

Oracle® Engineered Systems

Extending and Multi-Rack Cabling Guide



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Oracle Engineered Systems Extending and Multi-Rack Cabling Guide, 19.3.0

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Preface

This guide describes how to extend your engineered system and cable multiple racks together. It includes information about the cables, new server installation, and cabling tables.

- [Audience](#)
- [Documentation Accessibility](#)
- [Related Documentation](#)
- [Conventions](#)

Audience

This guide is intended for Oracle Engineered Systems customers and those responsible for data center site planning, configuration, and maintenance of the Oracle Engineered Systems and racks.

Documentation Accessibility

For information about Oracle's commitment to accessibility, visit the Oracle Accessibility Program website at <http://www.oracle.com/pls/topic/lookup?ctx=acc&id=docacc>.

Access to Oracle Support

Oracle customers that have purchased support have access to electronic support through My Oracle Support. For information, visit <http://www.oracle.com/pls/topic/lookup?ctx=acc&id=info> or visit <http://www.oracle.com/pls/topic/lookup?ctx=acc&id=trs> if you are hearing impaired.

Related Documentation

In addition to the Oracle Engineered System documentation set, the following guides contain hardware information for Oracle Engineered System:

- *Oracle Exadata Database Machine System Overview*
- *Oracle Exadata Database Machine Security Guide*
- *Oracle Engineered System Safety and Compliance Guide, Compliance Model No.: ESY27*
- *Oracle Engineered Systems Extending and Multi-Rack Cabling Guide*
- *Oracle Exadata Database Machine Maintenance Guide*
- *Oracle Exadata System Software User's Guide*

- *Oracle Exadata X8-2 Database Server Service Manual* at http://docs.oracle.com/cd/E93359_01/html/E93386/index.html
- *Oracle Exadata Storage Server X8-2 EF,HC, and XT Service Manual* at https://docs.oracle.com/cd/E93361_01/html/E93395/index.html
- *Oracle Exadata Database Server X8-8 Service Manual* at http://docs.oracle.com/cd/E93360_01/html/E96097/index.html
- *Oracle Server X7-2 Service Manual* at http://docs.oracle.com/cd/E72435_01/html/E72445/index.html
- *Oracle Server X7-2L Service Manual* at http://docs.oracle.com/cd/E72463_01/html/E72474/index.html
- *Oracle Server X7-8 Service Manual* at http://docs.oracle.com/cd/E71925_01/html/E71936/index.html
- *Oracle Server X6-2 Service Manual* at http://docs.oracle.com/cd/E62159_01/html/E62171/index.html
- *Oracle Server X6-2L Service Manual* at http://docs.oracle.com/cd/E62172_01/html/E62184/index.html
- *Oracle Server X5-2 Service Manual* at http://docs.oracle.com/cd/E41059_01/html/E48312/napsm.html
- *Oracle Server X5-2L Service Manual* at http://docs.oracle.com/cd/E41033_01/html/E48325/cnpsm.html#scrolltoc
- *Sun Server X4-8 Service Manual* at http://docs.oracle.com/cd/E40591_01/html/E40317/index.html
- *Sun Server X4-2 Service Manual* at http://docs.oracle.com/cd/E36975_01/html/E38045/gentextid-14757.html#scrolltoc
- *Sun Server X4-2L Service Manual* at http://docs.oracle.com/cd/E36974_01/html/E38145/gentextid-14728.html#scrolltoc
- *Sun Server X3-2 (formerly Sun Fire X4170 M3) Service Manual* at http://docs.oracle.com/cd/E22368_01/html/E27242/gentextid-14840.html#scrolltoc
- *Sun Server X3-2L (formerly Sun Fire X4270 M3) Service Manual* at http://docs.oracle.com/cd/E23393_01/html/E27229/gentextid-14804.html#scrolltoc
- *Sun Server X2-8 (formerly Sun Fire X4800 M2) Service Manual* at http://docs.oracle.com/cd/E20815_01/html/E20819/index.html
- *Sun Fire X4800 Server Service Manual* at <http://docs.oracle.com/cd/E19140-01/html/821-0282/index.html>
- *Sun Fire X4270 M2 Server Service Manual* at <http://docs.oracle.com/cd/E19245-01/E21671/index.html>
- *Sun Fire X4170 M2 Server Service Manual* at <http://docs.oracle.com/cd/E19762-01/E22369-02/index.html>
- *Sun Fire X4170, X4270, and X4275 Servers Service Manual* at <http://docs.oracle.com/cd/E19477-01/820-5830-13/index.html>
- *Sun Datacenter InfiniBand Switch 36 Firmware Version 2.1 Documentation* at http://docs.oracle.com/cd/E36265_01/index.html
- *Sun Datacenter InfiniBand Switch 36 Firmware Version 2.2 Documentation* at http://docs.oracle.com/cd/E76424_01/index.html

- *Sun Flash Accelerator F20 PCIe Card User's Guide* at <http://docs.oracle.com/cd/E19682-01/E21358/index.html>
- *Sun Flash Accelerator F40 PCIe Card User's Guide* at http://docs.oracle.com/cd/E29748_01/html/E29741/index.html
- *Sun Flash Accelerator F80 PCIe Card User's Guide* at http://docs.oracle.com/cd/E41278_01/html/E41251/index.html
- *Oracle Flash Accelerator F160 PCIe Card User Guide* at http://docs.oracle.com/cd/E54943_01/html/E54947/index.html
- *Oracle Flash Accelerator F320 PCIe Card User Guide* at http://docs.oracle.com/cd/E65386_01/html/E65387/index.html
- *Oracle Flash Accelerator F640 PCIe Card User Guide* at https://docs.oracle.com/cd/E87231_01/html/E87233/index.html
- Sun Storage 6 Gb SAS PCIe RAID HBA Documentation at <http://docs.oracle.com/cd/E19221-01/>
- Oracle Storage 12 Gb/s SAS PCIe RAID HBA, Internal Documentation Library at http://docs.oracle.com/cd/E52363_01/index.html
- Oracle Integrated Lights Out Manager (ILOM) Documentation at <http://www.oracle.com/goto/ilom/docs>
- "Cisco Catalyst 4948E and 4948E-F Ethernet Switches Data Sheet" at https://www.cisco.com/c/en/us/products/collateral/switches/catalyst-4948e-ethernet-switch/data_sheet_c78-598933.html
- "Cisco Nexus 9300-EX and 9300-FX Platform Switches Data Sheet" at <https://www.cisco.com/c/en/us/products/collateral/switches/nexus-9000-series-switches/datasheet-c78-736651.html>

Conventions

The following text conventions are used in this document:

Convention	Meaning
boldface	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.
<i>italic</i>	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.
monospace	Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.
\$ prompt	The dollar sign (\$) prompt indicates a command run as the <code>oracle</code> user.
# prompt	The pound (#) prompt indicates a command that is run as the <code>root</code> user.

1

Preparing to Extend Oracle Exadata Database Machine

Before extending any rack hardware, review the safety precautions and cabling information, and collect information about the current rack in this section.

- [About Extending Oracle Engineered System](#)
You can extend Oracle Engineered System either by adding servers to the current configuration or by cabling together multiple racks.
- [Reviewing the Safety Precautions](#)
Before upgrading Oracle Exadata Database Machines, read *Important Safety Information for Sun Hardware Systems* included with the rack.
- [Reviewing the Cable Precautions](#)
- [Estimating Cable Path Lengths](#)
- [Bundling Cables](#)
- [Reviewing the Cable Management Arm Guidelines](#)
Review the following cable management arm (CMA) guidelines before routing the cables.
- [Obtaining Current Configuration Information](#)
- [Preparing the Network Configuration](#)
When adding additional servers to your rack, you will need IP address and the current network configuration settings.
- [Moving Audit and Diagnostic Files](#)
- [Reviewing Release and Patch Levels](#)
When adding new servers to a rack, you must match the installed operating system version and software releases.
- [Performing Preliminary Checks](#)
- [Preparing to Add Servers](#)

1.1 About Extending Oracle Engineered System

You can extend Oracle Engineered System either by adding servers to the current configuration or by cabling together multiple racks.

Here are considerations when extending the Oracle Engineered System:

- **Elastic Configuration:** You can extend Oracle Engineered System from a fixed or custom configuration to another custom configuration by adding any combination of database or storage servers up to the allowed maximum.
- You can cable together any combination of Oracle Engineered System racks.
- **XM8 racks:** You must order Cisco Nexus 9336C-FX2 Switch and cables (and transceivers, if needed) before extending Oracle Engineered System X8M racks.

- **X4-2 racks:** You must order a Sun Datacenter InfiniBand Switch 36 switch and cables (and transceivers, if needed) before extending Oracle Engineered System X4-2 racks.

 **Note:**

- The cable lengths shown in [Multi-Rack Cabling Tables](#) assume the racks are adjacent to each other. If the racks are not adjacent, or there are obstacles in the raised floor, or if overhead cabling is used, then you may need longer cables lengths. Up to 100 meters is supported.
Only optical cables are supported for lengths greater than 5 meters.
- Only X8M racks can extend other X8M racks. You cannot connect earlier model racks that use RDMA over InfiniBand Network Fabric with X8M racks, which use RDMA over RoCE Network Fabric.
- Earlier Oracle Engineered System Racks can be extended with later Oracle Engineered System Racks up to X8, but not X8M.
- When extending Oracle Engineered System Eighth Rack with Oracle Exadata Storage Expansion Rack, ensure there are two separate disk groups. One disk group is for the drives in the Oracle Engineered System Eighth Rack, and the other disk group is for the drives in Oracle Exadata Storage Expansion Rack.

Multiple Oracle Engineered Systems can be run as separate environments, and connect through the RDMA Network Fabric. If you are planning to utilize multiple Oracle Engineered Systems in this manner, then note the following:

- All servers on the RDMA Network Fabric must have a unique IP address. When Oracle Engineered System is deployed, the default network is 192.168.10.1. You must modify the IP addresses before re-configuring the RDMA Network Fabric. Failure to do so causes duplicate IP addresses.
- After modifying the network, run the appropriate verification tools:
 - **X8M:** RDMA over RoCE Network Fabric
Run `infinicheck` commands to verify the network is working properly. You will create a file that contains IP addresses for Exadata Storage Servers, such as `cells`. The word `hosts` represents a file that contains the names of the hosts to check, or a comma-separated list of host names to check.

```
# /opt/oracle.SupportTools/ibdiagtools/infinicheck -g hosts -c cells
```

```

                                INFINICHECK
[Network Connectivity, Configuration and
Performance]
```

```
##### FABRIC TYPE TESTS #####
```

```
System type identified: RoCE
```

```
Verifying User Equivalence of user=root from all DBs to all CELLS.
```

```
##### RoCE CONFIGURATION TESTS #####
Checking for presence of RoCE devices on all DBs and CELLS

[SUCCESS].... RoCE devices on all DBs and CELLS look good

Checking for RoCE Policy Routing settings on all DBs and
CELLs

[SUCCESS].... RoCE Policy Routing settings look good

Checking for RoCE DSCP ToS mapping on all DBs and CELLS

[SUCCESS].... RoCE DSCP ToS settings look good

Checking for RoCE PFC settings and DSCP mapping on all DBs
and CELLS

[SUCCESS].... RoCE PFC and DSCP settings look good

Checking for RoCE interface MTU settings. Expected value :
2300

[SUCCESS].... RoCE interface MTU settings look good

Verifying switch advertised DSCP on all DBs and CELLS ports
( ~ 2 min )

[SUCCESS].... Advertised DSCP settings from RoCE switch looks good

##### CONNECTIVITY TESTS #####
[COMPUTE NODES -> STORAGE CELLS]
(60 seconds approx.)
(Will walk through QoS values: 0-6)
[SUCCESS].....Results OK

[SUCCESS]..... All can talk to all storage cells

[COMPUTE NODES -> COMPUTE NODES]
(60 seconds approx.)
(Will walk through QoS values: 0-6)
[SUCCESS].....Results OK

[SUCCESS]..... All hosts can talk to all other nodes

Verifying Subnet Masks on all nodes
[SUCCESS] ..... Subnet Masks is same across the network
```

– **X8 and earlier: RDMA over InfiniBand Network Fabric**

Run the `verify-topology` (or InfiniBand commands like `showtopology` and `ibdiagnet`) and `infinicheck` commands to verify the network is working

properly. You will create a file that contains IP addresses for Exadata Storage Servers, such as `combined_cellip.ora`. Here is an example:

```
# cd /opt/oracle.SupportTools/ibdiagtools
# ./verify-toplogy -t fattree
# ./infinicheck -c /tmp/combined_cellip.ora -b
```

- When Oracle Engineered Systems run in separate clusters, do not modify the `cellip.ora` files. The `cellip.ora` file on a database server should only include the IP addresses for the storage servers used with that database server.
- Cells with disk types different from what is already installed can be added, but the disk types cannot be mixed in the same Oracle Automatic Storage Management (Oracle ASM) disk group. For example, if the existing disk groups all use high performance disks, and cells with high capacity disks are being added, then it is necessary to create new disk groups for the high capacity disks.

