.

   Are HFI cards operating in a degraded mode, narrow width, or less than PCIe Gen3? Use `lspci` or `opahfirev` to verify the PCIe operating speed and bus width:

   - `lspci`: Verify HFI speed and bus width using lspci
   - `opahfirev`: Decode the Physical Configuration of an HFI

   Possible sources for narrow PCIe width:

   a. Be aware that OPA does support different width PCIe cards, including dual HFI cards using two x8 slices of a x16 physical connector. `opahfirev` is very useful for detecting this configuration.

   b. HFI Card partial insertion into x16 slots. Initially this appears to be a narrow width issue but re-inserting the card often resolves the issue. This may occur after a server is shipped. This step has resolved most width issues.

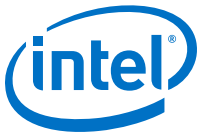
   c. Server physical configuration: Many servers support different PCIe logical widths based on riser card configuration. The slot may be physically x16 but internally limited to x8. Check other servers of the same configuration in the fabric. Check the server configuration. *This is also a common issue*.

   d. Swap the HFI to another server to determine if the problem follows the card or the server.

2. Use the Linux* `top` command to identify the key CPU load processes:

   ```
   # top
   ```

   `opatop` may be useful for checking for loads that vary over time. Use the `r` (rev), `f` (forward), and `L` (live) options to look through PM snapshots of system activity. This is also helpful for monitoring application startup versus run time loads. The



PM captures high resolution statistics, with very low system overhead, over periods up to two days. The tools that harvest the PM stats are `opatop` and the FM GUI.

```
# opatop
```

3. Check for high CPU percent processes.

   Examples of some issues:

   ksoftirqd process - known issue in RHEL* 7.1, the workaround is to reboot the individual server. The fix is to update to a newer release.

   Screen savers - when a Linux* GUI is enabled on hosts, the screen that runs when the user interface is idle may have a high CPU load.

   Test applications - look for MPI jobs or similar applications running in the background. This is a common issue particularly in a shared fabric bring-up environment. Use `kill -p` *`process`* to stop orphan applications or reboot the server to debug the issue.

4. Review the following sections of this document to isolate nodes with different or incorrect settings. Each area represents configuration variables that have been shown to create performance deltas.
   - Configure BIOS Settings on page 11
   - CPU Frequency Settings on page 11
   - OS Tuning on page 12

13.3 Debug Intel® Omni-Path Physical Link Issues

After you have run the FastFabric tool suite and identified issues with links, then it is useful to start root-causing the issues. This section focuses on Intel® Omni-Path Fabric physical links and not PCIe bus link issues.

OPA reporting tools are robust, but it can be confusing for new users to understand the difference between error counters and actual failures.

From an installation perspective, it is important to watch for physical issues with cabling, both copper and optical. In general, bend radius, cable insertion issues, and physical compression or damage to cables can result in transmission issues. OPA recovers from many issues transparently. This section helps root-cause solid failures as well as marginal links. Most often the issue is resolved simply by re-installing a cable and verifying that it clicks into the connector socket on the HFI or switch.

View the QSFP/cable details of a specific switch port using the command:

```
opasmaquery -o cableinfo -d 10 -l <lid> -m <switch portnumber>
```

To debug a particular switch, a useful technique is to get a snapshot of it, using the command:

```
opareport -o snapshot -F portguid:0x001175010265bb1d
```

13.3.1 OPA Link Transition Flow

To debug link issues, it is helpful to understand the four key link states, starting from Offline and running properly in the final Active state.

Note: The Fabric Manager, `opafm`, must be running to transition physical links from the Init state to the Active state. If you subsequently stop the Fabric Manager when a link is in the Active state, the link remains active. You can safely make changes to the `opafm.xml` file for the Fabric Manager and restart the service without dropping active links. As of the 10.0.0.696 software release, by default, the `opafm` service is not configured for autostart after IFS FULL installation.

PortState:

- Offline: link down. QSFP not present or not visible to the HFI driver.
- Polling: physical link training in progress. At this point you do not know if the other end of the QSFP is connected to a working OPA device.
- Init: Link training has completed, both sides are present. Typically waiting for the Fabric Manager to enable the link.
- Active: Normal operating state of a fully functional link.

