A Guide to Installing OFED on Linux*

The OpenFabrics Alliance (www.openfabrics.org)

Revisions

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Please address any issues or comments about this document to the OpenFabrics Alliance forums (www.openfabrics.org).

Contents

1 – Introduction

This section describes the following:

- Purpose for which this guide is written
- Audience for whom this document is written.
- Suggested background for the reader to better understand the content.
- What the reader should be able to accomplish with this document.

Purpose

This installation guide is written to provide guidance for those interested in, but inexperienced with, the OpenFabrics™ Alliance (OFA) OpenFabrics Enterprise Distribution (OFED™) software installation on Linux*. This guide also provides some background on the OpenFabrics OFED stack.

The installation process is straightforward, but the many nuances of different Linux distributions and versions can complicate any installation. Thus, this document should be used as a pattern for installing OFED on a fresh Linux installation; it is not intended to be an inclusive guide for all Linux distributions and versions.

This document does not teach you about programming for RDMA; OFA offers training specifically for this. See the OFA website for information (www.openfabrics.org).

This document does not provide instructions for installing on other than InfiniBand HCAs that OFED supports, as listed in this document.

Intended Audience

This document is intended for a range of users. The information here can be helpful to the following professionals:

- Enthusiasts interested in trying OFED on small clusters to learn about OFED, how it works, how to install and use it, and how to write RDMA applications.
- IT technologists interested in configuring and evaluating OFED for their infrastructures.
- HPC administrators installing a new cluster using RDMA, especially if the administrator is not familiar with OFED installation.

Helpful Experience

OFED is freely available as source codes, which must be compiled. It is helpful if you

- Have experience installing Linux on a server (the more experience, the better).
- Understand compiling of source code (though this is not required).
- Understand basic networking.
- Have experience with InfiniBand (if you're installing on InfiniBand host channel adapters).

- Are familiar with your InfiniBand host channel adapters' (HCA) configuration requirements.

If you do not have experience in the appropriate areas above, this document will help you get through the installation process, but installation may take more time than if you have experience.

If you have never installed Linux on a server and do not have a basic understanding of networking, we recommend you review these topics before installing OFED.

Objectives

The instructions and guidance in this document should enable you to

- Complete a fresh install of a recent version of a Linux distribution with the required Linux packages on two standalone servers with InfiniBand HCAs. (This manual does not cover Linux run as a virtual machine.)
- Completely install and compile OFED on these two servers.
- Configure your InfiniBand HCAs.
- Verify your InfiniBand network is ready.

NOTE

CentOS is used as an example in this installation guide; screen captures are from CentOS. It is a popular distribution, which is very similar to Red Hat* Enterprise Linux (RHEL*). Other distributions similar to RHEL should install in a comparable manner. But, all distributions vary somewhat, and prior to installing OFED, it is best to review the release notes and other documents included in the OFED sources (located in the /docs directory), looking for information about compiling and installing OFED on your specific distribution. Related documents are discussed later in this guide.*

NOTE

If you are going to install OFED on any existing server with a Linux distribution (whether or not covered in this document) using the instructions in this document, your installation may differ enough to cause OFED not to install correctly for that installation. There are many nuances in Linux distributions and OFED versions that can result in unsuccessful compilation and installation. For example, an OFED version released for a particular Linux kernel may not function correctly if that Linux kernel is upgraded after OFED is installed and the OFED version is not upgraded.

2 - OFED Overview

This section describes the following:

- Why is OFED necessary
- A brief overview of OFED
- OFED provided with Linux distributions

This information is also available on the OpenFabrics Alliance web site (www.openfabrics.org).

Why Do I Need OFED?

If you want to create computing clusters with extremely fast communications based on InfiniBand or iWARP fabrics, OFED is your best choice to get your network up and running quickly. OFED provides a complete software stack for InfiniBand, with APIs, drivers, and scripts, in a single installable package.

OFED enables RDMA over InfiniBand* using InfiniBand host channel adapters from various independent hardware vendors (IHVs), and it supports internet Wide Area RDMA Protocol (iWARP). OFED is written and tested for Linux* and Microsoft Windows* operating systems by the OpenFabrics Alliance, which also makes it available for free download.

What is OFED?

OFED is open-source software for RDMA and kernel bypass applications. OFED is used in business, research and scientific environments that require highly efficient networks, storage connectivity, and parallel computing. The software provides high-performance computing sites and enterprise data centers with flexibility and investment protection as computing evolves towards applications that require extreme speeds, massive scalability, and utility-class reliability.

As shown in Figure 1, OFED includes kernel-level drivers, channel-oriented RDMA and send/receive operations, kernel bypasses of the operating system, both kernel and user-level application programming interface (APIs) and services for parallel message passing (MPI), sockets data exchange (e.g., RDS, SDP), NAS and SAN storage (e.g. iSER, NFS-RDMA, SRP), and file system/database systems.