When adding the same type of disk, ensure that the grid disk sizes are exactly the same even if the new disks are larger than the existing ones. For example, if the existing disks are 3 TB, and the additional disks are 4 TB, then it is necessary to create grid disks that match the size on the 3 TB disks. A new disk group can be created using the extra 1 TB of disk space.

- In order to access Exadata Storage Servers in one Oracle Engineered System by another Oracle Engineered System when they are not running as a single cluster, Exadata Storage Servers must have unique Oracle ASM disk group and failure group names on each Oracle Engineered System.

For example, for two Oracle Engineered Systems cabled together but run as separate clusters, the following names should be unique:

- Cell name
 - Cell disk name
 - Grid disk name
 - Oracle ASM failure group name
- All equipment receives a Customer Support Identifier (CSI). Any new equipment for the Oracle Engineered System has a new CSI. Contact Oracle Support Services to reconcile the new CSI with the existing Oracle Engineered System CSI. Have the original instance numbers or serial numbers available, as well as the new numbers when contacting Oracle Support Services.

For X8M: RDMA over RoCE Network Fabric

The RDMA Network Fabric can be used for external connectivity. The external connectivity ports in the Cisco Nexus C9336C-FX2 switch can connect to media servers for tape backup, data loading, and client and application access. Use the available ports on the leaf switches for external connectivity. There are 12 ports per rack. The available ports are 1, 2, 3, 34, 35 and 36 in each leaf switch. For high availability connections, connect one port to one leaf switch and the other port to the second leaf switch. The validated InfiniBand cable lengths are:

- Up to 5 meters passive copper QSFP cables or QSFP breakout to SFP Cables
- Up to 100 meters fiber optic QSFP cables or QSFP breakout to SFP Cables

For X8 and earlier: RDMA over InfiniBand Network Fabric

The RDMA Network Fabric can be used for external connectivity. The external connectivity ports in the Sun Datacenter InfiniBand Switch 36 switches can connect to media servers for tape backup, data loading, and client and application access. Use the available ports on the leaf switches for external connectivity. There are 12 ports per rack. The available ports are 5B, 6A, 6B, 7A, 7B, and 12A in each leaf switch. For high availability connections, connect one port to one leaf switch and the other port to the second leaf switch. The validated InfiniBand cable lengths are:

- Up to 5 meters passive copper 4X QDR QSFP cables
- Up to 100 meters fiber optic 4X QDR QSFP cables

Related Topics

- Elastic Configurations

1.2 Reviewing the Safety Precautions

Before upgrading Oracle Exadata Database Machines, read *Important Safety Information for Sun Hardware Systems* included with the rack.

Note:

Contact a service representative or Oracle Advanced Customer Support to confirm that Oracle has qualified your equipment for installation and use in Oracle Exadata Database Machine. Oracle is not liable for any issues when you install or use non-qualified equipment.

See Also:

- *Oracle Exadata Database Machine Installation and Configuration Guide* for safety guidelines
- *Oracle Engineered System Safety and Compliance Guide, Compliance Model No.: ESY27* for safety notices

1.3 Reviewing the Cable Precautions

Review the following RDMA Network Fabric cable precautions before working with the cables:

- Fiber optic cables with laser transceivers must be of type Class 1.
- Do not allow any copper core cable to bend to a radius tighter than 127 mm (5 inches). Tight bends can damage the cables internally.
- Do not allow any optical cable to bend to a radius tighter than 85 mm (3.4 inches). Tight bends can damage the cables internally.
- Do not use zip ties to bundle or support cables. The sharp edges of the ties can damage the cables internally. Use hook-and-loop straps.

- Do not allow any cable to experience extreme tension. Do not pull or drag the cables, which can damage them internally.
- Unroll a cable for its length.
- Do not twist cables more than one revolution for their entire length. Twisting a cable might damage it internally.
- Do not route cables where they can be stepped on, or experience rolling loads. A crushing effect can damage the cable internally.

1.4 Estimating Cable Path Lengths

Cable paths should be as short as possible. When the length of a cable path has been calculated, select the shortest cable to satisfy the length requirement. When specifying a cable, consider the following:

- Bends in the cable path increase the required length of the cable. Rarely does a cable travel in a straight line from connector to connector. Bends in the cable path are necessary, and each bend increases the total length.
- Bundling increases the required length of the cables. Bundling causes one or more cables to follow a common path. However, the bend radius is different in different parts of the bundle. If the bundle is large and unorganized, and there are many bends, one cable might experience only the inner radius of bends, while another cable might experience the outer radius of bends. In this situation, the differences of the required lengths of the cables is quite substantial.
- When calculating the cable path length and route is under the floor, take into consideration the height of the raised floor.

1.5 Bundling Cables

When bundling RDMA Network Fabric cables in groups, use hook-and-loop straps to keep cables organized. If possible, use color-coordinated straps to help identify cables and their routing. Splitter and C-4 copper conductor cables are fairly thick and heavy for their length. Consider the retention strength of the hook-and-loop straps when supporting cables. Bundle as few cables as reasonably possible. If the cables break free of their straps and fall free, the cables might break internally when they strike the floor or from sudden changes in tension.

Bundle the cables using many hook-and-loop straps. Oracle recommends that no more than eight cables be bundled together.

Place the hook-and-loop straps as close together as reasonably possible, for example, one strap every foot (0.3 m). If a cable breaks free from a strap, then the cable cannot fall far before it is retained by another strap.

- [Floor and Underfloor Delivery of Cables](#)

1.5.1 Floor and Underfloor Delivery of Cables

The RDMA Network Fabric switches accept cables from floor or underfloor delivery. Floor and underfloor delivery limits the tension in the cable to the weight of the cable for the rack height of the switch.

 **Note:**

Overhead cabling details are not included in this guide. For details on overhead cabling, contact a certified service engineer.

1.6 Reviewing the Cable Management Arm Guidelines

Review the following cable management arm (CMA) guidelines before routing the cables.

- Remove all required cables from the packaging, and allow cables to acclimate or reach operating temperature, if possible. The acclimation period is usually 24 hours. This improves the ability to manipulate the cables.
- Label both ends of each cable using a label stock that meets the ANSI/TIA/EIA 606-A standard, if possible.
- Begin the installation procedure in ascending order.
- Only slide out one server at a time. Sliding out more than one server can cause cables to drop cause problems when sliding the servers back.
- Separate the installation by dressing cables with the least stringent bend radius requirements first. The following bend radius requirements are based on EIA/TIA 568-x standards, and may vary from the manufacturer's requirements:
 - CAT5e UTP: 4 x diameter of the cable or 1 inch; 25.4 mm minimum bend radius
 - AC power cables: 4 x diameter of the cable or 1 inch; 25.4 mm minimum bend radius
 - **For X8M:** RDMA over RoCE Network Fabric
 - 30 AWG: Single cable diameter of 4.5 +/- 0.2 mm and lengths from 1 to 3 meters; 21 mm single bend minimum bend radius or 45 mm repeated bends.
 - 26 AWG: Single cable diameter of 5.8 +0.3 mm/-1.0 mm and lengths from 2.5 to 5 meters; 29 mm single bend minimum bend radius or 58 mm repeated bends.
 - **For X8 and earlier:** RDMA over InfiniBand Network Fabric
 - TwinAx: 5 x diameter of the cable or 1.175 inch; 33 mm minimum bend radius.
 - Quad Small Form-factor Pluggable (QSFP) cable: 6 x diameter of the cable or 2 inch; 55 mm minimum bend radius.
 - Fiber core cable: 10 x diameter of the cable or 1.22 inch; 31.75 mm minimum bend radius for a 0.125 cable.
- Install the cables with the best longevity rate first.

1.7 Obtaining Current Configuration Information

The current configuration information is used to plan patching requirements, configure new IP addresses, and so on. The following information should be collected as described before extending the rack:

- The Oracle EXAchk report for the current rack.
- Image history information using the following command:

```
dcli -g ~/all_group -l root "imagehistory" > imagehistory.txt
```

- Current IP addresses defined for all Exadata Storage Servers and database servers using the following command:

```
dcli -g ~/all_group -l root "ifconfig" > ifconfig_all.txt
```

- Information about the configuration of the cells, cell disks, flash logs, and IORM plans using the following commands:

```
dcli -g ~/cell_group -l root "cellcli -e list cell detail" > cell_detail.txt
```

```
dcli -g ~/cell_group -l root "cellcli -e list physicaldisk detail" > \ physicaldisk_detail.txt
```

```
dcli -g ~/cell_group -l root "cellcli -e list griddisk attributes \ name,offset,size,status,asmmodestatus,asmdeactivationoutcome" > griddisk.txt
```

```
dcli -g ~/cell_group -l root "cellcli -e list flashcache detail" > \ fc_detail.txt
```

```
dcli -g ~/cell_group -l root "cellcli -e list flashlog detail" > fl_detail.txt
```

```
dcli -g ~/cell_group -l root "cellcli -e list iormplan detail" > \ iorm_detail.txt
```

- HugePages memory configuration on the database servers using the following command:

```
dcli -g ~/dbs_group -l root "cat /proc/meminfo | grep 'HugePages'" > \ hugepages.txt
```

- **For X8M:** RDMA over RoCE Network Fabric, you should have a list of the switch names from the initial configuration with OEDA. Put the names in a file, for example, roceswitches.txt, with each switch name on a separate line.
- **For X8 and earlier:** RDMA over InfiniBand Network Fabric, use the following command:

```
ibswitches > ibswitches.txt
```

Use the `nm2version` on each Sun Datacenter InfiniBand Switch 36 switch to get its firmware version.

- The following network files from the first database server in the rack:

```
- /etc/resolv.conf
```

- /etc/ntp.conf
- /etc/network
- /etc/sysconfig/network-scripts/ifcfg-*
- Any users, user identifiers, groups and group identifiers created for cluster-managed services that need to be created on the new servers, such as Oracle GoldenGate.
- /etc/passwd
- /etc/group
- Output of current cluster status using the following command:

```
crsctl stat res -t > crs_stat.txt
```

- Patch information from the Grid Infrastructure and Oracle homes using the following commands. The commands must be run as Grid Infrastructure home owner, and the Oracle home owner.

```
/u01/app/oracle/product/11.2.0/dbhome_1/OPatch/opatch lsinventory -  
oh \  
GRID_HOME -detail -all_nodes > opatch_grid.txt
```

```
/u01/app/oracle/product/11.2.0/dbhome_1/OPatch/opatch lsinventory -  
oh \  
ORACLE_HOME -detail -all_nodes >> opatch_oracle.txt
```

In the preceding commands, *GRID_HOME* is the path for the Grid Infrastructure home directory, and *ORACLE_HOME* is the path for the Oracle home directory.