13.3.2 Verify the Fabric Manager is Running

From the Management Node, run the following command to report all HFIs and Switches.

```
# opafabricinfo
```

If it fails, try the following steps:

- Check status of the Fabric Manager process using the command:

  ```
  # systemctl status opafm
  ```

- Restart the Fabric Manager using the command:

  ```
  # systemctl start opafm
  ```

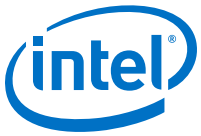
13.3.3 Check the State of All Links in the System

The `opaextracterror` command generates a CSV output representing the entire link state of the fabric.

```
# opaextracterror > link_status.csv
```

13.3.4 Check the State of HFI Links from a Server

If you are debugging server link issues, the `opainfo` command may be useful for a single server view.



`opainfo` captures a variety of data useful for debugging server related link issues. Multiple OPA commands can be used to extract individual data elements, however, this command is unique in the combination of data it provides.

- PortState: see OPA Link Transition Flow on page 30.
- LinkWidth: a fully functional link should indicate Act:4 and En:4.
- QSFP: Physical cable information for the QSFP, in this case a 5M Optical (AOC) Finisar cable.
- Link Quality: Range = 0 - 5 where 5 is Excellent.

```
# opainfo
hfi1_0:1                PortGID:0xfe80000000000000:001175010165b19c
   PortState:     Active
   LinkSpeed      Act: 25Gb         En: 25Gb
   LinkWidth      Act: 4            En: 4
   LinkWidthDnGrd ActTx: 4  Rx: 4   En: 3,4
   LCRC           Act: 14-bit       En: 14-bit,16-bit,48-bit Mgmt: True
   LID: 0x00000001-0x00000001       SM LID: 0x00000002 SL: 0
   QSFP: PassiveCu, 1m   FCI Electronics   P/N 10131941-2010LF  Rev 5
   Xmit Data:           22581581 MB Pkts:           5100825193
   Recv Data:           18725619 MB Pkts:           4024569756
   Link Quality: 5 (Excellent)
```

13.3.5 Link Width, Downgrades, and opafm.xml

By default, OPA links run in x4 link width mode. OPA has a highly robust link mechanism, as compared to InfiniBand*, and it allows links to run in reduced widths with no data loss.

Three things to know:

1. By default, the `opafm.xml` configuration file requires links to start up in x4 link width mode. This is configurable separately for HFI and ISL links using the **WidthPolicy** parameter.
2. Link downgrade ranges are also configurable in the `opafm.xml` file, using the **MaxDroppedLanes** parameter.
3. Default configuration example - A link that successfully starts up in x4 width and subsequently downgrades to x3 width continues to operate. If the link is restarted, by a server reboot, for example, and attempts to run by less than x4 width, then the link is disabled by the Fabric Manager and does not enter the Active state.

The `opainfo` command for HFIs is useful for checking the link width and link downgrade configuration on servers.

For a system view of all links that are running in less than x4 width mode, use the command:

```
# opareport -o errors -o slowlinks
```

13.3.6 How to Check Fabric Connectivity

For large fabrics, follow the flow described in Generate Cable Map Topology Files on page 16.

13.3.7 Physical Links Stability Test using opacabletest

Intel® Omni-Path Architecture uses a quality metric for reporting status (`opainfo`). The quality metric ranges from 5 (excellent) to 1 (poor). For a more quantitative metric, use `cabletest` to generate traffic from on the HFI and ISL links, and `opaextractperf` and `opaextracterrors` to harvest the data.

Before you begin:

- Clear error counters prior to test using `opareport -o none -clearall` and check the error counters after the test.
- Check to make sure there are no errors in fabric using: `opareport -o errors`
- Use `opatop` to monitor fabric utilization.