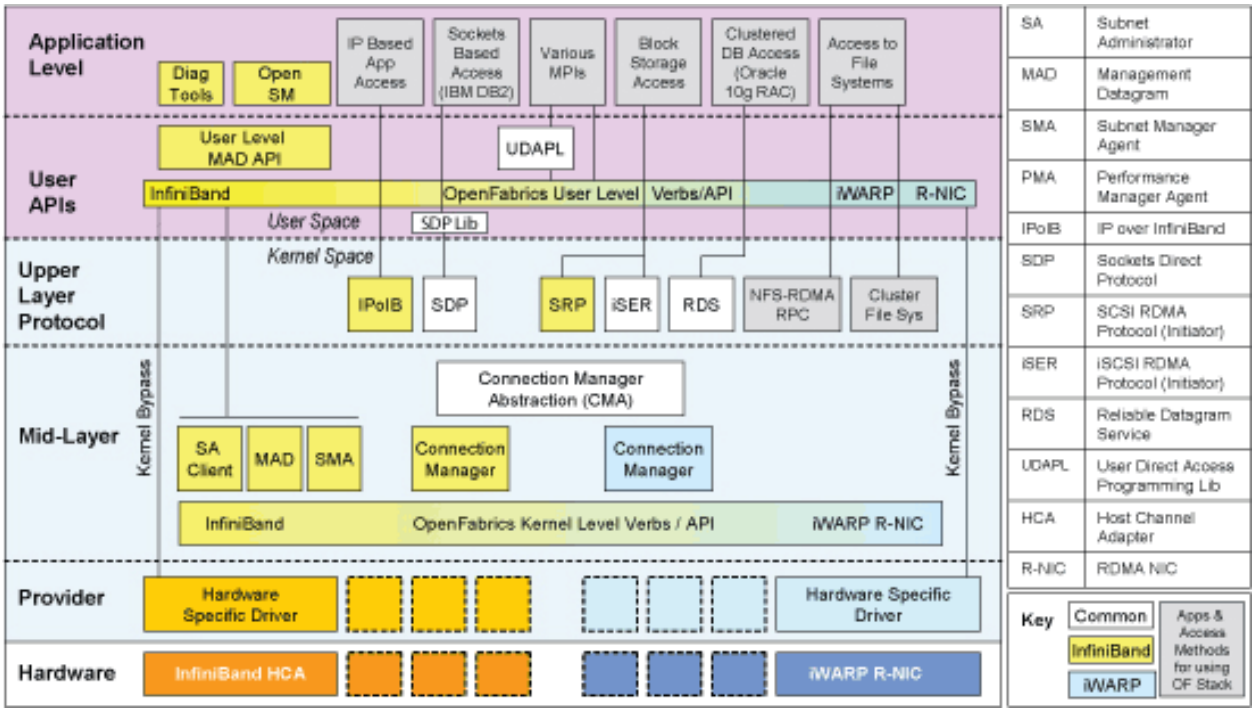

Figure 1. OFED Software Stack.

The network and fabric technologies that provide RDMA performance with OFED include the following:

- 10 Gigabit Ethernet
- iWARP for Ethernet
- RDMA over Converged Ethernet (RoCE)
- 10/20/40 Gigabit InfiniBand

OFED is available for many Linux and Windows distributions, including:

- Red Hat* Enterprise Linux (RHEL*).
- Novell* SUSE* Linux Enterprise Server (SLES*).
- Oracle* Enterprise Linux (OEL*).
- Microsoft Windows Server* operating systems.

Some of these distributions ship OFED in-box, tested for their particular release. This makes OFED easily accessible and usable by OEMs and end users, facilitating quick adoption in multiple market verticals in the high-performance computing, enterprise data center, and storage sectors. The entire set of OpenFabrics Software – from which modules and patches are selected to form OFED releases – resides on the OpenFabrics servers and is available for download (www.openfabrics.org).

Can I Use the OFED Version Included with My Linux Distribution?

You can use the OFED version that came with your Linux distribution. However, this document was not created for that use case and does not support or cover installations of OFED included in Linux distributions.

It's likely the OFED version in your Linux distribution was verified by the distributor for the particular version with which it is included, but it's also likely it is not the latest version available from the OpenFabrics Alliance. New hardware available from OFA members might not be supported by your Linux distribution; you would need to manually install any needed drivers, etc.

For the most recent software, you should install the latest version of OFED, preferably on a clean install of the latest version of your Linux distribution.

3 - The OFED Distribution

This section describes the following:

- Where to get OFED sources
- OFED components
- Supported operating systems, compute platforms, InfiniBand* hardware, and 3rd-party software

This section generally describes the OFED release, which is available as a free download from www.openfabrics.org.

NOTE

For details of a specific release, see that version's release notes and other documents included in the /docs directory.

OFED Sources

You can find OFED sources at the following locations:

- All OFED sources for Linux are located under git://git.openfabrics.org/.
- Kernel sources: git://git.openfabrics.org/ofed_1_5/linux-2.6.git ofed_kernel_1_5.
- User level Sources can be downloaded from www.openfabrics.org/downloads/ as written in the BUILD_ID
- Release notes for all versions can be downloaded from www.openfabrics.org/downloads/OFED/release_notes

The kernel sources are based on the Linux 2.6.30 mainline kernel. Its patches are included in the OFED sources directory. For details, see HOWTO.build_ofed in the /docs/readme_and_howto directory of each OFED release.

NOTE

This guide makes several references to the release notes and other documents provided in the OFED distribution. If you want to look at these documents and the OFED components as you continue through this guide, you can download OFED now or download just the release notes as noted above. Refer to **Downloading/Extracting OFED** *on page 15 before proceeding.*

OFED Components

OFED is distributed as a tarball. The tarball contents can vary between versions. Check the release notes for any distribution, or, after downloading the OFED source, check the release notes in the /docs directory for differences from the following general list.

The tarball contains the following:

- OpenFabrics core and Upper Layer Protocols (ULPs):

  InfiniBand HCA drivers (mthca, mlx4, qib, ehca)

  iWARP RNIC driver (cxgb3, nes)

  OFED Core

  ULPs: IPoIB, SDP, SRP Initiator and target, iSER[1] Initiator and target, RDS, uDAPL, qlgc_vnic, and NFS-RDMA[1].

- OpenFabrics utilities:

  OpenSM (OSM): InfiniBand Subnet Manager

  Diagnostic tools

  Performance tests

- MPI:

  OSU* MPI stack supporting the InfiniBand and iWARP interfaces

  Open MPI stack supporting the InfiniBand and iWARP interfaces

  OSU MVAPICH2 stack supporting the InfiniBand and iWARP interfaces

  MPI benchmark tests (OSU benchmarks, Intel* MPI benchmarks, Presta)

- Extra packages:

  open-iscsi: open-iscsi initiator with iSER support

  ib-bonding: Bonding driver for IPoIB interface

  infinipath-psm: Performance-Scaled Messaging API, an accelerated interface to QLogic HCAs

- Sources of all software modules (provided under use conditions mentioned in the modules' LICENSE files)

- Documentation

Note

1. iSER Target and NFS-RDMA are Beta versions.

2. All other OFED components are production releases.

3. See release notes for each package in the /docs directory.

4. Any Topspin copyright belongs to Cisco Systems,* Inc.*

5. Refer to other specific notes in the release notes file once you have downloaded the OFED source tarball.

Supported Platforms and Operating Systems

OFED supports the following platform architectures:

- x86_64
- x86 (32-bit)
- ppc64
- ia64

Supported Linux Operating Systems

OFED has been tested on the following Linux distributions.

NOTE

See the specific version's release notes for tested Linux versions.