Related Topics

- [Oracle Autonomous Health Framework User's Guide](#)
- [Oracle Exadata Database Machine exachk or HealthCheck \(Doc ID 1070954.1\)](#)

1.8 Preparing the Network Configuration

When adding additional servers to your rack, you will need IP address and the current network configuration settings.

When adding additional servers or rack to an existing rack, the IP addresses for the new servers are obtained using Oracle Exadata Deployment Assistant (OEDA). If adding additional servers to an existing rack, then the application should only include the new servers. If adding an additional rack, then the new rack should use its own OEDA. The exact Oracle Automatic Storage Management (Oracle ASM) disk group configuration currently in use may not be reflected by the application. This is not an issue, as the grid disks and disk groups are configured manually. All other items, such as the Oracle home location and owner, should be defined exactly as the existing configuration.

When adding Oracle Exadata X4-2 Database Server or later or Oracle Exadata Storage Server X4-2L or later, the bonding configuration must match the existing servers in the rack. The OEDA InfiniBand configuration page has an option to select

the type of bonding. Select the option for active-active bonding, or deselect the option for active-passive bonding.

The configuration file generated by the application is used by OEDA. After using OEDA, use the `checkip.sh` and `dbm.dat` files to verify the network configuration. The only errors that should occur are from the `ping` command to the SCAN addresses, Cisco switch, and Sun Datacenter InfiniBand Switch 36 switches.

Related Topics

- [Configuring New Servers Manually](#)
When adding servers to a non-Eighth Rack Oracle Engineered System, you can configure the servers manually instead of using OEDA.

1.9 Moving Audit and Diagnostic Files

The files in the `$GRID_HOME/rdbms/audit` directory and the `$GRID_HOME/log/diagnostics` directory should be moved or deleted before extending a cluster. Oracle recommends moving or deleting the files a day or two before the planned extension because it may take time.

1.10 Reviewing Release and Patch Levels

When adding new servers to a rack, you must match the installed operating system version and software releases.

The new rack or servers most-likely have a later release or patch level than the current rack. In some cases, you may want to update the current rack release to the later release. In other cases, you may want to stay at your current release, and choose to reimagine the new rack to match the current rack. Whatever you choose to do, ensure that the existing and new servers and Sun Datacenter InfiniBand Switch 36 switches are at the same patch level.

Tip:

Check My Oracle Support note 888828.1 for latest information on minimum releases.

Older servers in a rack may need to be patched to a later release to meet the minimum required software release. In addition, older database servers might use Oracle Linux release 5.3. Those servers need to be updated to a newer Oracle Linux release.

Additional patching considerations include the Oracle Grid Infrastructure and Oracle Database home releases and bundle patch updates. If new patches will be applied, then Oracle recommends changing the existing servers so that the new servers will inherit the releases as part of the extension procedure. This way, the number of servers being patched is lower. Any patching of the existing servers should be performed in advance so they are at the desired level when the extension work is scheduled, thereby reducing the total amount of work required during the extension.

Related Topics

- [Exadata Database Machine and Exadata Storage Server Supported Versions \(My Oracle Support Doc ID 888828.1\)](#)
- [Updating key software components on database hosts to match those on the cells \(My Oracle Support Doc ID 1284070.1\)](#)

1.11 Performing Preliminary Checks

Perform a visual check of Oracle Exadata Database Machine physical systems before extending the hardware.

1. Check the rack for damage.
2. Check the rack for loose or missing screws.
3. Check Oracle Exadata Database Machine for the ordered configuration.
4. Check that all cable connections are secure and well seated.
5. Check power cables.
6. Ensure the correct connectors have been supplied for the data center facility power source.
7. Check network data cables.
8. Check the site location tile arrangement for cable access and airflow.
9. Check the data center airflow into the front of Oracle Exadata Database Machine.

1.12 Preparing to Add Servers

Perform the following tasks before adding the servers:

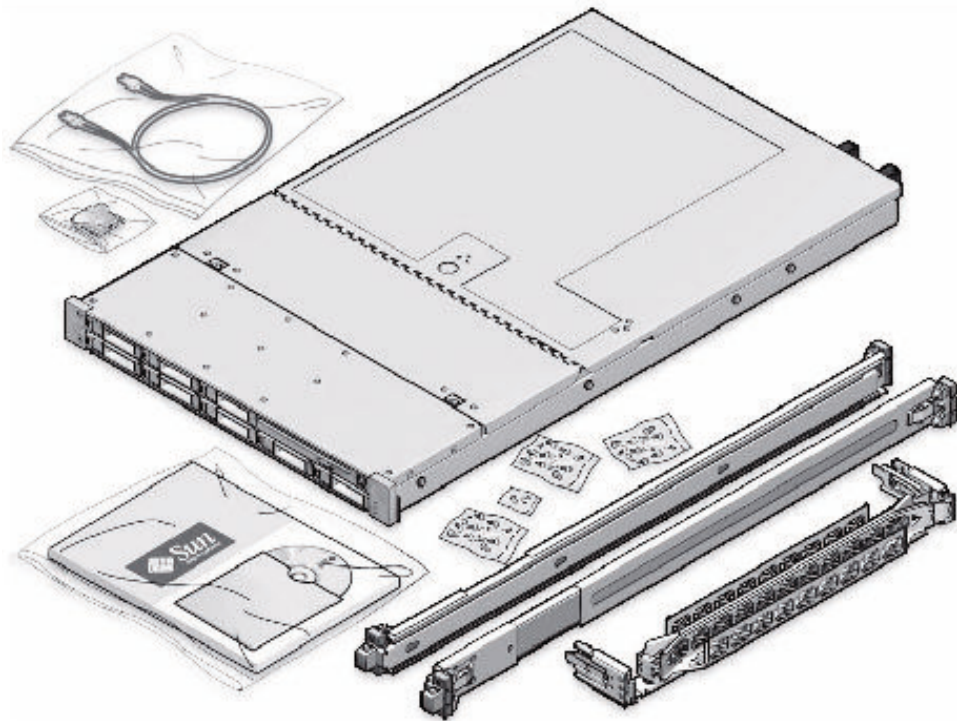
1. Unpack the Oracle Exadata Database Machine expansion kit.
2. Unpack all Oracle Exadata Database Machine server components from the packing cartons. The following items should be packaged with the servers:
 - Oracle Database servers or Exadata Storage Server
 - Power cord, packaged with country kit
 - Cable management arm with installation instructions
 - Rackmount kit containing rack rails and installation instructions
 - (Optional) Sun server documentation and media kit

Note:

If you are extending Oracle Exadata Database Machine X4-2, Oracle Exadata Database Machine X3-8 Full Rack, or Oracle Exadata Database Machine X2-2 (with X4170 and X4275 servers) half rack, then order the expansion kit that includes a Sun Datacenter InfiniBand Switch 36 switch.

Figure 1-1 shows the components in the server expansion kit.

Figure 1-1 Server Components for Upgrade



3. Lay out the cables for the servers.
4. Unroll the cables and stretch them to remove the bends.
5. Apply the cable labels. Oracle recommends labeling all cables before installation.
6. Install the servers.
7. Cable the servers.

 **See Also:**

- *Oracle Exadata Database Machine Maintenance Guide* for information about cable labels
- "[Adding New Servers](#)" for information about installing the servers
- "[Cabling Database Servers](#)" and "[Cabling Exadata Storage Servers](#)" for information about cabling the servers

2

Extending the Hardware

Oracle Exadata Database Machine can be extended from a Quarter Rack to Half Rack, from a Half Rack to a Full Rack, and by cabling racks together.

All new equipment receives a Customer Support Identifier (CSI). Any new equipment for your Oracle Engineered System Rack has a new CSI. Contact Oracle Support Services to reconcile the new CSI with the existing Oracle Engineered System Rack CSI. Have the original instance numbers or serial numbers available, as well as the new numbers when contacting Oracle Support Services.

- [Extending an Eighth Rack to a Quarter Rack in Oracle Engineered System X4-2 and Later](#)
- [Extending an Eighth Rack to a Quarter Rack in Oracle Exadata Database Machine X3-2](#)
- [Extending Elastic Configurations](#)
Oracle Engineered System is available in Elastic Configurations that consist of a number of database and storage servers up to the capacity of the rack, as defined within Oracle Exadata Configuration Assistant (OECA).
- [Extending a Rack by Adding Another Rack](#)
Extending your Oracle Engineered System Rack by adding another rack consists of cabling and configuring the racks together.

2.1 Extending an Eighth Rack to a Quarter Rack in Oracle Engineered System X4-2 and Later

Extending Oracle Engineered System X4-2 or X5-2 from an eighth rack to a quarter rack is done using software. No hardware modifications are needed to extend the rack.

However, hardware modifications may be needed for other Oracle Engineered System versions. See [Oracle Exadata Database Machine X6-2: Adding High Capacity Disks and Flash Cards](#) and [Oracle Engineered System X7-2, X8-2, X8M: Upgrading Eighth Rack Systems to a Quarter Rack](#) for details.

This procedure can be done with no downtime or outages, other than a rolling database outage.

 **Note:**

In the following procedures, the disk group names and sizes are examples. The values should be changed in the commands to match the actual system.

The procedures assume user equivalence exists between the `root` user on the first database server and all other database servers, and to the `celladmin` user on all storage cells.

The text files `cell_group` and `db_group` should be created to contain lists of cell host names and database server host names, respectively.

- [Reviewing and Validating Current Configuration of Eighth Rack Oracle Exadata Database Machine X4-2 or Later](#)
The following procedure describes how to review and validate the current configuration.
- [Activating Database Server Cores in Eighth Rack Oracle Exadata Database Machine X4-2 or Later](#)
The following procedure describes how to activate the database server cores.
- [Oracle Exadata Database Machine X6-2: Adding High Capacity Disks and Flash Cards](#)
- [Oracle Engineered System X7-2, X8-2, X8M: Upgrading Eighth Rack Systems to a Quarter Rack](#)
- [Activating Storage Server Cores and Disks in Eighth Rack Oracle Exadata Database Machine X4-2 or Later](#)
The following procedure describes how to activate the storage server cores and disks.
- [Creating Grid Disks in Eighth Rack Oracle Exadata Database Machine X4-2 or Later](#)
Grid disk creation must follow a specific order to ensure the proper offset.
- [Adding Grid Disks to Oracle ASM Disk Groups in Eighth Rack Oracle Exadata Database Machine X4-2 or Later](#)
The following procedure describes how to add the grid disks to Oracle ASM disk groups.
- [Validating New Quarter Rack Configuration for Oracle Exadata Database Machine X4-2 or Later](#)
After adding the grid disks to the Oracle ASM disk groups, validate the configuration.

2.1.1 Reviewing and Validating Current Configuration of Eighth Rack Oracle Exadata Database Machine X4-2 or Later

The following procedure describes how to review and validate the current configuration.

1. Log in as the `root` user on the first database server.

- Review the current configuration of the database servers using the following command:

```
# dcli -g db_group -l root 'dbmcli -e list dbserver attributes
coreCount'
```

The following is an example of the output from the command for Oracle Exadata Database Machine X5-2 Eighth Rack:

```
dm01db01: 18
dm01db02: 18
```

Note:

The number of active cores in Oracle Exadata Database Machine X5-2 Eighth Rack database server is 18. The number of active cores in Oracle Exadata Database Machine X4-2 Eighth Rack database server is 12.

If the number of cores on a database server configured as an eighth rack differs, then contact Oracle Support Services.

- Review the current configuration of the storage servers using the following command. The expected output is `TRUE`.

```
# dcli -g cell_group -l celladmin 'cellcli -e LIST CELL attributes
eighthtrack'
```

2.1.2 Activating Database Server Cores in Eighth Rack Oracle Exadata Database Machine X4-2 or Later

The following procedure describes how to activate the database server cores.