Detailed procedure:

1. Start and stop cable test on the Management Node either from the `opafastfabric` TUI or using CLI commands:

   a. `# opafastfabric`

   b. `4) Host Verification/Admin`

   c. `a) Start or Stop Bit Error Rate cable Test`

   Or to run manually, use the following tests for hosts, then ISLs. Test each one for a reasonable time, typically 5 - 15 minutes.

   ```
   # /usr/sbin/opacabletest  -A -n 3 -f '/etc/sysconfig/opa/allhosts'  stop_fi
   stop_isl

   # opareport -o none -clearall

   # /usr/sbin/opacabletest  -A -n 3 -f '/etc/sysconfig/opa/allhosts'  start_fi
   ```

   Run the previous command for 5 - 15 minutes for the hosts.

   ```
   # /usr/sbin/opacabletest  -A -n 3 -f '/etc/sysconfig/opa/allhosts'  stop_fi
   start_isl
   ```

   Run the previous command for 5 - 15 minutes for the ISLs.

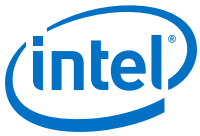
   ```
   # /usr/sbin/opacabletest  -A -n 3 -f '/etc/sysconfig/opa/allhosts'  stop_isl
   stop_fi

   # opaextractperf > link_stability_perf.csv

   # opaextracterrors > link_stability_counters.csv
   ```

   Use `opatop` to view link utilization.

2. For large fabrics, check stability using a long run of `opacabletest` (typically 4-8 hours). Short runs of 10-15 minutes are fine for initial validation.

How to interpret the results:

The `opaextracterrors` command is a misnomer, it captures interesting statistics for evaluating links, but most of the content is not indicative of failures. The OPA fabric has robust end-to-end recovery mechanisms that handle issues.



Suggest looking specifically at the following columns:

- LinkWidthDnGradeTxActive - expect to see x4 Width
- LinkWidthDnGradeRxActive - expect to see x4 Width
- LinkQualityIndicator - 5 is excellent, 4 is acceptable, 3 is marginal and clearly an issue.
- LinkDowned - when an HFI is reset, the link down count increases, so rebooting a server results in small increments. If you see a link with significantly higher counts than its reboot expectations, then take a look at the server `/var/log/messages` file to determine whether the server is rebooting or the link is re-initializing.

For the other error counters, run a column sort and look for high error counts (greater than 100x) versus other links and take a look at the link types. Optical links have higher retry rates. This is not typically an issue unless they far exceed their peers.

The output is useful for verifying that every link is being tested. Unusual fabric `opaextractperf` topologies may result in non-optimum cabletest results. One workaround is to separately run isl and fi (HFI) link tests, then look at the total error results.

13.3.8 How to Debug and Fix Physical Link Issues

Check the topology before and after each of the debug steps using:

```
# opareport -o verifyall -T test_topology.xm
```

If the original issue was marginal operation rather than a hard failure, then re-run `cabletest` and analyze the `opaextracterrors` results to verify whether the issues were resolved.

At this point, you have a list of links with issues. Intel recommends the following approach for physical link resolution:

1. Unplug and re-insert each end of a physical cable. Check that the cable actually clicks into place. It may be useful to do this step separately for each end of the cable. Re-run `opacabletest` and verify whether the issue has been resolved or not.

   Note: This step has resolved more link issues in fabric installs than all others.
2. Swap the questionable cable with a known good cable to isolate whether it is an HFI/Switch issue or cable issue.
3. If step 2 worked, then install the questionable cable into another location and verify whether it works.
4. If the issue is corrected, then the issue may be a mechanical latching issue on the HFI/Switch connector.
5. If the original issue was marginal operation rather than a hard failure, then re-run `opacabletest` and analyze the `opaextracterrors` results to verify whether the issues were resolved.
6. Re-run the physical links stability test using `opacabletest`.