- RedHat EL5 up4
- RedHat EL5 up5
- RedHat EL5 up6
- RedHat EL6
- SLES10 SP3
- SLES11
- SLES11 SP1
- CentOS5.4
- CentOS5.5
- OpenSuSE 11.2
- kernel.org

Supported Host Channel Adapters and iWARP RNICs

OFED supports several manufacturers' InfiniBand Host Channel Adapters (HCAs) and iWARP RNICs. Generally, newer HCAs are supported in later OFED releases.

NOTE

Be sure to check the specific version's release notes for a HCA or RNIC you consider using.

Generally, OFED supports IB HCAs from the following manufacturers:

- Mellanox* Technologies
- Qlogic*
- IBM*

OFED supports iWARP RNICs by the following manufacturers:

- Chelsio* Communications
- Intel*

Supported Switches

OFED supports switches from the following manufacturers.

Note

Refer to the specific version's release notes for a switch you consider using.

- Voltaire*
- Qlogic
- Flextronics*
- Oracle (Sun)
- Mellanox

Supported Third-party Packages

OFED releases are tested with various 3rd-party packages.

Note

Refer to the specific version's release notes for the current packages.

4 - Preparing to Install OFED on Linux*

This section describes the following:

- Minimum hardware requirements for OFED installation
- Background preparation for installing OFED
- Installation overview

Minimum Hardware Requirements

You should have the following components, connectivity, and disk space.

Note

Refer to the specific version's release notes for details of tested Linux versions and supported HCAs, RNICs, and switches.

- Supported server platforms with supported InfiniBand HCAs or iWARP RNICs
- Supported Linux operating system install CD/DVD
- 300 MB free disk space to build and install OFED (this is space in addition to space required for the Linux installation, including necessary packages for compiling OFED)
- Internet connection

Which Version of OFED Should You Install?

It is always best to install the most recent general release of OFED, especially if you are using newer HCAs and/or RNICs.

How Are OFED Versions Numbered?

OFED tarballs are numbered by their versions (1.4.x, 1.5.x, etc.), with alpha, beta, and release candidate (rc) indicators. Generally available versions omit the alpha, beta, and rc suffixes. For purposes of this installation guide, you should use a generally available version.

How Long Will it Take?

You should plan on spending about two (2) hours doing a fresh install of Linux and OFED; OFED build and install takes approximately 30 minutes, if no errors are encountered. If you are installing on an existing platform, plan on much more time, depending on the number and kinds of issues you experience.

Installation Overview

The installation process in this document includes the following steps:

1. Install Linux.
2. Verify network and internet connectivity.
3. Download OFED.
4. Unpack OFED.
5. Review release notes and other documents.
6. Run the OFED install script.
7. Create the HCA IPoIB configuration.
8. Verify InfiniBand HCA communication.

NOTE

If you are using iWARP or other fabric, refer to the OFED README file after you download the tarball.

5 - Installing Linux

This section describes the Linux installation requirements for installing OFED.

NOTE

This guide assumes you are performing a new Linux installation. While installing OFED on an existing Linux installation is possible, doing so might require additional work not covered in this guide.

This guide does not cover running Linux or OFED as a virtual machine.

Follow your Linux distribution's instructions for a fresh Linux installation. In general, the following might be helpful:

- Until the installation is complete, disable firewalls and other features that might potentially inhibit internet access.
- In addition to your intentions for the server's configuration (web, file, print, etc.), include 'development' as the platform's configuration. This will help reduce the number of packages you need to install in order to build and install OFED.
- You must install OFED as root. Some distributions use a sudo group and command. You will need to be able to switch to the root user before installing OFED, so you must create a root password.
- You can save time by checking for and installing the required packages listed below during the initial Linux installation, rather than adding them afterwards. Your ability to do this will depend on the particular distribution you are installing.

NOTE

You can compile and install OFED independently on each machine in an heterogeneous cluster, or compile and install on a single shared directory, and then install on each of the other nodes of a homogeneous cluster using the RPMs and configuration of the first machine. If you plan on installing using the latter method, you only need to install the development resources on the first machine. Refer to the README file for details on installing in the second manner, which is not covered in detail in this guide.

NOTE

Do NOT install the OFED packages that came with your Linux distribution.

NOTE

For this installation, we recommend you not run updates to your installation prior to installing OFED. The objective of this installation process is to get OFED running on your system quickly. Updates prior to installing OFED might create a configuration that prevents OFED from successfully compiling or running. If you update Linux after getting your OFED environment up and running, you might have to update OFED packages afterwards. Thus, we recommend a clean Linux install without updates, then installing OFED, confirming your InfiniBand network operates, then running any updates and updating OFED as necessary.

Install Required Packages

OFED is distributed as source codes that you must compile and install after the Linux distribution is installed. The Linux packages listed in the following two tables are required on the machine that will compile OFED.

Depending on your Linux distribution, you can install these with the Linux installation or afterwards, using the **Add/Remove Software** tool, YaST, or other file management application.

Table 1. OS-dependent Required Packages

Linux Distribution	All platforms	Notes
All	`gcc, glib, glib-devel, glibc, glibc-devel, zlib-devel, libstdc++-devel`	To build 32-bit libraries on x86_86 and ppc64 install `glibc-devel-32bit`
Red Hat, Fedora	`kernel-devel, rpm-build, redhat-rpm-config`	
SUSE Linux Enterprise Server* (SLES)	`kernel-source, rpm`	

Table 2. Interface-dependent Required Packages

Specific Interfaces	All platforms	Notes
MVAPICH	a Fortran Compiler, such as `gcc-g77`	
MVAPICH2	`libsysfs-devel`	
OpenMPI	`libsysfs-devel`	
Ibutils	`tcl-8.4, tcl-devel-8.4, tk, libstdc++-devel`	
mstflint	`libstdc++-devel (32-bit on ppc64), gcc-c++`	To build 32-bit libraries on x86_86 and ppc64 install `libstdc++-devel-32bit`

rnfs-utils	On Red Hat:
	`krb5-devel, krb5-libs, libevent-devel,nfs-utils-lib-devel, openldap-devel, e2fsprogs-devel`
	
	On SLES11:
	`krb5-devel, libevent-devel, nfsidmap-devel, libopenssl-devel, libblkid-devel`
	
	On SLES10:
	`krb5-devel, libevent, nfsidmap, krb5, openldap2-devel, cyrus-sasl-devel, e2fsprogs-devel`	

Verify Internet Connectivity

Ensure you have internet connectivity by opening a browser and opening a web page, such as www.openfabrics.org.

6 - Installing OFED

This section describes the OFED installation process.