- Log in as the `root` user on the first database server.
- Activate all the database server cores using the following `dcli` utility command on the database server group:

```
# dcli -g db_group -l root 'dbmcli -e \
ALTER DBSERVER pendingCoreCount = number_of_cores'
```

In the preceding command, *number_of_cores* is the total number of cores to activate. The value includes the existing core count and the additional cores to be activated. The following command shows how to activate all the cores in Oracle Exadata Database Machine X5-2 Eighth Rack:

```
# dcli -g db_group -l root 'dbmcli -e ALTER DBSERVER pendingCoreCount =
36'
```

For a description of the supported core counts for each server model, see [Restrictions for Capacity-On-Demand on Oracle Exadata Database Machine](#)

3. Restart each database server.

Note:

If this procedure is done in a rolling fashion with the Oracle Database and Oracle Grid Infrastructure active, then ensure the following before restarting the database server:

- All Oracle ASM grid disks are online..
- There are no active Oracle ASM rebalance operations. You can query the `V$ASM_OPERATION` view for the status of the rebalance operation.
- Shut down Oracle Database and Oracle Grid Infrastructure in a controlled manner, failing over services as needed. .

4. Verify the following items on the database server after the restart completes and before proceeding to the next server:

- The Oracle Database and Oracle Grid Infrastructure services are active.
See *Using SRVCTL to Verify That Instances are Running in Oracle Real Application Clusters Administration and Deployment Guide* and the `crsctl status resource -w "TARGET = ONLINE" -t` command.
- The number of active cores is correct. Use the `dbmcli -e list dbserver attributes coreCount` command to verify the number of cores.

See Also:

- Changing a Disk to Offline or Online.
- Stopping One or More Instances and Oracle RAC Databases Using SRVCTL in *Oracle Real Application Clusters Administration and Deployment Guide*
- `crsctl stop cluster`
- Increasing the Number of Active Cores on Database Servers

2.1.3 Oracle Exadata Database Machine X6-2: Adding High Capacity Disks and Flash Cards

Upgrade of Oracle Exadata Database Machine X6-2 Eighth Rack High Capacity systems require hardware modification, but upgrade of X6-2 Extreme Flash does not require hardware modification.

Eighth Rack High Capacity storage servers have half the cores enabled, but half the disks and flash cards are removed. Eighth Rack Extreme Flash storage servers have half the cores and flash drives enabled.

Eighth Rack database servers have half the cores enabled.

On Oracle Exadata Database Machine X6-2 Eighth Rack systems with High Capacity disks, you can add high capacity disks and flash cards to extend the system to a Quarter Rack:

1. Install the six 8 TB disks in HDD slots 6 - 11.
2. Install the two F320 flash cards in PCIe slots 1 and 4.

2.1.4 Oracle Engineered System X7-2, X8-2, X8M: Upgrading Eighth Rack Systems to a Quarter Rack

Upgrade of Oracle Engineered System X7-2, X8-2, or X8M-2 Eighth Rack systems requires hardware modification. Eighth Rack database servers have one of the CPUs removed, and all of the memory for CPU1 was moved to CPU0. Storage servers have half the cores enabled, and half the disks and flash cards were removed.

On Oracle Engineered System X7-2, X8-2, or X8M Eighth Rack systems with Extreme Flash storage servers, you can add CPUs and flash cards to extend the system to a Quarter Rack.

For Oracle Engineered System X7-2, X8-2, or X8M-2 Eighth Rack systems with High Capacity storage servers, you can add the CPU and memory to the database servers and additional Eighth Rack High Capacity storage servers to expand the system.

1. On the Exadata X7-2, X8-2, or X8M-2 database server, install CPU1, move half of CPU0's memory to CPU1, and move the 10/25GbE PCI card to PCIe slot 1.
2. On Exadata X7-2, X8-2, or X8M-2 Extreme Flash Storage Servers, install four F640/F640v2 flash cards in PCIe slots 2,3,8, and 9.

2.1.5 Activating Storage Server Cores and Disks in Eighth Rack Oracle Exadata Database Machine X4-2 or Later

The following procedure describes how to activate the storage server cores and disks.

1. Log in as the `root` user on the first database server.
2. Activate the cores on the storage server group using the following command. The command uses the `dcli` utility, and runs the command as the `celladmin` user.

```
# dcli -g cell_group -l celladmin cellcli -e "alter cell
eighthRack=false"
```

3. Create the cell disks using the following command:

```
# dcli -g cell_group -l celladmin cellcli -e "create celldisk all"
```

4. Recreate the flash log using the following commands:

```
# dcli -g cell_group -l celladmin cellcli -e "drop flashlog all force"
# dcli -g cell_group -l celladmin cellcli -e "create flashlog all"
```

- Expand the flash cache using the following command:

```
# dcli -g cell_group -l celladmin cellcli -e "alter flashcache all"
```

2.1.6 Creating Grid Disks in Eighth Rack Oracle Exadata Database Machine X4-2 or Later

Grid disk creation must follow a specific order to ensure the proper offset.

The order of grid disk creation must follow the same sequence that was used during initial grid disks creation. For a standard deployment using Oracle Exadata Deployment Assistant, the order is DATA, RECO, and DBFS_DG. Create all DATA grid disks first, followed by the RECO grid disks, and then the DBFS_DG grid disks.

The following procedure describes how to create the grid disks:

Note:

The commands shown in this procedure use the standard deployment grid disk prefix names of DATA, RECO and DBFS_DG. The sizes being checked are on cell disk 02. Cell disk 02 is used because the disk layout for cell disks 00 and 01 are different from the other cell disks in the server.

- Check the size of the grid disks using the following commands. Each cell should return the same size for the grid disks starting with the same grid disk prefix.

```
# dcli -g cell_group -l celladmin cellcli -e \
"list griddisk attributes name, size where name like \'DATA.*_02_*\'"
```

```
# dcli -g cell_group -l celladmin cellcli -e \
"list griddisk attributes name, size where name like \'RECO.*_02_*\'"
```

```
# dcli -g cell_group -l celladmin cellcli -e \
"list griddisk attributes name, size where name like \'DBFS_DG.*_02_*\'"
```

The sizes shown are used during grid disk creation.

- Create the grid disks for the disk groups using the sizes shown in step 1. The following table shows the commands to create the grid disks based on rack type and disk group.

Table 2-1 Commands to Create Disk Groups When Extending Oracle Exadata Database Machine X4-2 Eighth Rack or Later

Rack	Commands
Extreme Flash Oracle Exadata Database Machine X5-2 and later	<pre>dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_FD_04_\'hostname -s\' celldisk=FD_04_\'hostname -s \',size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_FD_05_\'hostname -s\' celldisk=FD_05_\'hostname -s \',size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_FD_06_\'hostname -s\' celldisk=FD_06_\'hostname -s \',size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_FD_07_\'hostname -s\' celldisk=FD_07_\'hostname -s \',size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_FD_04_\'hostname -s\' celldisk=FD_04_\'hostname -s \',size=recosize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_FD_05_\'hostname -s\' celldisk=FD_05_\'hostname -s \',size=recosize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_FD_06_\'hostname -s\' celldisk=FD_06_\'hostname -s \',size=recosize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_FD_07_\'hostname -s\' celldisk=FD_07_\'hostname -s \',size=recosize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_FD_04_\'hostname -s\' celldisk=FD_04_\'hostname -s \',size=dbfssize, \ cachingPolicy=none"</pre>

Table 2-1 (Cont.) Commands to Create Disk Groups When Extending Oracle Exadata Database Machine X4-2 Eighth Rack or Later

Rack	Commands
	<pre> dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_FD_05_\'hostname -s\' celldisk=FD_05_\'hostname -s \',size=dbfssize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_FD_06_\'hostname -s\' celldisk=FD_06_\'hostname -s \',size=dbfssize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_FD_07_\'hostname -s\' celldisk=FD_07_\'hostname -s \',size=dbfssize, \ cachingPolicy=none" </pre>

Table 2-1 (Cont.) Commands to Create Disk Groups When Extending Oracle Exadata Database Machine X4-2 Eighth Rack or Later

Rack	Commands
High Capacity Oracle Exadata Database Machine X5-2 or Oracle Exadata Database Machine X4-2 and later	<pre>dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_06_\'hostname -s\' celldisk=CD_06_\'hostname -s \',size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_07_\'hostname -s\' celldisk=CD_07_\'hostname -s \',size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_08_\'hostname -s\' celldisk=CD_08_\'hostname -s \',size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_09_\'hostname -s\' celldisk=CD_09_\'hostname -s \',size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_10_\'hostname -s\' celldisk=CD_10_\'hostname -s \',size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_11_\'hostname -s\' celldisk=CD_11_\'hostname -s \',size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_06_\'hostname -s\' celldisk=CD_06_\'hostname -s \',size=recosize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_07_\'hostname -s\' celldisk=CD_07_\'hostname -s \',size=recosize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_08_\'hostname -s\' celldisk=CD_08_\'hostname -s \',size=recosize, \</pre>

Table 2-1 (Cont.) Commands to Create Disk Groups When Extending Oracle Exadata Database Machine X4-2 Eighth Rack or Later

Rack	Commands
	<pre> cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_09_\'hostname -s\' celldisk=CD_09_\'hostname -s \',size=recosize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_10_\'hostname -s\' celldisk=CD_10_\'hostname -s \',size=recosize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_11_\'hostname -s\' celldisk=CD_11_\'hostname -s \',size=recosize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_CD_06_\'hostname -s\' celldisk=CD_06_\'hostname -s \',size=dbfssize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_CD_07_\'hostname -s\' celldisk=CD_07_\'hostname -s \',size=dbfssize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_CD_08_\'hostname -s\' celldisk=CD_08_\'hostname -s \',size=dbfssize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_CD_09_\'hostname -s\' celldisk=CD_09_\'hostname -s \',size=dbfssize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ </pre>

Table 2-1 (Cont.) Commands to Create Disk Groups When Extending Oracle Exadata Database Machine X4-2 Eighth Rack or Later

Rack	Commands
	<pre>DBFS_DG_CD_10_\'hostname -s\' celldisk=CD_10_\'hostname -s \',size=dbfssize, \ cachingPolicy=none" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_CD_11_\'hostname -s\' celldisk=CD_11_\'hostname -s \',size=dbfssize, \ cachingPolicy=none"</pre>

2.1.7 Adding Grid Disks to Oracle ASM Disk Groups in Eighth Rack Oracle Exadata Database Machine X4-2 or Later

The following procedure describes how to add the grid disks to Oracle ASM disk groups.

The grid disks created in [Creating Grid Disks in Eighth Rack Oracle Exadata Database Machine X4-2 or Later](#) must be added as Oracle ASM disks to their corresponding, existing Oracle ASM disk groups.

1. Validate the following:
 - No rebalance operation is currently running.
 - All Oracle ASM disks are active.
2. Log in to the first database server as the owner who runs the Oracle Grid Infrastructure software.
3. Set the environment to access the +ASM instance on the server.
4. Log in to the ASM instance as the `sysasm` user using the following command:

```
$ sqlplus / as sysasm
```

5. Validate the current settings, as follows:

```
SQL> set lines 100
SQL> column attribute format a20
SQL> column value format a20
SQL> column diskgroup format a20
SQL> SELECT att.name attribute, upper(att.value) value, dg.name
diskgroup
FROM V$ASM_ATTRIBUTE att, V$ASM_DISKGROUP DG
WHERE DG.group_number=att.group_number AND att.name LIKE
'%appliance.mode%'
ORDER BY att.group_number;
```

The output should be similar to the following:

ATTRIBUTE	VALUE	DISKGROUP
appliance.mode	TRUE	DATA1
appliance.mode	TRUE	DBFS_DG
appliance.mode	TRUE	RECO1

6. Disable the `appliance.mode` attribute for any disk group that shows `TRUE` using the following commands:

```
SQL> ALTER DISKGROUP data_diskgroup set attribute
'appliance.mode'='FALSE';
SQL> ALTER DISKGROUP reco_diskgroup set attribute
'appliance.mode'='FALSE';
SQL> ALTER DISKGROUP dbfs_dg_diskgroup set attribute
'appliance.mode'='FALSE';
```

In the preceding commands, `data_diskgroup`, `reco_diskgroup`, and `dbfs_dg_diskgroup` are the names of the DATA, RECO and DBFS_DG disk groups, respectively.