13.3.9 Link Debug CLI Commands

- Identify fabric errors:

```
# opareport -o errors
```

- Identify slow links (< x4 width):

```
# opareport -o slowlinks
```

- Find links that are not plugged in or not seen by the interface. Find all links stuck in the Offline state:

```
# opareport -A -m -F portphysstate:offline -o comps -d 5
```

- A link stuck in Polling may indicate that the other end of the cable is not inserted correctly. In this case, typically, one end is Polling and the other end is Offline.
- Find all links stuck in the Polling state:

```
# opareport -A -m -F portphysstate:polling -o comps -d 5
```

- Identify bad links:

```
# opaextractbadlinks
```

- As a debug step, temporarily disable all bad links and append `/etc/sysconfig/opa/disabled.0:0.csv` with a list of all bad links disabled.

```
# opaextractbadlinks | opadisableports
```

- To enable links previously disabled:

```
# cat /etc/sysconfig/opa/disabled.0:0.csv | opaenableports
```

- To bounce a link, simulating a cable pull and re-insert on a server. It may take up to 60 seconds for the port to re-enter the active state.

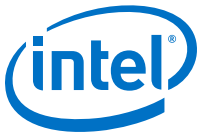
```
# opaportconfig bounce
```

- Check status using:

```
# opainfo
```

- `opaportconfig` and `opaportinfo` are key commands for port debugging. Run the commands with the `–help` option to see available parameters.
- To disable a set of links, extract them to a `csv` file using `opaextractsellinks`. In the following example, links are extracted to `linkstodisable.csv`. To disable a set of links, run:

```
opadisableports < linkstodisable.csv
```



By default, all disabled links are appended to the file `/etc/sysconfig/opa/disabled\:1\:1.csv`.

To enable the disabled ports, run:

```
opaenableports < /etc/sysconfig/opa/disabled\:1\:1.csv
```

After enabling the ports, the file `/etc/sysconfig/opa/disabled\:1\:1.csv` purges the links that are enabled.

Note: For each listed link, the switch port closer to this node is disabled.

Run `opaportinfo -l` *<lid of switch>* `-m` *<port number>*. Check the port state by running:

```
opaportinfo -l 3 -m 0x10
```

Note: Be sure to exclude the SM node on the Edge switch you are on and run `disableports` from the `linkstodisable` file to prevent cutting off this node from the fabric.

13.4 Use opatop for Bandwidth and Error Summary

Use the `opatop` Textual User Interface (TUI) to look at bandwidth and error summary of HFIs and switches.

This section provides a high-level overview of `opatop`.

- `1)` selects HFIs and `2)` selects SW.

  Intel recommends selecting `2)` SWs. In this display, HFIs show up as Send/Rcv and ISLs show up as Int.
- On the Group Information screen:
  - Select (`W`) for Bandwidth.
  - Select (`E`) for Error summary.
- Use `u` to move to an upper level.
- Use `2)` to view SWs Bandwidth and error summary.

For details, see the *Intel® Omni-Path Fabric Suite FastFabric User Guide*, opatop Fabric Performance Monitor section.

13.5 Use the Beacon LED on HFIs and Edge Switches

The LED beaconing flash pattern can be turned ON/OFF with the `opaportconfig` command. This can be used to identify the HFI and switches/ports installed in racks that need attention.

For HFI:

```
opaportconfig -l 0x001 ledoff
Disabling Led at LID 0x00000001 Port 0 via local port 1 (0x0011750101671ed9)

opaportconfig -l 0x001 ledon
Enabling LED at LID 0x00000001 Port 0 via local port 1 (0x0011750101671ed9)
```

For Switch port:

```
opaportconfig -l 0x002 -m 40 ledon (where –m 40 is port number)
Enabling LED at LID 0x00000002 Port 40 via local port 1 (0x0011750101671ed9)

opaportconfig -l 0x002 -m 40 ledoff
Disabling Led at LID 0x00000002 Port 40 via local port 1 (0x0011750101671ed9)
```

13.6 Decode the Physical Configuration of an HFI

The `opahfirev` command provides a quick snapshot of an Intel® Omni-Path Host Fabric Interface (HFI), providing both PCIe status and physical configuration state, complementary to the `opainfo` command.

```
# opahfirev
######################
node145  - HFI 0000:03:00.0    # Compute Server name = node145, PCIE addr
0000:03:00.0
HFI:   hfi1_0
Board: ChipABI 3.0, ChipRev 7.16, SW Compat 3
SN:    0x0067671e
Bus:   Speed 8GT/s, Width x16    # PCIe Gen3 = 8GT/s, with a x16 configuration
GUID:  0011:7501:0167:671e
TMM:   10.0.0.992.40
######################
```

Note the new field for TMM firmware version, an optional micro-controller for thermal monitoring on vendor-specific HFI adapters using the SMBus.