NOTE

This installation guide is based on the OFED version 1.5.3.2. If you use a different version, the process may vary.

NOTE

In addition to the general availability release versions, there are daily builds of OFED codes that incorporate patches and changes in development. This is pre-release code.

There are also release candidate (rc) versions of code in the OFED directories. .

NOTE

You must install OFED as root.

Downloading/Extracting OFED

OFED is released as a tarball that can be downloaded and extracted on your server.

To download the OFED sources, do the following:

1. Open a web browser and navigate to www.openfabrics.org/downloads.
2. Click the OFED directory.
3. Click the 1.5.3 directory.
4. Download the 1.5.3.2.tgz tarball file to an appropriate directory in your root home directory.
5. Change to the directory of the tarball.
6. Extract the files using `tar xzvf <tarball_filename>`
   Extracting creates an OFED directory with the OFED files in it (Figure 2).

After extracting, review the README file in the OFED root directory and review the release notes for this version in the `/docs` directory.

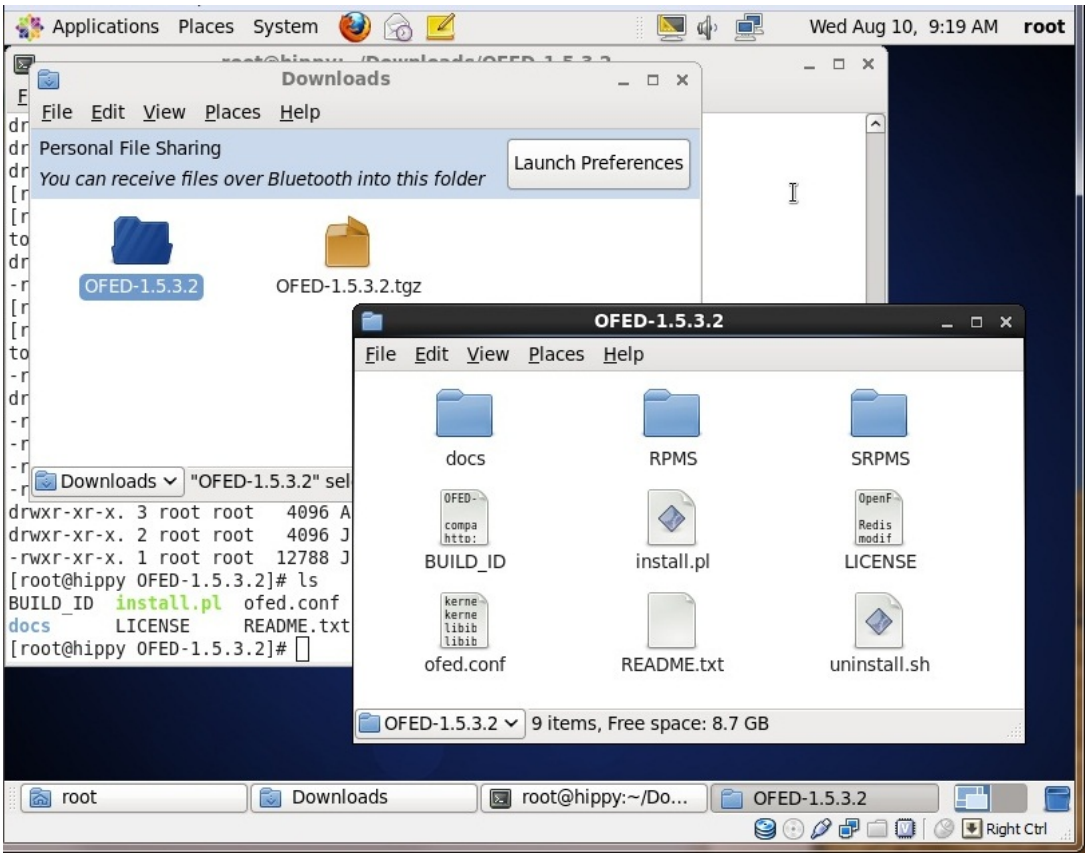

Figure 2. Unpacked OFED Files.

Installation Options

You can install OFED using an automated script or as an executable command.

When you use the `install.pl` script, installation is automatic, after selecting a few options. You can also install OFED using `install.pl` with command options; this method is described in the README file.

You can install OFED in the following manner:

- Install independently on each machine of a heterogeneous or homogeneous cluster.
- Install on a single shared directory, and then install on each of the other nodes of a homogeneous cluster using the RPMs and configuration of the first machine.

NOTE

The installation process creates configuration files that you can use to install on a homogeneous cluster. If installing on a heterogeneous cluster, the configuration settings might not be appropriate for different machines.

Installing OFED

The following instructions cover an initial installation (compile and install), whether on a shared (e.g. NFS) directory or not.

1. In a terminal window, log in as root.
2. Change to the OFED directory of extracted files containing the `install.pl` script.
3. Enter `./install.pl` to run the automated install script (Figure 3).