7. Add the grid disks to the Oracle ASM disk groups. The following table shows the commands to create the grid disks based on rack type and disk group. Adding the new disks requires a rebalance of the system.

Table 2-2 Commands to Add Disk Groups When Extending Eighth Rack Oracle Exadata Database Machine X4-2 and Later

Rack	Commands
Extreme Flash Oracle Exadata Database Machine X5-2 and later	<pre>SQL> ALTER DISKGROUP data_diskgroup ADD DISK 'o/*/ DATA_FD_0[4-7]*' \ REBALANCE POWER 32; SQL> ALTER DISKGROUP reco_diskgroup ADD DISK 'o/*/ RECO_FD_0[4-7]*' \ REBALANCE POWER 32; SQL> ALTER DISKGROUP dbfs_dg_diskgroup ADD DISK 'o/*/ DBFS_DG_FD_0[4-7]*'\ REBALANCE POWER 32;</pre>

Table 2-2 (Cont.) Commands to Add Disk Groups When Extending Eighth Rack Oracle Exadata Database Machine X4-2 and Later

Rack	Commands
High Capacity Oracle Exadata Database Machine X5-2 or Oracle Exadata Database Machine X4-2 and later	<pre>SQL> ALTER DISKGROUP data_diskgroup ADD DISK 'o/*/ DATA_CD_0[6-9]*', ' \ o/*/DATA_CD_1[0-1]*' REBALANCE POWER 32; SQL> ALTER DISKGROUP reco_diskgroup ADD DISK 'o/*/ RECO_CD_0[6-9]*', ' \ o/*/RECO_CD_1[0-1]*' REBALANCE POWER 32; SQL> ALTER DISKGROUP dbfs_dg_diskgroup ADD DISK ' \ o/*/DBFS_DG_CD_0[6-9]*', ' o/*/DBFS_DG_CD_1[0-1]*' REBALANCE POWER 32;</pre>

The preceding commands return Diskgroup altered, if successful.

- (Optional) Monitor the current rebalance operation using the following command:

```
SQL> SELECT * FROM gv$asm_operation;
```

- Re-enable the `appliance.mode` attribute, if it was disabled in step 6 using the following commands:

```
SQL> ALTER DISKGROUP data_diskgroup set attribute
'appliance.mode'='TRUE';
SQL> ALTER DISKGROUP reco_diskgroup set attribute
'appliance.mode'='TRUE';
SQL> ALTER DISKGROUP dbfs_dg_diskgroup set attribute
'appliance.mode'='TRUE';
```

2.1.8 Validating New Quarter Rack Configuration for Oracle Exadata Database Machine X4-2 or Later

After adding the grid disks to the Oracle ASM disk groups, validate the configuration.

- Log in as the `root` user on the first database server.
- Check the core count using the following command:

```
# dcli -g db_group -l root 'dbmcli -e list dbserver attributes
coreCount'
```

- Review the storage server configuration using the following command.

```
# dcli -g cell_group -l celladmin 'cellcli -e list cell attributes
eighthtrack'
```

The output should show FALSE.

4. Review the appliance mode for each disk group using the following commands:

```
SQL> set lines 100
SQL> column attribute format a20
SQL> column value format a20
SQL> column diskgroup format a20
SQL> SELECT att.name attribute, upper(att.value) value, dg.name
diskgroup \
FROM V$ASM_ATTRIBUTE att, V$ASM_DISKGROUP
DG \
WHERE DG.group_number = att.group_number
AND \
att.name LIKE '%appliance.mode%' ORDER BY DG.group_number;
```

5. Validate the number of Oracle ASM disks using the following command:

```
SQL> SELECT
g.name,d.failgroup,d.mode_status,count(*) \
FROM v$asm_diskgroup g, v$asm_disk
d \
WHERE
d.group_number=g.group_number \
GROUP BY g.name,d.failgroup,d.mode_status;
```

NAME	FAILGROUP	MODE_ST	COUNT(*)
DATA01	EXA01CELADM01	ONLINE	12
DATA01	EXA01CELADM02	ONLINE	12
DATA01	EXA01CELADM03	ONLINE	12
RECO01	EXA01CELADM01	ONLINE	12
RECO01	EXA01CELADM02	ONLINE	12
RECO01	EXA01CELADM03	ONLINE	12
RECO02	EXA01CELADM01	ONLINE	12
RECO02	EXA01CELADM02	ONLINE	12
RECO02	EXA01CELADM03	ONLINE	12
DBFS_DG	EXA01CELADM01	ONLINE	10
DBFS_DG	EXA01CELADM02	ONLINE	10
DBFS_DG	EXA01CELADM03	ONLINE	10

All two-socket systems (except eighth rack configurations) will have 12 disks per cell for any system model. Eighth rack configurations will have 6 disks per cell.

2.2 Extending an Eighth Rack to a Quarter Rack in Oracle Exadata Database Machine X3-2

Extending Oracle Exadata Database Machine X3-2 or earlier rack from an eighth rack to a quarter rack is done using software. No hardware modifications are needed to extend the rack. This procedure can be done with no downtime or outages, other than a rolling database outage. The following procedures in this section describe how to extend an Oracle Exadata Database Machine X3-2 eighth rack to a quarter rack:

- [Reviewing and Validating Current Configuration of Oracle Exadata Database Machine X3-2 Eighth Rack](#)
- [Activating Database Server Cores in Oracle Exadata Database Machine X3-2 Eighth Rack](#)
This task describes how to activate the database server cores for capacity-on-demand.
- [Activating Storage Server Cores and Disks in Oracle Exadata Database Machine X3-2 Eighth Rack](#)
- [Creating Grid Disks in Oracle Exadata Database Machine X3-2 Eighth Rack](#)
Grid disk creation must follow a specific order to ensure the proper offset.
- [Adding Grid Disks to Oracle ASM Disk Groups in Oracle Exadata Database Machine X3-2 Eighth Rack](#)
This procedure describes how to add the grid disks to Oracle ASM disk groups.
- [Validating New Oracle Exadata Database Machine X3-2 Quarter Rack Configuration](#)

2.2.1 Reviewing and Validating Current Configuration of Oracle Exadata Database Machine X3-2 Eighth Rack

The following procedure describes how to review and validate the current configuration:

1. Log in as the `root` user on the first database server.
2. Review the current configuration of the database servers using the following command:

```
# dcli -g db_group -l root /opt/oracle.SupportTools/resourcecontrol -show
```

The following is an example of the output from the command:

```
dm01db01: [INFO] Validated hardware and OS. Proceed.  
dm01db01:  
dm01db01: system_bios_version: 25010600  
dm01db01: restore_status: Ok  
dm01db01: config_sync_status: Ok  
dm01db01: reset_to_defaults: Off  
dm01db01: [SHOW] Number of cores active per socket: 4  
dm01db02: [INFO] Validated hardware and OS. Proceed.  
dm01db02:  
dm01db02: system_bios_version: 25010600
```

```
dm01db02: restore_status: Ok
dm01db02: config_sync_status: Ok
dm01db02: reset_to_defaults: Off
dm01db02: [SHOW] Number of cores active per socket: 4
```

 **Note:**

The number of active cores in Oracle Exadata Database Machine X3-2 Eighth Rack database server is 4.

If the number of cores on a database server configured as an eighth rack differs, then contact Oracle Support Services.

Ensure the output for `restore_status` and `config_sync_status` are shown as `Ok` before continuing this procedure.

3. Review the current configuration of the storage servers using the following command. The expected output is `TRUE`.

```
# dcli -g cell_group -l celladmin 'cellcli -e LIST CELL attributes eighthrack'
```

4. Ensure that flash disks are not used in Oracle ASM disk groups using the following command. Flash cache is dropped and recreated during this procedure:

```
# dcli -g cell_group -l celladmin cellcli -e "list griddisk attributes \
asmDiskgroupName,asmDiskName,diskType where diskType ='FlashDisk' \
and asmDiskgroupName !=null"
```

No rows should be returned by the command.

2.2.2 Activating Database Server Cores in Oracle Exadata Database Machine X3-2 Eighth Rack

This task describes how to activate the database server cores for capacity-on-demand.

:

1. Log in as the `root` user on the first database server.
2. Activate all the database server cores using the following `dcli` utility command on the database server group:

```
# dcli -g db_group -l root /opt/oracle.SupportTools/
resourcecontrol \
-core number_of_cores
```

In the preceding command, `number_of_cores` is the total number of cores to activate. To activate all the cores, enter `All` for the number of cores.

3. Restart the database servers in a rolling manner using the following command:

```
# shutdown -r now
```


 **Note:**

Ensure the output for `restore_status` and `config_sync_status` are shown as `Ok` before activating the storage server cores and disks. Getting the status from the BIOS after restarting may take several minutes.

Related Topics

- Increasing the Number of Active Cores on Database Servers
- Capacity-On-Demand Information

2.2.3 Activating Storage Server Cores and Disks in Oracle Exadata Database Machine X3-2 Eighth Rack

The following procedure describes how to activate the storage server cores and disks:

1. Log in as the `root` user on the first database server.
2. Activate the cores on the storage server group using the following command. The command uses the `dcli` utility, and runs the command as the `celladmin` user.

```
# dcli -g cell_group -l celladmin cellcli -e "alter cell eighthRack=false"
```

3. Create the cell disks using the following command:

```
# dcli -g cell_group -l celladmin cellcli -e "create celldisk all"
```

4. Recreate the flash log using the following commands:

```
# dcli -g cell_group -l celladmin cellcli -e "drop flashlog all force"  
# dcli -g cell_group -l celladmin cellcli -e "create flashlog all"
```

5. Expand the flash cache using the following command:

```
# dcli -g cell_group -l celladmin cellcli -e "alter flashcache all"
```

2.2.4 Creating Grid Disks in Oracle Exadata Database Machine X3-2 Eighth Rack

Grid disk creation must follow a specific order to ensure the proper offset.

The order of grid disk creation must follow the same sequence that was used during initial grid disks creation. For a standard deployment using Oracle Exadata Deployment Assistant, the order is `DATA`, `RECO`, and `DBFS_DG`. Create all `DATA` grid disks first, followed by the `RECO` grid disks, and then the `DBFS_DG` grid disks.

The following procedure describes how to create the grid disks:

 **Note:**

The commands shown in this procedure use the standard deployment grid disk prefix names of DATA, RECO and DBFS_DG. The sizes being checked are on cell disk 02. Cell disk 02 is used because the disk layout for cell disks 00 and 01 are different from the other cell disks in the server.

1. Check the size of the grid disks using the following commands. Each cell should return the same size for the grid disks starting with the same grid disk prefix.

```
# dcli -g cell_group -l celladmin cellcli -e \
"list griddisk attributes name, size where name like \'DATA.*02.*\'"
```

```
# dcli -g cell_group -l celladmin cellcli -e \
"list griddisk attributes name, size where name like \'RECO.*02.*\'"
```

```
# dcli -g cell_group -l celladmin cellcli -e \
"list griddisk attributes name, size where name like \'DBFS_DG.*02.*\'"
```

The sizes shown are used during grid disk creation.

2. Create the grid disks for the disk groups using the sizes shown in step 1. The following table shows the commands to create the grid disks based on rack type and disk group.