- Check the TMM firmware version using: `opatmmtool -fwversion`.
- Check the TMM firmware version in the `hfi1_smbus.fw` file using:

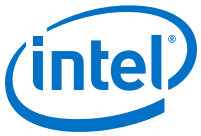
  ```
  opatmmtool -f /lib/firmware/updates/hfi1_smbus.fw fileversion
  ```

- If the `fwversion` is less than `fileversion`, then update the TMM firmware version using:

  ```
  opatmmtool -f /lib/firmware/updates/hfi1_smbus.fw update
  ```

13.7 Verify Fabric Manager Sweep

By default, Fabric Manager sweeps every five minutes as defined in the `/etc/sysconfig/opafm.xml` file. Sweeps are triggered sooner if there are fabric changes such as hosts, switches, or links going up or down. Edit `/var/log/messages` and search for `CYCLE START`. Each cycle start has a complementary cycle end. Any links with errors are noted during this sweep cycle.



An example of a clean SM sweep follows:

```
Feb 16 16:12:08 hds1fnb8261 fm0_sm[3946]: PROGR[topology]: SM: topology_main: TT:
DISCOVERY CYCLE START - REASON: Scheduled sweep interval
Feb 16 16:12:08 hds1fnb8261 fm0_sm[3946]: PROGR[topology]: SM: topology_main:
DISCOVERY CYCLE END. 9 SWs, 131 HFIs, 131 end ports, 523 total ports, 1 SM(s),
1902 packets, 0 retries, 0.350 sec sweep
```

Compare the sweep result with `opafabricinfo` and the fabric topology.

13.8 Verify PM Sweep Duration

To show the sweep duration, open `opatop` then select `i`.

```
opatop: Img:Tue Feb 16 01:54:43 2016, Hist  Now:Tue Feb 16 09:53:26 2016
Image Info:
 Sweep Start: Tue Feb 16 01:54:43 2016
 Sweep Duration: 0.001 Seconds

 Num SW-Ports:       3  HFI-Ports:       2
 Num SWs:            1  Num Links:       2  Num SMs:         2

 Num Fail Nodes:       0  Ports:       0  Unexpected Clear Ports: 0
 Num Skip Nodes:       0  Ports:       0
```

Select `r` to traverse the previous sweep duration time from history files. By default, PM sweeps every ten seconds. The latest ten image files (100 sec) are stored in RAM and up to 24 hours of history is stored in `/var/usr/lib/opa-fm`.

13.9 Check Credit Loop Operation

For details on credit loops, see the *Intel® Omni-Path Fabric Suite Fabric Manager User Guide* QoS Operation section.

To verify that a fabric does not have a credit loop issue, use:

```
# opareport -o validatecreditloops
```

The output should report similar to the following where no credit loops are detected:

```
Fabric summary: 135 devices, 126 HFIs, 9 switches,
504 connections, 16880 routing decisions,
15750 analyzed routes, 0 incomplete routes
Done Building Graphical Layout of All Routes
Routes are deadlock free (No credit loops detected)
```

13.10 Fabric Manager Routing Algorithm

If long Fabric Manager (FM) sweep times are observed or FM sweeps do not finish when a large number of nodes are bounced, consider changing the FM routing algorithm to `fattree` from the default `shortestpath`. You can do this by updating the `/etc/sysconfig/opafm.xml` file as shown in the following example:

```
<!-- ***************** Fabric Routing ***************************** -->
<!-- The following Routing Algorithms are supported -->
<!-- shortestpath - pick shortest path and balance lids on ISLs -->
<!-- dgshortestpath - A variation of shortestpath that uses the        -->
<!--             RoutingOrder parameter to control the order in which   -->
<!--             switch egress ports are assigned to LIDs being routed  -->
<!--             through the fabric. This can provide a better balance  -->
<!--             of traffic through fabrics with multiple types of end  -->
<!--             nodes.                                                 -->
<!--             See the <DGShortestPathTopology> section, below, for   -->
<!--             more information.                                      -->
<!-- fattree -  A variation of shortestpath with better balancing      -->
<!--             and improved SM performance on fat tree-like fabrics.  -->
<RoutingAlgorithm>fattree</RoutingAlgorithm>
```