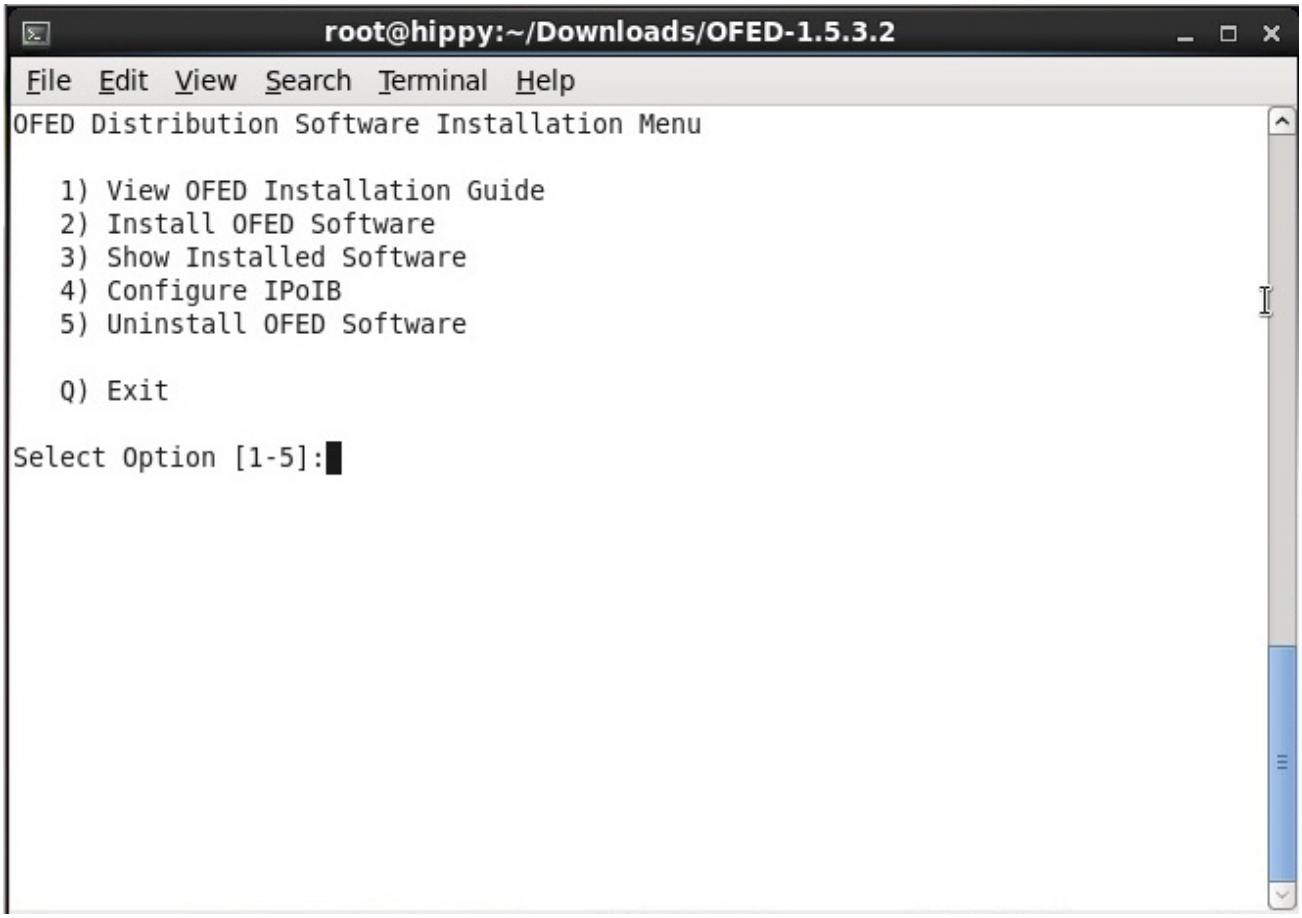

Figure 3. OFED Install Menu.

Options:

1. The OFED installation guide is the README file included in the OFED directory.
2. Install proceeds with the process described below.
3. Shows all the installed packages after installation.
4. Launches a prompted configuration script to define your IPoIB interface. The result is saved as the configuration file for the interface in this machine.

5. Uninstalls any currently installed OFED software. While the instructions here assume this is a fresh installation, if it is not, you do not need to uninstall existing OFED software to run this installation. The script will uninstall OFED automatically.

Q Exits the installation script.

NOTE

The above menu also appears after you complete the installation.

4. Select option 2. You are then prompted through several installation options (Figure 4).

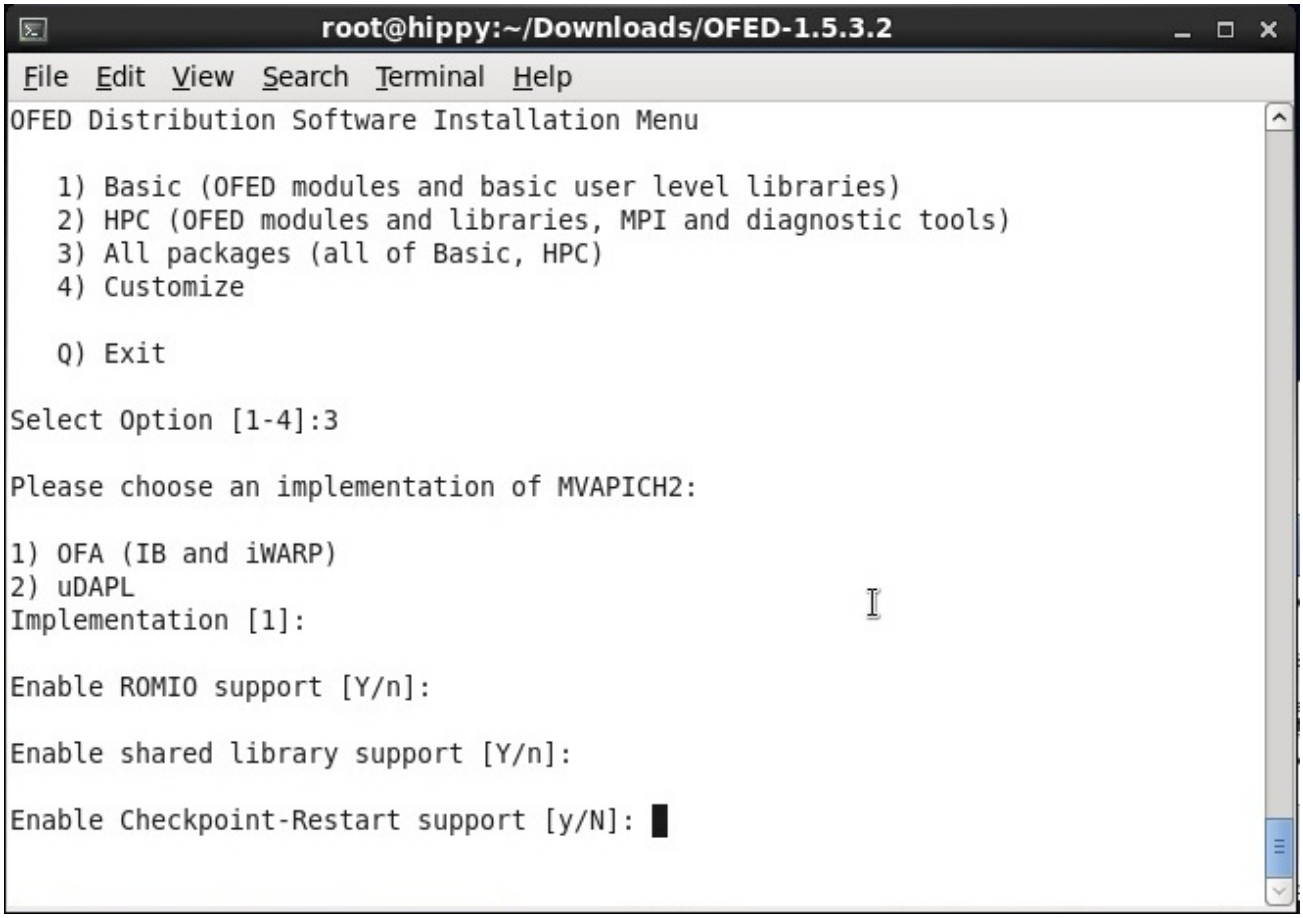

Figure 4. Installation Options.