Table 2-3 Commands to Create Disk Groups When Extending Oracle Exadata Database Machine X3-2 Eighth Rack

Rack	Commands
High Performance or High Capacity Oracle Exadata Database Machine X3-2	<pre> dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_06_\<`hostname -s\<` celldisk=CD_06_\<`hostname -s \<`,size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_07_\<`hostname -s\<` celldisk=CD_07_\<`hostname -s \<`,size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_08_\<`hostname -s\<` celldisk=CD_08_\<`hostname -s \<`,size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_09_\<`hostname -s\<` celldisk=CD_09_\<`hostname -s \<`,size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_10_\<`hostname -s\<` celldisk=CD_10_\<`hostname -s \<`,size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DATA_CD_11_\<`hostname -s\<` celldisk=CD_11_\<`hostname -s \<`,size=datasize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_06_\<`hostname -s\<` celldisk=CD_06_\<`hostname -s \<`,size=recosize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_07_\<`hostname -s\<` celldisk=CD_07_\<`hostname -s \<`,size=recosize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_08_\<`hostname -s\<` celldisk=CD_08_\<`hostname -s \<`,size=recosize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_09_\<`hostname -s\<` celldisk=CD_09_\<`hostname -s </pre>

Table 2-3 (Cont.) Commands to Create Disk Groups When Extending Oracle Exadata Database Machine X3-2 Eighth Rack

Rack	Commands
	<pre> \`,size=recosize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_10_\<`hostname -s\<` celldisk=CD_10_\<`hostname -s \`,size=recosize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ RECO_CD_11_\<`hostname -s\<` celldisk=CD_11_\<`hostname -s \`,size=recosize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_CD_06_\<`hostname -s\<` celldisk=CD_06_\<`hostname -s \`,size=dbfssize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_CD_07_\<`hostname -s\<` celldisk=CD_07_\<`hostname -s \`,size=dbfssize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_CD_08_\<`hostname -s\<` celldisk=CD_08_\<`hostname -s \`,size=dbfssize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_CD_09_\<`hostname -s\<` celldisk=CD_09_\<`hostname -s \`,size=dbfssize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_CD_10_\<`hostname -s\<` celldisk=CD_10_\<`hostname -s \`,size=dbfssize" dcli -g cell_group -l celladmin "cellcli -e create griddisk \ DBFS_DG_CD_11_\<`hostname -s\<` celldisk=CD_11_\<`hostname -s \`,size=dbfssize" </pre>

2.2.5 Adding Grid Disks to Oracle ASM Disk Groups in Oracle Exadata Database Machine X3-2 Eighth Rack

This procedure describes how to add the grid disks to Oracle ASM disk groups.

The grid disks created in [Creating Grid Disks in Oracle Exadata Database Machine X3-2 Eighth Rack](#) must be added as Oracle ASM disks to their corresponding, existing Oracle ASM disk groups.

1. Validate the following:
 - No rebalance operation is currently running.
 - All Oracle ASM disks are active.
2. Log in to the first database server as the owner who runs the Oracle Grid Infrastructure software.
3. Set the environment to access the +ASM instance on the server.
4. Log in to the ASM instance as the `sysasm` user using the following command:

```
$ sqlplus / as sysasm
```

5. Validate the current settings, as follows:

```
SQL> set lines 100
SQL> column attribute format a20
SQL> column value format a20
SQL> column diskgroup format a20
SQL> SELECT att.name attribute, upper(att.value) value, dg.name
diskgroup \
FROM V$ASM_ATTRIBUTE att, V$ASM_DISKGROUP
DG \
WHERE DG.group_number = att.group_number
AND \
att.name LIKE '%appliance.mode%' ORDER BY att.group_number;
```

The output should be similar to the following:

ATTRIBUTE	VALUE	DISKGROUP
appliance.mode	TRUE	DATA1
appliance.mode	TRUE	DBFS_DG
appliance.mode	TRUE	RECO1

6. Disable the `appliance.mode` attribute for any disk group that shows `TRUE` using the following commands:

```
SQL> ALTER DISKGROUP data_diskgroup set attribute
'appliance.mode'='FALSE';
SQL> ALTER DISKGROUP reco_diskgroup set attribute
'appliance.mode'='FALSE';
SQL> ALTER DISKGROUP dbfs_dg_diskgroup set attribute
'appliance.mode'='FALSE';
```

In the preceding commands, `data_diskgroup`, `reco_diskgroup`, and `dbfs_dg_diskgroup` are the names of the DATA, RECO and DBFS_DG disk groups, respectively.

7. Add the grid disks to the Oracle ASM disk groups. The following table shows the commands to create the grid disks based on rack type and disk group. Adding the new disks requires a rebalance of the system.

Table 2-4 Commands to Add Disk Groups When Extending an Oracle Exadata Database Machine X3-2 Eighth Rack

Rack	Commands
High Capacity or High Performance Oracle Exadata Database Machine X3-2	<pre>SQL> ALTER DISKGROUP data_diskgroup ADD DISK 'o/*/ DATA_CD_0[6-9]*', ' \ o/*/DATA_CD_1[0-1]*' REBALANCE POWER 32; SQL> ALTER DISKGROUP reco_diskgroup ADD DISK 'o/*/ RECO_CD_0[6-9]*', ' \ o/*/RECO_CD_1[0-1]*' REBALANCE POWER 32; SQL> ALTER DISKGROUP dbfs_dg_diskgroup ADD DISK ' \ o/*/DBFS_DG_CD_0[6-9]*', ' o/*/DBFS_DG_CD_1[0-1]*' REBALANCE POWER 32;</pre>

The preceding commands return `Diskgroup altered`, if successful.

8. (Optional) Monitor the current rebalance operation using the following command:

```
SQL> SELECT * FROM gv$asm_operation;
```

9. Re-enable the `appliance.mode` attribute, if it was disabled in step 6 using the following commands:

```
SQL> ALTER DISKGROUP data_diskgroup set attribute
'appliance.mode'='TRUE';
SQL> ALTER DISKGROUP recodiskgroup set attribute
'appliance.mode'='TRUE';
SQL> ALTER DISKGROUP dbfs_dg_diskgroup set attribute
'appliance.mode'='TRUE';
```

2.2.6 Validating New Oracle Exadata Database Machine X3-2 Quarter Rack Configuration

After adding the grid disks to the Oracle ASM disk groups, validate the configuration. The following procedure describes how to validate the configuration:

1. Log in as the `root` user on the first database server.
2. Check the core count using the following command:

```
# dcli -g db_group -l root 'dbmcli -e list dserver attributes coreCount'
```
3. Review the storage server configuration using the following command.

```
# dcli -g cell_group -l celladmin 'cellcli -e list cell attributes eighthtrack'
```

The output should show FALSE.

4. Review the appliance mode for each disk group using the following commands:

```
SQL> set lines 100
SQL> column attribute format a20
SQL> column value format a20
SQL> column diskgroup format a20
SQL> SELECT att.name attribute, upper(att.value) value, dg.name diskgroup \
FROM V$ASM_ATTRIBUTE att, V$ASM_DISKGROUP DG \
WHERE DG.group_number =att.group_number AND \
att.name LIKE '%appliance.mode%' ORDER BY DG.group_number;
```

5. Validate the number of Oracle ASM disks using the following command:

```
SQL> SELECT g.name,d.failgroup,d.mode_status,count(*) \
FROM v$asm_diskgroup g, v$asm_disk d \
WHERE d.group_number=g.group_number \
GROUP BY g.name,d.failgroup,d.mode_status;
```

2.3 Extending Elastic Configurations

Oracle Engineered System is available in Elastic Configurations that consist of a number of database and storage servers up to the capacity of the rack, as defined within Oracle Exadata Configuration Assistant (OECA).

Additional database and storage servers can be added if space is available; see OECA for details. The upgrade process includes adding new servers and cables

Note:

It is possible to extend the hardware while the machine is online, and with no downtime. However, extreme care should be taken. In addition, patch application to existing switches and servers should be done before extending the hardware.

- [Removing the Doors](#)
This procedure describes how to remove the doors on Oracle Engineered System.
- [Adding New Switches](#)
You can add individual new RDMA Network Fabric switches as needed to meet growing resource requirements.
- [Adding New Servers](#)
For systems that are not an Eighth Rack, you can add new servers to an Oracle Engineered System Rack that is not at full capacity.
- [Cabling Database Servers](#)
- [Cabling Storage Servers](#)
After the new Storage Servers are installed, you need to connect them to the existing equipment.
- [Closing the Rack](#)
After installing new equipment, you must replace the panels and close the rack.

2.3.1 Removing the Doors

This procedure describes how to remove the doors on Oracle Engineered System.



Note:

For Oracle Engineered System X7 systems, refer to

- If you are adding hardware to an Oracle Engineered System X7 rack, refer to "Remove the Doors" in *Oracle Rack Cabinet 1242 User's Guide* at https://docs.oracle.com/cd/E85660_01/html/E87280/gshfw.html#scrolltoc.
- If you are adding hardware to an earlier Oracle Engineered System rack, then refer to "Remove the Doors" in *Sun Rack II User's Guide* at <https://docs.oracle.com/cd/E19657-01/html/E29153/z40004911007624.html#scrolltoc>.

2.3.2 Adding New Switches

You can add individual new RDMA Network Fabric switches as needed to meet growing resource requirements.

The instructions are different for X8M, RDMA over RoCE Network Fabric from the instruction for X8 and earlier, RDMA over InfiniBand Network Fabric

- [Adding a Cisco Nexus 9336C Switch \(Optional\)](#)
- [Adding a Sun Datacenter InfiniBand Switch 36 \(Optional\)](#)

2.3.2.1 Adding a Cisco Nexus 9336C Switch (Optional)

This procedure is for X8M, RDMA over RoCE Network Fabric.

- Extending a Oracle Engineered System X8M-2 to another X8M-2.
- Extending a Oracle Engineered System X8M-8 to another X8M-8.
- This is not applicable to X8 or earlier.



Note:

The steps in this procedure are specific to Oracle Engineered System. They are not the same as the steps in the Cisco Nexus manual.

1. Unpack the Cisco Nexus switch components from the packing cartons. The following items should be in the packing cartons:
 - Cisco Nexus 9336C-FX2 Switch
 - Cable bracket and rackmount kit
 - Cable management bracket and cover
 - Two rack rail assemblies

- Assortment of screws and captive nuts
- Cisco Nexus 9336C-FX2 Switch documentation

The service label procedure on top of the switch includes descriptions of the preceding items.

2. Remove the trough from the rack in RU1. Put the cables aside while installing the RDMA Network Fabric switch. The trough can be discarded.
3. Install cage nuts in each rack rail in the appropriate holes.
4. Attach the brackets with cutouts to the power supply side of the switch.
5. Attach the C-brackets to the switch on the side of the ports.
6. Slide the switch halfway into the rack from the front. Keep the switch to the left side of the rack as far as possible while pulling the two power cords through the C-bracket on the right side.
7. Slide the server in rack location U2 out to the locked service position. This improves access to the rear of the switch during further assembly.
8. Install the slide rails from the rear of the rack into the C-brackets on the switch, pushing them up to the rack rail.
9. Attach an assembled cable arm bracket to the slide rail and using a No. 3 Phillips screwdriver, screw these together into the rack rail:
 - a. Install the lower screw loosely with the cable arm bracket rotated 90 degrees downward. This allows better finger access to the screw.
 - b. Rotate the cable arm bracket to the correct position.
 - c. Install the upper screw.
 - d. Tighten both screws.

If available, a screwdriver with a long-shaft (16-inch / 400mm) will allow easier installation such that the handle is outside the rack and beyond the cabling.
10. Push the switch completely into the rack from the front, routing the power cords through the cutout on the rail bracket.
11. Secure the switch to the front rack rail with M6 16mm screws. Tighten the screws using the No. 3 Phillips screwdriver.
12. Install the lower part of the cable management arm across the back of the switch.
13. Connect the cables to the appropriate ports.
14. Install the upper part of the cable management arm.
15. Slide the server in rack location U2 back into the rack.
16. Install power cords to the switch power supply slots on the front.
17. Loosen the front screws to install the vented filler panel brackets. Tighten the screws, and snap on the vented filler panel in front of the switch.