14.0 Run Benchmark and Stress Tests

Configuration for both Bandwidth and Latency Test:

```
# source /usr/mpi/gcc/openmpi-1.10.0-35-hfi/bin/mpivars.sh
# cd /usr/mpi/gcc/openmpi-1.10.0-35-hfi/bin/
```

If it does not exist already, create host2 file with two nodes:

```
# export LD_LIBRARY_PATH=/usr/mpi/gcc/openmpi-1.10.0-35-hfi/lib64
```

14.1 Run Bandwidth Test

From `/usr/lib/opa/src/mpi_apps` run:

```
# ./run_bw3
```

This test uses hosts defined in the `mpi_hosts` file.

14.2 Run Latency Test

From `/usr/lib/opa/src/mpi_apps` run:

```
# ./run_lat3
```

14.3 Run MPI Deviation Test

From `/usr/lib/opa/src/mpi_apps` run:

```
# ./run_deviation 20 -bwtol 20 -lattol 50
```

14.4 Run mpi_groupstress (Cable Stress)

Note: This section describes a procedure for using Cable Test for OEM testing of custom interconnects such as backplanes, integrated switches, and custom HFIs. This test is not for use by end customers.

See the *Intel® Omni-Path Fabric Suite FastFabric Command Line Interface Reference Guide* for detailed information. The test is located in `/usr/lib/opa/src/mpi_apps`.

1. Create `mpi_group_hosts`:

```
# /usr/lib/opa/src/mpi_apps/gen_group_hosts
```

   Accept the defaults.

2. Verify file contents from `/usr/lib/opa/src/mpi_apps/mpi_group_hosts`:

```
# cat mpi_group_hosts
/usr/lib/opa/src/mpi_apps/groupstress/mpi_groupstress.c
mpicc -o mpi_groupstress_ompi mpi_groupstress.c
```

3. Clear error counters:

```
# opareport -o none -clearall
```

4. Confirm no errors exist:

```
# opareport -o errors
```

5. Run `mpi_groupstress` test:

```
# mpirun -machinefile /usr/lib/opa/src/mpi_apps/mpi_group_hosts ./
mpi_groupstress
MPI_GroupStress BIBW Cable Stress Test
6 groups of 2, running for 60 minutes.
```

6. Run `opatop` to monitor the link utilization during the test. For HFI use 1, then W and for switches use 2, then W.

   An output example of `opatop` 1, W follows:

```
Group BW Stats: HFIs   Criteria: Util-High  Number: 10
Snd:  TotMBps  AvgMBps  MinMBps  MaxMBps      TotKPps  AvgKPps  MinKPps  MaxKPps
        45618     7603        0     9173         6590     1098        0     1328
 Buckt 0+%   10+%   20+%   30+%   40+%   50+%   60+%   70+%   80+%   90+%
         1      0      0      0      0      0      0      5      0      0
Rcv:  TotMBps  AvgMBps  MinMBps  MaxMBps      TotKPps  AvgKPps  MinKPps  MaxKPps
        45619     7603        0     9173         6595     1099        0     1328
 Buckt 0+%   10+%   20+%   30+%   40+%   50+%   60+%   70+%   80+%   90+%
         1      0      0      0      0      0      0      5      0      0
```

   By default, the test runs for 60 minutes. To run for longer duration, specify minutes in the `mpirun` command. For example, `./mpi_groupstress 120` runs for 2 hours.

7. Check error counts after the test:

```
# opareport -o errors
```

8. View the log file which is available for analysis in `/usr/lib/opa/src/mpi_apps/logs`. The log filename format is `mpi_groupstress.`*`date_time`*.