Options:

1. A Basic installation includes only OFED modules and some user libraries.
2. An HPC install includes MPI and diagnostic tools.
3. All packages include the entire OFED stack, MPI implementations, and more.
4. Steps you through a selection of software to install.

Q Exits the menu.

You can choose between two implementations of MVAPICH2.

You can enable support for ROMIO, a high-performance MPI-IO implementation available from Argonne National Laboratory.

You can enable support for Linux shared libraries.

You can enable support for Checkpoint-Restart if used.

After selecting your options, any existing OFED installation is uninstalled, and the build begins (Figure 5 and Figure 6).

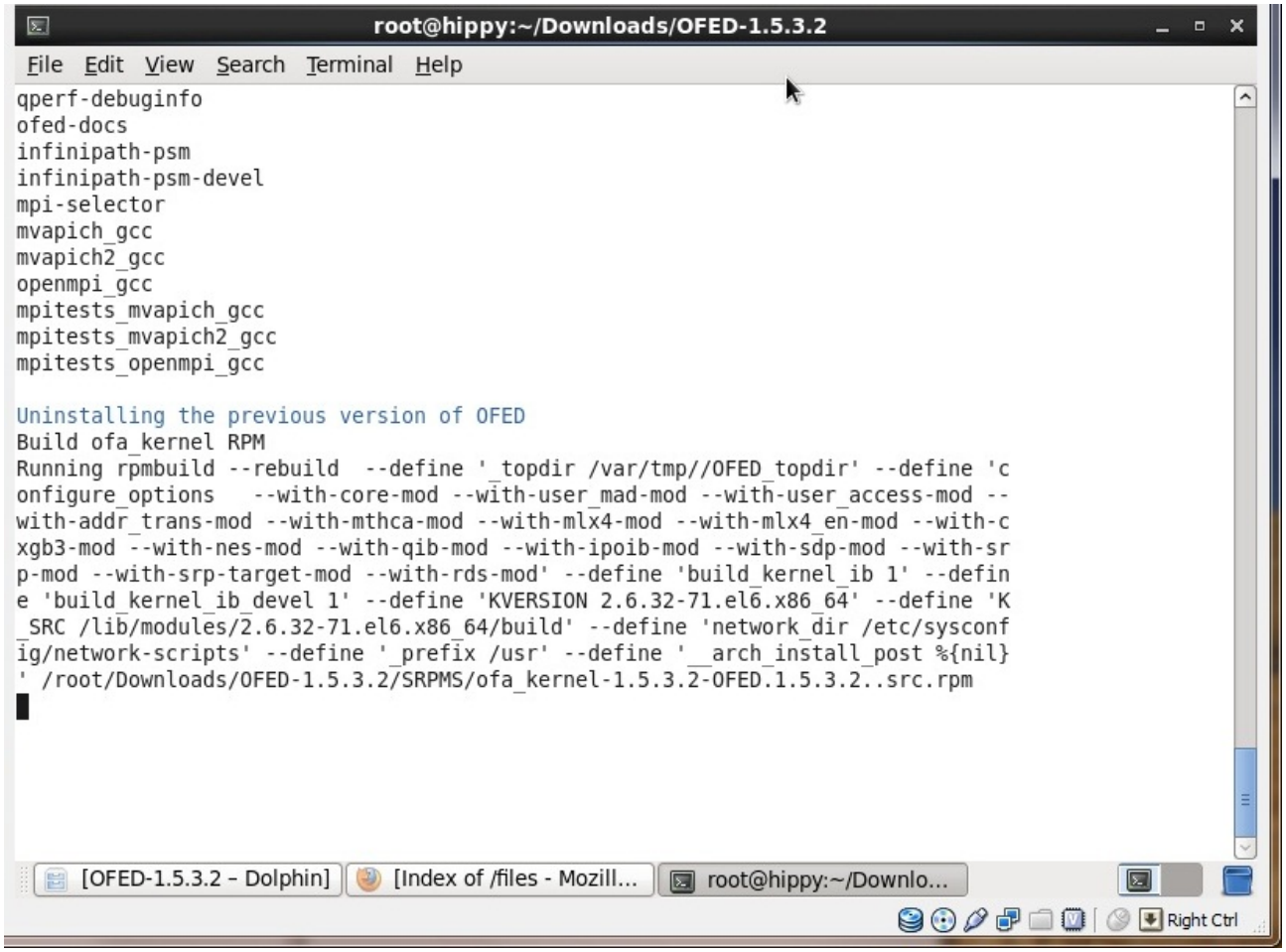

Figure 5. Installing OFED.

Figure 6. Installation in Process.

Encountering errors, such as missing packages, during compiling and installing the RPMs will stop the build and return an error. The error in Figure 7 occurred due to missing packages. To correct this error, the required packages must be installed.