 **See Also:**

- *Oracle Exadata Database Machine System Overview* to view the rack layout
- *Oracle Exadata Database Machine System Overview* for information about networking cables

2.3.2.2 Adding a Sun Datacenter InfiniBand Switch 36 (Optional)

This procedure applies to X8 and earlier, RDMA over InfiniBand Network Fabric.

- This is not applicable to Oracle Engineered System X8M.
- Upgrading a rack with Sun Fire X4170 Oracle Database Servers to Oracle Exadata Database Machine Half Rack or Oracle Exadata Database Machine Full Rack.
- Extending a Quarter Rack or Eighth Rack.
- Extending an Oracle Exadata Database Machine X4-2 rack.

 **Note:**

The steps in this procedure are specific to Oracle Exadata Database Machine. They are not the same as the steps in the Sun Datacenter InfiniBand Switch 36 manual.

1. Unpack the Sun Datacenter InfiniBand Switch 36 switch components from the packing cartons. The following items should be in the packing cartons:
 - Sun Datacenter InfiniBand Switch 36 switch
 - Cable bracket and rackmount kit
 - Cable management bracket and cover
 - Two rack rail assemblies
 - Assortment of screws and captive nuts
 - Sun Datacenter InfiniBand Switch 36 documentationThe service label procedure on top of the switch includes descriptions of the preceding items.
2. X5 racks only: Remove the trough from the rack in RU1 and put the cables aside while installing the Sun Datacenter InfiniBand Switch 36 switch. The trough can be discarded.
3. Install cage nuts in each rack rail in the appropriate holes.
4. Attach the brackets with cutouts to the power supply side of the switch.
5. Attach the C-brackets to the switch on the side of the Sun Datacenter InfiniBand Switch 36 ports.

6. Slide the switch halfway into the rack from the front. You need to keep it to the left side of the rack as far as possible while pulling the two power cords through the C-bracket on the right side.
7. Slide the server in rack location U2 out to the locked service position. This improves access to the rear of the switch during further assembly.
8. Install the slide rails from the rear of the rack into the C-brackets on the switch, pushing them up to the rack rail.
9. Attach an assembled cable arm bracket to the slide rail and using a No. 3 Phillips screwdriver, screw these together into the rack rail:
 - a. Install the lower screw loosely with the cable arm bracket rotated 90 degrees downward. This allows better finger access to the screw.
 - b. Rotate the cable arm bracket to the correct position.
 - c. Install the upper screw.
 - d. Tighten both screws.

If available, a screwdriver with a long-shaft (16-inch / 400mm) will allow easier installation such that the handle is outside the rack and beyond the cabling.
10. Push the switch completely into the rack from the front, routing the power cords through the cutout on the rail bracket.
11. Secure the switch to the front rack rail with M6 16mm screws. Tighten the screws using the No. 3 Phillips screwdriver.
12. Install the lower part of the cable management arm across the back of the switch.
13. Connect the cables to the appropriate ports.
14. Install the upper part of the cable management arm.
15. Slide the server in rack location U2 back into the rack.
16. Install power cords to the Sun Datacenter InfiniBand Switch 36 switch power supply slots on the front.
17. Loosen the front screws to install the vented filler panel brackets. Tighten the screws, and snap on the vented filler panel in front of the switch.

 **See Also:**

- [Oracle Exadata Database Machine System Overview](#) to view the rack layout
- [Oracle Exadata Database Machine System Overview](#) for information about InfiniBand networking cables

2.3.3 Adding New Servers

For systems that are not an Eighth Rack, you can add new servers to an Oracle Engineered System Rack that is not at full capacity.

You can add individual database or storage servers as needed to meet growing resource requirements using the Elastic Configuration method. Additional database

servers and storage servers can be added if space is available; see Oracle Exadata Configuration Assistant (OECA) for details. The upgrade process includes adding new servers and cables. Additional hardware may be required.

 **Note:**

- Always load equipment into the rack from the bottom up, so that the rack does not become top-heavy and tip over. Extend the rack anti-tip bar to prevent the rack from tipping during equipment installation.
- The new servers need to be configured manually.

- [Preparing to Install New Servers](#)
Before you install a new server, prepare the rack unit for the server installation.
- [Installing the Rack Assembly](#)
After preparing for installation, you next install the rack assembly to hold the new servers.
- [Installing the Server](#)
After preparing for the installation and installing the rack assembly, you then install the new server.

Related Topics

- [Setting Up New Servers](#)
New servers need to be configured when extending Oracle Engineered System Elastic Configurations.

2.3.3.1 Preparing to Install New Servers

Before you install a new server, prepare the rack unit for the server installation.

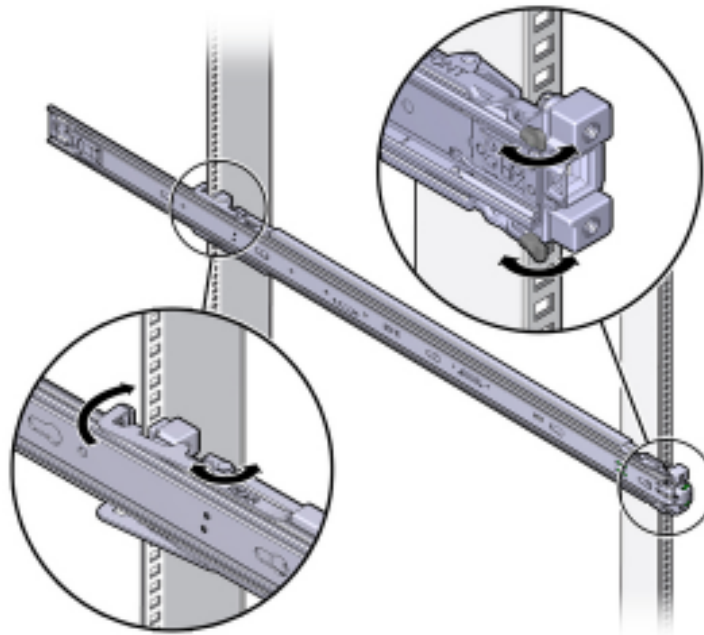
1. Identify the rack unit where the server will be installed. Fill the first available unit, starting from the bottom of the rack.
2. Remove and discard the trough, which attaches the cable harness when no server is installed in the unit.
3. Remove and discard the solid filler.

2.3.3.2 Installing the Rack Assembly

After preparing for installation, you next install the rack assembly to hold the new servers.

1. Position a mounting bracket against the chassis so that the slide-rail lock is at the server front, and the five keyhole openings on the mounting bracket are aligned with the five locating pins on the side of the chassis.
2. Orient the slide-rail assembly so that the ball-bearing track is forward and locked in place.
3. Starting on either side of the rack, align the rear of the slide-rail assembly against the inside of the rear rack rail, and push until the assembly locks into place with an audible click.

Figure 2-1 Locking the Slide-Rail Assembly Against the Inside of the Rear Rack Rail



4. Align the front of the slide-rail assembly against the outside of the front rack rail, and push until the assembly locks into place and you hear the click.
5. Repeat steps 2 to 4 on the other side on the rack.

2.3.3.3 Installing the Server

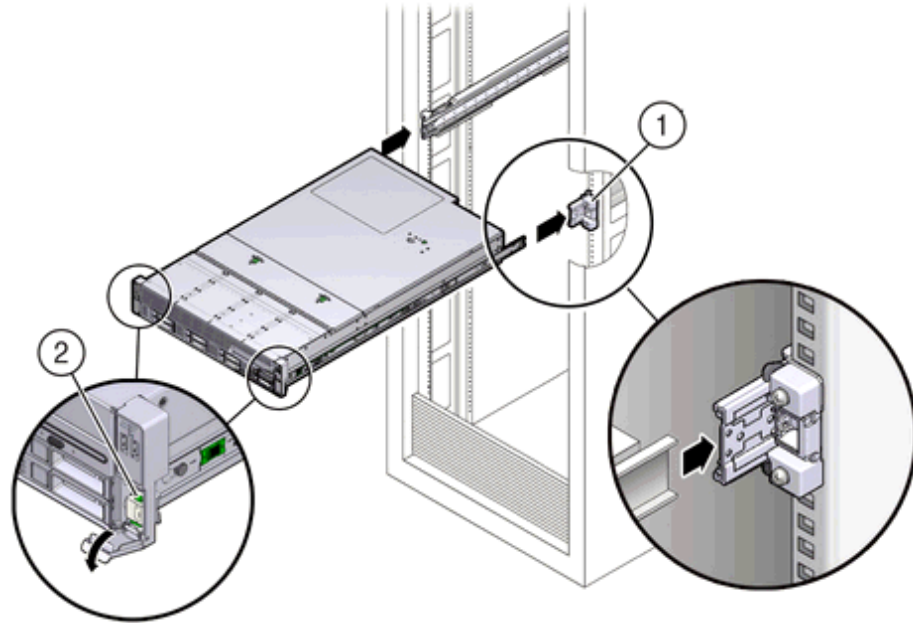
After preparing for the installation and installing the rack assembly, you then install the new server.

⚠ WARNING:

- Installing a server requires a minimum of two people or a lift because of the weight of each server. Attempting this procedure alone can result in equipment damage, personal injury, or both.
- Always load equipment into the rack from the bottom up, so that the rack does not become top-heavy and tip over. Extend the rack anti-tip bar to prevent the rack from tipping during equipment installation.

1. Read the service label on the top cover of the server before installing a server into the rack.
2. Push the server into the slide rail assembly:
 - a. Push the slide rails into the slide rail assemblies as far as possible.
 - b. Position the server so the rear ends of the mounting brackets are aligned with the slide rail assemblies mounted in the equipment rack.

Figure 2-2 Aligning the Rear Ends of the Mounting Brackets with the Slide Rail Assemblies in the Rack



The callouts in the preceding image highlight the following:

- 1: Mounting bracket inserted into slide rail
- 2: Slide-rail release lever
- c. Insert the mounting brackets into the slide rails, and push the server into the rack until the mounting brackets encounter the slide rail stops, approximately 30 cm (12 inches).
- d. Simultaneously push down and hold the slide rail release levers on each mounting bracket while pushing the server into the rack.

 **Note:**

Oracle recommends that two people push the servers into the rack: one person to move the server in and out of the rack, and another person to watch the cables and cable management arm (CMA).

- e. Continue pushing until the slide rail locks on the front of the mounting brackets engage the slide rail assemblies, and you hear the click.
3. Cable the new server as described in [Cabling Exadata Storage Servers](#).

2.3.4 Cabling Database Servers

After the new database servers are installed, they need to be cabled to the existing equipment. The following procedure describes how to cable the new equipment in the rack. The images shown in the procedure are of a Sun Fire X4170 M2 Oracle Database Server.

 **Note:**

- The existing cable connections in the rack do not change.
- The blue cables connect to Oracle Database servers, and the black cables connect to Exadata Storage Servers. These network cables are for the NET0 Ethernet interface port.
- Attach and route the management cables on the CMA and rear panel one server at a time. Do not slide out more than one server at a time.
- Start from the bottom of the rack, and work upward. Route the cables through the CMA with the dongle on the top and power cables on the bottom.
- Longer hook and loop straps are needed when cabling three CAT5e cables or two TwinAx cables.

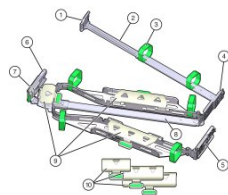
1. Connect the CAT5e cables, AC power cables, and USB to their respective ports on the rear of the server. Ensure the flat side of the dongle is flush against the CMA inner rail.

Figure 2-3 Cables at the Rear of the Server



2. Adjust the green cable management arm (CMA) brackets

Figure 2-4 Cable Management Arm (CMA) Brackets



Description of the CMA callouts in the preceding image"

- a. Connector A

- b. Front slide bar
 - c. Velcro straps (6)
 - d. Connector B
 - e. Connector C
 - f. Connector D
 - g. Slide-rail latching bracket (used with connector D)
 - h. Rear slide bar
 - i. Cable covers
 - j. Cable covers
3. Attach the CMA to the server.
 4. Route the CAT5e and power cables through the wire clip.