9. Extract the log file in Comma-Separated Values (CSV) format for errors and performance.

```
# opaextracterror
# opaextractperf
```

14.5 Run run_mpi_stress

The default traffic pattern is "all-to-all" for this test.

Refer to *Intel® Omni-Path Fabric Suite FastFabric Command Line Interface Reference Guide* for detailed information.

The test is located in `/usr/lib/opa/src/mpi_apps`.

1. Clear error counters:

```
# opareport -o none --clearall
```

2. Confirm no errors exist:

```
# opareport -o error
```

3. Run `mpi_stress` test using a 60 minute duration:

```
# ./run_mpi_stress all -t 60
```

4. Run `opatop` to monitor the link utilization during the test.
5. Check error counts after the test:

```
# opareport -o errors
```

6. View the log file that is available for analysis in `/usr/lib/opa/src/mpi_apps/logs`. The log filename format is `mpi_stress.`*`date_time`*.
7. Extract the log file in CSV format for errors and performance.

```
# opaextracterror
# opaextractperf
```

15.0 Take State Dump of a Switch

Note: Taking a state dump is a disruptive process and requires reboot of the switch after the state dump is taken. A state dump should only be taken if required to debug an issue.

A state dump of a switch is taken from an internally-managed switch in the fabric, using its LID.

Prerequisites

- Find the LID of the switch whose state you want to dump by running the `opaextractlids|grep` *`switch name`* command.
- Contact the support team to get the correct username and password for the `supportLogin` command.

Procedure

The following example shows taking a state dump of a switch with the LID 0x04. The following process applies to both managed and externally-managed switches.

1. Log in to the switch. The default administrator username and password are `admin` and `adminpass`.
2. Run the `supportLogin` command using the support username and password.

```
Edge-> supportLogin
username: Username
password: Password
```

Note: If the shell prompt is returned (`shell->`), exit the shell and continue to the next step.

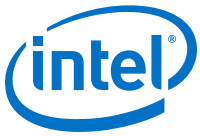
3. While logged in to support, run the `ismTakeStateDump` command.

```
Edge-> ismTakeStateDump -lid 0x0004
Dumping state of the switch at lid 4 to /firmware/prr-LID0004.gz
```

4. From the Management Node, SFTP to the switch to retrieve the log:

```
sftp admin@<internally managed switch> with password adminpass.
admin@10.228.222.20's password:
Connected to 10.228.222.20.
sftp> dir
admin       operator      prr-LID0004.gz   prr-LID0005.gz   prr-LID0015.gz
get prr-LID0004.gz
```

5. Reboot the switch where the state dump was taken to clear the state dump. For externally-managed switches, use FastFabric to reboot the switch.



16.0 BKMs for OPA Commands

Note: OPA commands should be issued from the Management Node where the IFS Full package was installed.

16.1 Retrieve Host Fabric Interface (HFI) Temperature

Use the command:

```
# cat /sys/class/infiniband/hfi1_X/tempsense
```

where *X* represents the device number.

When you send the command, the information is acquired at that specific time. Do not be concerned with the file's date/time.

An example of the output and the definition for each group of numbers follows:

```
# cat /sys/class/infiniband/hfi1_0/tempsense
68.50 0.00 105.00 105.00 0 0 0
```

Table 1. HFI Temperature Output Definitions

Example Value	Definition
68.50	Actual temperature Temperature steps are 0.25 °C increments.
0.00	Low limit
105.00	Upper limit
105.00	Critical limit
0	Low limit flag 1 = flag is set.
0	Upper limit flag 1 = flag is set.
0	Critical limit flag 1 = flag is set.

16.2 Read Error Counters

To use the default thresholds defined in the `/etc/sysconfig/opa/opamon.conf` file, use the command:

```
# opareport -o errors
```

To run against a different threshold file, for example `/etc/sysconfig/opa/opamon.si.conf`, use the command:

```
# opareport -o errors -c /etc/sysconfig/opa/filename.conf
```

16.3 Clear Error Counters

Use the command:

```
# opareport -o none --clearall
```

16.4 Load and Unload Intel® Omni-Path Host HFI Driver

If the configuration is changed, you may need to reload the HFI driver.