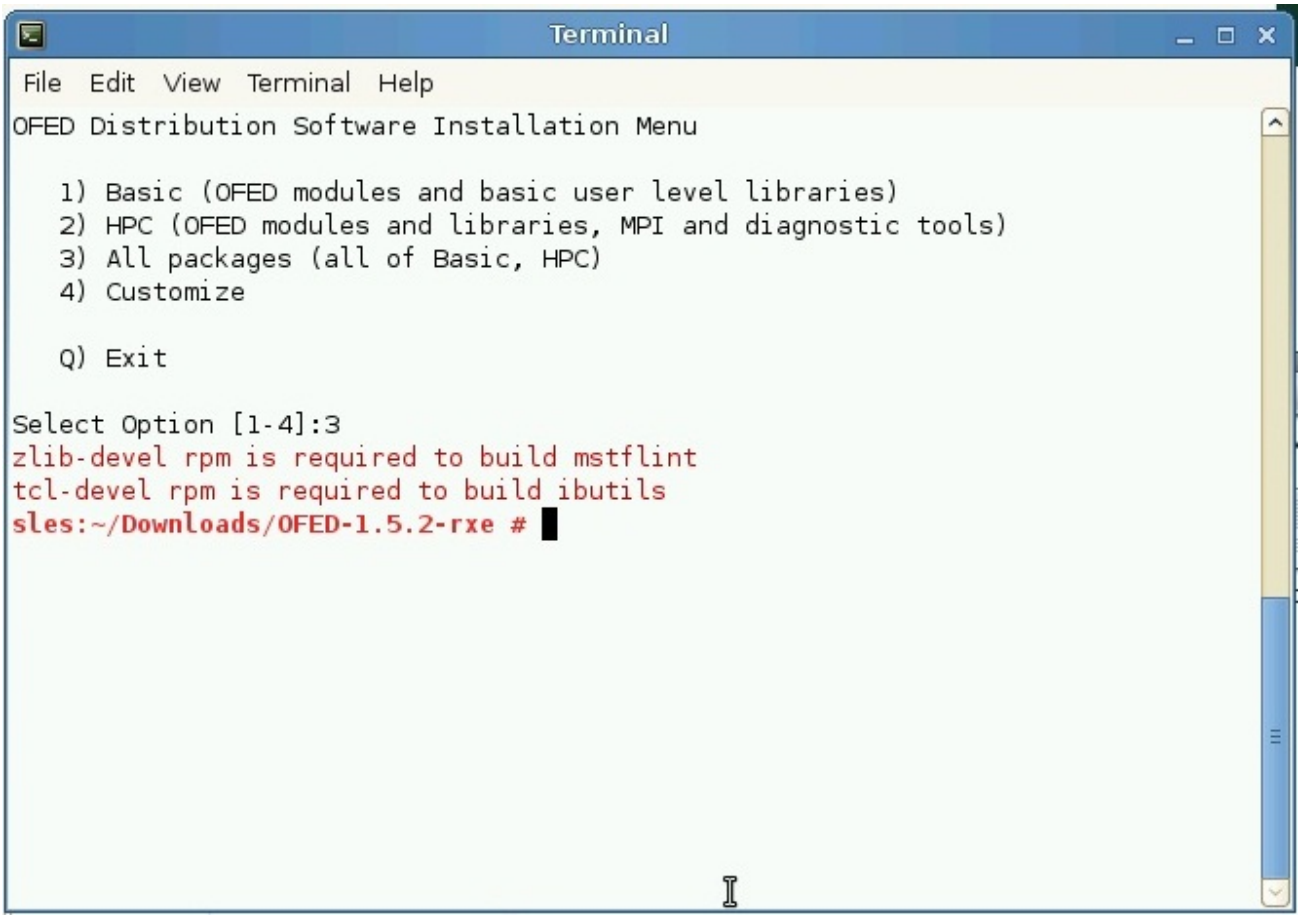

Figure 7. Missing Packages Encountered During Build (SLES11 OS).

Compiling and installing the RPMs can take about 30 minutes. Once complete, the messages in Figure 8 appear.

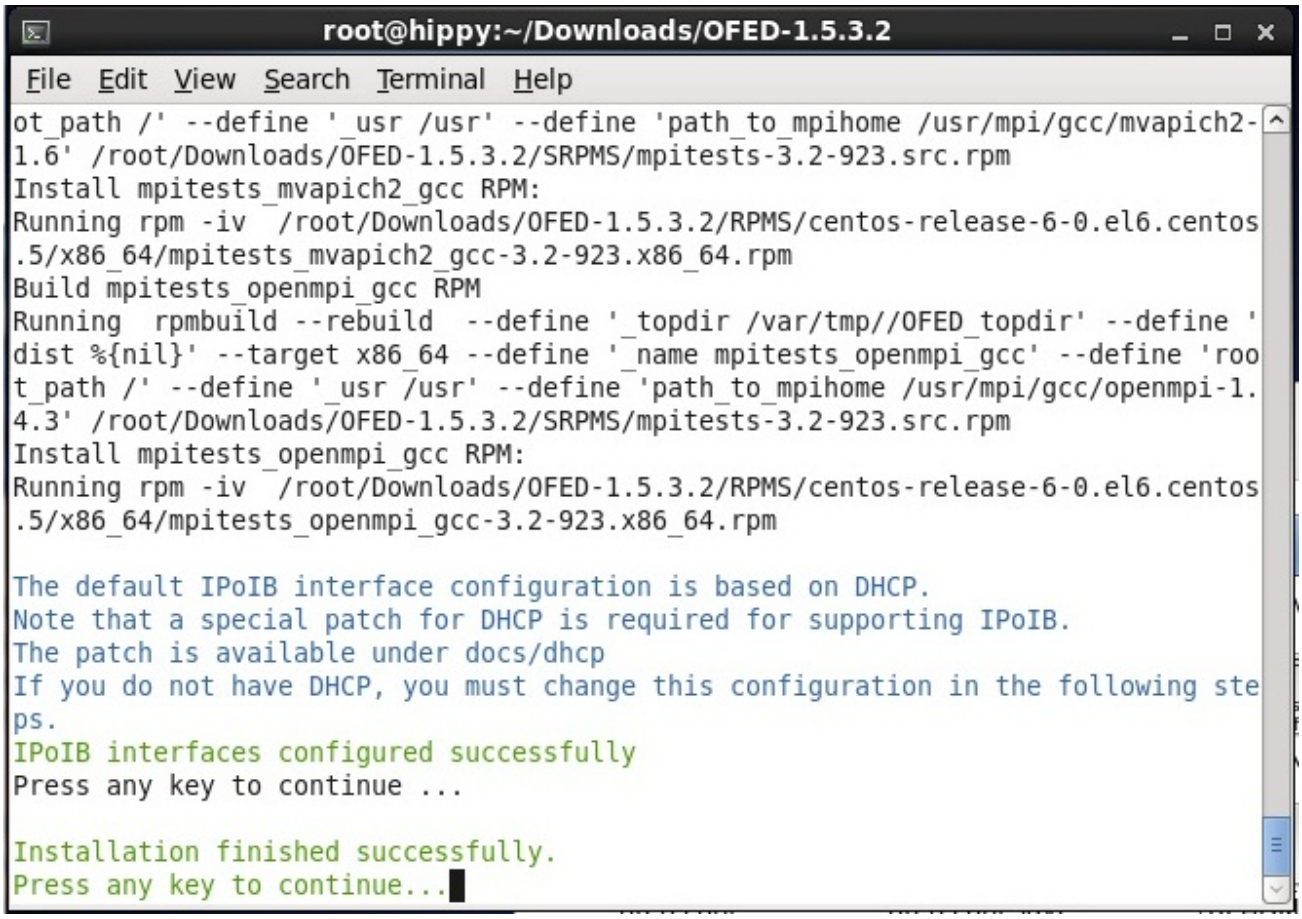

Figure 8. Successful Installation Messages.