Unload the HFI driver using:

```
# modprobe -r hfi1
```

Load the HFI driver using:

```
# modprobe hfi1
```

Note: The HFI driver should not be reloaded on SM nodes due to unloading other required dependencies and restarting them. On all other nodes, you may have to restart the IPoIB interface with `ifup` after the HFI driver is reloaded.

16.5 Analyze Links

To include the link quality of local HFI port, use the command:

```
# opainfo output
```

To include links with lower quality, use the command:

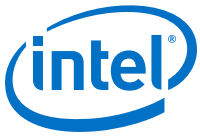
```
# opareport –o errors
```

To output the ports with a link quality less than or equal to *value*, use the command:

```
# opareport -o links -F linkqualLE:value
```

To output the ports with a link quality greater than or equal to *value*, use the command:

```
# opareport -o links -F linkqualGE:value
```



To output the ports with a link quality equal to *value*, use the command:

```
# opareport -o links -F linkqual:value
```

Table 2. Link Quality Values and Description

Link Quality Value	Description
5	Working at or above preferred link quality, no action needed.
3	Working on low end of acceptable link quality, recommended corrective action on next maintenance window.
2	Working below acceptable link quality, recommend timely corrective action.
1	Working far below acceptable link quality, recommend immediate corrective action.
0	Link down

16.6 Trace Route between Two Nodes

Use the command:

```
# opareport -o route -S nodepat:"hds1fnb6101 hfi1_0" -D nodepat:"hds1fnb6103
hfi1_0"
```

To trace using LID, use the command:

```
# opareport -o route -S lid:5 -D lid:8
```

16.7 Analyze All Fabric ISLs Routing Balance

Use the command:

```
# opareport -o treepathusage
```

16.8 Dump Switch ASIC Forwarding Tables

To display all switch unicast forwarding tables DLIDs and Egress ports, use the command:

```
# opareport -o linear
```

To display multicast groups and members, use the command:

```
# opareport -o mcast
```

16.9 Configure Redundant Fabric Manager (FM) Priority

This section describes several configuration methods.

16.9.1 Configure FM Priority from a Local or Remote Terminal

Perform the following steps:

1. Edit the `/etc/sysconfig/opafm.xml` file.
2. Select the `<Priority>0</Priority>` value and change `0` to the number you want (0 - 15).
3. Save the file.
4. Start or restart the Fabric Manager to load the new file, using the command:

```
# opafm restart
```

Note: If you set a Fabric Manager to a higher priority, it becomes the master Fabric Manager automatically. The sticky finger option is disabled by default.

16.9.2 Configure FM Elevated Priority

Perform the following steps:

1. Edit the `/etc/sysconfig/opafm.xml` file.
2. Select the `<ElevatedPriority>0</ElevatedPriority>` value and change `0` to the number you want (0 - 15).
3. Save the file.
4. Start or restart the Fabric Manager to load the new file, using the command:

```
# opafm restart
```

16.9.3 Configuration Consistency for Priority/Elevated Priority

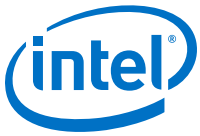
Priority and Elevated Priority are not part of the `opafm.xml` configuration consistency checksum calculation. This makes standby Fabric Managers with mismatched configuration inactive because they are not valid to take over as Master in case of failover.

Having different values for Priority and Elevated Priority settings for SM instances is allowed and failover works as documented per Priority/ElevatedPriority settings. In normal failover without elevated priority, if the original Master Fabric Manager goes down, the Standby Fabric Manager becomes Master. When the original Master comes back up, it again takes over as Master.

Note: In sticky failover, Elevated Priority is used and with sticky failover enabled, when the original Master comes back up, it does NOT take over.

16.9.4 Display FM states from the Management Node

Run the `opafabricinfo` command to view the new active master SM.



17.0 Final Fabric Checks

After addressing all issues, perform final fabric checks as described in Verify Server and Fabric on page 26.