Configuration Files

The installation process creates two configuration files stored in /etc/infiniband: `ofed.conf` and `ofed_net.conf`.

- `ofed.conf` contains the installed software modules and configuration settings you selected from the menu.
- `ofed_net.conf` contains the IPoIB configuration.

These files can be used to automate additional installations using command line options with `./install.pl`, as described in the README file.

Installation also can create the IPoIB interface configuration file, `ifcfg-ib<n>`, saved into the following directory, depending on the distribution you have:

- RedHat-based: `/etc/sysconfig/network-scripts/`
- SuSE-based: `/etc/sysconfig/network/`

This is the configuration for the resident HCA. You should check this configuration file after installation to see if the file was successfully created, and that it contains the parameters for your particular network. If the file was not created, or does not contain the correct configuration, you can create or change the file as described **8 - Setting up IPoIB** later.

If You See Compile Errors

Errors during the build process usually occur because of missing packages required to compile the code. Use the **Add/Remove Software** tool, YaST, or other Linux tool to search for each missing package and install it. Depending on the Linux distribution you installed, you might need to find missing packages on additional installation CDs/DVDs or download them from a repository. In some distributions, you might need to find a replacement package for the required package.

Installing on a Homogeneous Cluster

To accelerate OFED installation across a homogeneous cluster, you can use the parameters of the `ofed.conf` file created during the first installation to install the necessary packages on the rest of the cluster. Similarly, the `ofed_net.conf` file helps accelerate IPoIB configuration, though you might need to set up IP addresses for each HCA.

NOTE

The cluster must be a homogeneous cluster of identical machines.

To install across other machines, use the following command, specifying the `ofed.conf` file.

```
./OFED-X.X.X/install.pl -c <path>/ofed.conf -n <path>/ofed_net.conf
```

For more details, refer to the README file for the OFED distribution you are installing.

8 - Setting up IPoIB

This section describes the process for configuring and testing your IPoIB communications.

See the README file and/or release notes for additional details about configuring IPoIB.

Creating the IPoIB Configuration File

You can use the interactive menu option (#4) in the OFED software installation menu (launched by `./intstall.pl`) to configure IPoIB, or manually create a configuration file. Both methods result in a configuration file (`ifcfg-ib<n>`) stored in the following directory, depending on the distribution you have:

- RedHat-based: `/etc/sysconfig/network-scripts/`
- SuSE-based: `/etc/sysconfig/network/`

Interactive Configuration

To start the interactive configuration process, enter '**4**' at the software installation menu.

The interactive configuration prompts you for the following (enter IP addresses as IPv4 addresses (xxx.xxx.xxx.xxx):

- IPv4 address
- Netmask
- Network
- Broadcast address
- Activate on boot?

Enter each value when prompted. The configuration file will be written to the directory indicated above as `ibcfg-ib<n>`, where n is the number for the HCA.

After completing the configuration, change to the appropriate directory listed above (depending on Linux distribution), and check that the file contains the values you requested.

If the file is not present, or it has the incorrect values, manually create/edit the file as described below.

Manual Configuration

To manually create the configuration file, do the following.

1. Change to the `/etc/sysconfig/network-scripts` (for RedHat) or `/etc/sysconfig/network` (for SuSE) directory.
2. Use a text editor to open/create the filename `ibcfg-ib<n>` in this directory.
3. Add the following lines to the file, inserting the appropriate values for the HCA (replace <n> with the number you assign to the HCA).

```
DEVICE=ib<n>
ONBOOT=yes
BOOTPROTO=static
IPADDR=xxx.xxx.xxx.xxx
NETMASK=xxx.xxx.xxx.xxx
NETWORK=xxx.xxx.xxx.xxx
BROADCAST=xxx.xxx.xxx.xxx
```

4. Save the file.

   Your HCA should be ready.

5. Reboot your machine.

Checking the HCA Driver

After rebooting your machine, the HCA should be up and running. To check the HCA driver is running, do the following.

1. Enter `ibv_devinfo`.

   `hca_id: <linux device name>` should print on the first line of the output.

   If the HCA driver is running, your installation has been successful so far.

Installing on Machine 2

The next step is to install Linux and OFED on the second server, reboot the system, and check that the HCA driver is up and running.

Remember, if you are installing on a homogenous cluster, you can install OFED using the `install.pl` script with a command line that uses the configuration files and RPMs from the first installation. See the README file for details.

Checking IB Communications Across Servers

1. With both servers running, start a subnet manager by entering the following on one of the servers:

   ```
   /etc/init.d/opensmd start
   ```

2. Check the status of all ports by entering the following:

   ```
   ibv_devinfo
   ```

   Each port should report with a `PORT_ACTIVE` state.

If both ports report active, OFED installed correctly and your InfiniBand network is running.

Your installations are complete.

NOTE

After checking communications, you should check and update any driver(s) for your InfiniBand HCA, and then, recheck your InfiniBand communications.

9 - Support

This section describes support resources.

Installation Support

There are many possibilities that can prevent OFED from installing successfully and the software from running normally. Some include:

- Missing packages required to compile the source codes.
- Upgraded Linux kernel that is incompatible with the version of OFED being installed.
- Missing or outdated driver for the HCA in your system.
- Linux distribution not tested with the OFED release you are installing.

If you experience problems you cannot resolve, join the OpenFabric's mailing lists to ask questions of OFA members (www.openfabrics.org), or post to the OpenFabrics forum on the OFA website.

Learning Resources

The OFA offers several opportunities for learning how to write code to utilize RDMA, get involved in the OFA community, and learn how others are using OFED.

- OFA hosts a yearly international conference. See the OpenFabrics web site for details at www.openfabrics.org/workshop.
- OFA offers periodic RDMA programming courses. See the OpenFabrics web site for details on these training classes.
- The OFA website provides archived seminar content and videos from past events and international conferences. Register on the OFA web site to access this content for free.