Figure 2-5 Cables Routed Through the Cable Management Arm



5. Bend the CAT5e and power cables to enter the CMA, while adhering to the bend radius minimums.
6. Secure the CAT5e and power cables under the cable clasps.

Figure 2-6 Cables Secured under the Cable Clasps



7. Route the cables through the CMA, and secure them with hook and loop straps at equal intervals.

Figure 2-7 Cables Secured with Hook and Loop Straps at Regular Intervals



8. Connect the RDMA Network Fabric or TwinAx cables with the initial bend resting on the CMA. The TwinAx cables are for client access to the database servers.

Figure 2-8 RDMA Network Fabric or TwinAx Cables Positioned on the CMA



9. Secure the RDMA Network Fabric or TwinAx cables with hook and loop straps at equal intervals.

Figure 2-9 RDMA Network Fabric or TwinAx Cables Secured with Hook and Loop Straps at Regular Intervals



10. Route the fiber core cables.
11. Rest the cables over the green clasp on the CMA.
12. Attach the red ILOM cables to the database server.
13. Attach the network cables to the Oracle Database server.
14. Attach the cables from Oracle Database server to the RDMA Network Fabricswitches.
15. Connect the orange Ethernet cable to the KVM switch.
16. Connect the red and blue Ethernet cables to the Cisco switch.
17. Verify operation of the slide rails and CMA for each server, as follows:

 **Note:**

Oracle recommends that two people do this step. One person to move the server in and out of the rack, and another person to observe the cables and CMA.

- a. Slowly pull the server out of the rack until the slide rails reach their stops.
 - b. Inspect the attached cables for any binding or kinks.
 - c. Verify the CMA extends fully from the slide rails.
18. Push the server back into the rack, as follows:
- a. Release the two sets of slide rail stops.
 - b. Push in both levers simultaneously, and slide the server into the rack. The first stop in the set are levers located on the inside of each slide rail, just behind the back panel of the server. The levers are labeled `PUSH`. The server slides approximately 46 cm (18 inches) and stop.
 - c. Verify the cables and CMA retract without binding.
 - d. Simultaneously push or pull both slide rail release buttons, and push the server completely into the rack until both slide rails engage. The second stop in the set are the slide rail release buttons located near the front of each mounting bracket.
19. Dress the cables, and then tie off the cables with the straps. Oracle recommends the cables should be dressed in bundles of eight or less.
20. Extend and then fully retract the server to check cable travel by sliding each server out and back fully to ensure that the cables are not binding or catching.
21. Repeat the procedure for the rest of the servers.
22. Connect the power cables to the power distribution units (PDUs). Ensure the breaker switches are in the OFF position before connecting the power cables. Do not plug the power cables into the facility receptacles at this time.

See Also:

- *Oracle Exadata Database Machine System Overview* for cabling tables
- "[Reviewing the Cable Management Arm Guidelines](#)" for the bend radius minimums
- "[Floor and Underfloor Delivery of InfiniBand Cables](#)"

2.3.5 Cabling Storage Servers

After the new Storage Servers are installed, you need to connect them to the existing equipment.

The following procedure describes how to cable the new equipment in the rack.

Note:

- The existing cable connections in the rack do not change.
- The blue cables connect to Oracle Database servers, and the black cables connect to Exadata Storage Servers. These network cables are for the NET0 Ethernet interface port.
- Attach and route the management cables on the CMA and rear panel one server at a time. Do not slide out more than one server at a time.
- Start from the bottom of the rack, and work upward.
- Longer hook and loop straps are needed when cabling three CAT5e cables or two TwinAx cables.

1. Attach a CMA to the server.
2. Insert the cables into their ports through the hook and loop straps, then route the cables into the CMA in this order:
 - a. Power
 - b. Ethernet
 - c. RDMA Network Fabric

Figure 2-10 Rear of the Server Showing Power and Network Cables



3. Route the cables through the CMA and secure them with hook and loop straps on both sides of each bend in the CMA.

Figure 2-11 Cables Routed Through the CMA and Secured with Hook and Loop Straps



4. Close the crossbar covers to secure the cables in the straightaway.
5. Verify operation of the slide rails and the CMA for each server:

 **Note:**

Oracle recommends that two people do this step: one person to move the server in and out of the rack, and another person to watch the cables and the CMA.

- a. Slowly pull the server out of the rack until the slide rails reach their stops.
- b. Inspect the attached cables for any binding or kinks.
- c. Verify that the CMA extends fully from the slide rails.
6. Push the server back into the rack:
 - a. Release the two sets of slide rail stops.
 - b. Locate the levers on the inside of each slide rail, just behind the back panel of the server. They are labeled PUSH.
 - c. Simultaneously push in both levers and slide the server into the rack, until it stops in approximately 46 cm (18 inches).
 - d. Verify that the cables and CMA retract without binding.
 - e. Locate the slide rail release buttons near the front of each mounting bracket.
 - f. Simultaneously push in both slide rail release buttons and slide the server completely into the rack, until both slide rails engage.
7. Dress the cables, and then tie off the cables with the straps. Oracle recommends that you dress the RDMA Network Fabric cables in bundles of eight or fewer.
8. Slide each server out and back fully to ensure that the cables are not binding or catching.
9. Repeat the procedure for all servers.
10. Connect the power cables to the power distribution units (PDUs). Ensure the breaker switches are in the OFF position before connecting the power cables. Do not plug the power cables into the facility receptacles now.

 **See Also:**[Multi-Rack Cabling Tables](#)

Oracle Exadata Database Machine System Overview for the cabling tables for your system

2.3.6 Closing the Rack

After installing new equipment, you must replace the panels and close the rack.

There are two rack models in use with Oracle Engineered System Racks. Refer to the appropriate documentation for the most up-to-date steps:

- *Oracle Rack Cabinet 1242 User's Guide* at http://docs.oracle.com/cd/E85660_01/html/E87280/index.html
- *Sun Rack II User's Guide* at <https://docs.oracle.com/cd/E19657-01/html/E29153/index.html>

The following steps provide an overview of the process.

1. Replace the rack front and rear doors as follows:
 - a. Retrieve the doors, and place them carefully on the door hinges.
 - b. Connect the front and rear door grounding strap to the frame.
 - c. Close the doors.
 - d. (Optional) Lock the doors. The keys are in the shipping kit.
2. (Optional) Replace the side panels, if they were removed for the upgrade, as follows:
 - a. Lift each side panel up and onto the side of the rack. The top of the rack should support the weight of the side panel. Ensure the panel fasteners line up with the grooves in the rack frame.
 - b. Turn each side panel fastener one-quarter turn clockwise using the side panel removal tool. Turn the fasteners next to the panel lock clockwise. There are 10 fasteners per side panel.
 - c. (Optional) Lock each side panel. The key is in the shipping kit. The locks are located on the bottom, center of the side panels.
 - d. Connect the grounding straps to the side panels.

After closing the rack, proceed to [Configuring the New Hardware](#) to configure the new hardware.

2.4 Extending a Rack by Adding Another Rack

Extending your Oracle Engineered System Rack by adding another rack consists of cabling and configuring the racks together.

Racks up to model X8 can be cabled together with no downtime. X8M and newer racks might require downtime when cabling racks together.

⚠ WARNING:

Cabling within a live network must be done carefully in order to avoid potentially serious disruptions.

- [Overview of Adding Another Rack to an Existing System](#)
Review the following notes before cabling racks together.
- [Cabling Two Racks Together](#)
The simplest case of extending an Engineered System rack is to cable two racks together.
- [Cabling Several Racks Together](#)
You can cable several racks together by following a series of steps in a specific order.

2.4.1 Overview of Adding Another Rack to an Existing System

Review the following notes before cabling racks together.

- There is some performance degradation while cabling the racks together, for models up to X8. This degradation results from reduced network bandwidth, and the data retransmission due to packet loss when a cable is unplugged.
- When connecting racks up to model X8-2, the environment is not a high-availability environment because one leaf switch will need to be off. All traffic goes through the remaining leaf switch.
- Only the existing racks are operational when adding racks. The servers on any new racks must be powered down.
- The software running on the systems cannot have problems related to RDMA Network Fabric restarts. To verify the configuration, before connecting multiple racks together, run `infinicheck` without the performance tests (use the `-e` option).
- It is assumed that each Oracle Engineered System Rack has three RDMA Network Fabric switches already installed.
- The new racks have been configured with the appropriate IP addresses to be migrated into the expanded system prior to any cabling, and there are no duplicate IP addresses.
- The procedures for extending X8M racks with RDMA over RoCE Network Fabric are different than the procedures for racks with RDMA over InfiniBand Network Fabric (X8 and earlier.)
- For X8M racks, the Oracle Engineered System needs one loopback IP interface per spine. The IP addressing scheme uses IANA 'Shared Address Space' 100.64.0.0/10. This ensures that there is no overlap with IPv4 addresses in the network using other schemes.
 - Leaf loopback0 IPs are assigned as 100.64.0.101, 100.64.0.102, 100.64.0.103, and so on.
 - Spine loopback0 IPs are assigned as 100.64.0.201, 100.64.0.202, up to 100.64.0.208.

2.4.2 Cabling Two Racks Together

The simplest case of extending an Engineered System rack is to cable two racks together.

- [Cabling Two Racks Together–X8M](#)
Use this procedure to cable together two racks that both use RDMA over RoCE Network Fabric.
- [Cabling Two Racks Together–X8 and Earlier](#)
Use this procedure to cable together two racks that both use RDMA over InfiniBand Network Fabric.

Related Topics

- [Multi-Rack Cabling Tables for Oracle Engineered System Rack X2 to X8](#)
- [Multi-Rack Cabling Tables for Oracle Engineered System Rack X8M](#)
- [Cabling Diagrams for a Rack](#)

2.4.2.1 Cabling Two Racks Together–X8M

Use this procedure to cable together two racks that both use RDMA over RoCE Network Fabric.

 **Note:**

Cabling two X8M racks together requires downtime for both racks.

In this procedure, the existing rack is R1, and the new rack is R2.

1. Ensure the new rack is near the existing rack.
The RDMA Network Fabric cables must be able to reach the servers in each rack.
2. Ensure you have a backup of the current switch configuration for each switch in the existing and new rack.
For each switch, complete the steps in the Oracle Exadata Database Machine Maintenance Guide, section Backing Up Settings on the RDMA over RoCE Network Fabric Switch.
3. Shut down all servers on both the new rack (R2) and the existing rack (R1).
The switches should remain available.
4. Apply the multi-rack spine switch configuration to the two spine switches.
 - a. Log in to the server that has downloaded the RDMA network switch patch ZIP file for the latest release.
If you do not have the patch ZIP file available, you can download the patch for your Oracle Exadata System Software release. For example, for 19.3 release, the patch is 29963277- RDMA network switch (7.0(3)17(6)) and InfiniBand network switch (2.2.13-2).
 - b. Make a copy of the golden configuration file for each switch.

After extracting the patch ZIP file, run these commands from patch directory:

```
# cp roce_switch_templates/roce_spine_switch_multi.cfg
roce_spine_switch_multi_R1SS.cfg
# cp roce_switch_templates/roce_spine_switch_multi.cfg
roce_spine_switch_multi_R2SS.cfg
```

- c. Edit each copy of the spine switch configuration file.

Using a text editor, replace each occurrence of %SPINE_LOOPBACK_IP0% with the correct IP address for the switch, as indicated in the table below.

Switch	SPINE_LOOPBACK_IP0
Rack 1 spine switch (R1SS)	100.64.0.201
Rack 2 spine switch (R2SS)	100.64.0.202

- d. Apply the updated multi-rack configuration file to its corresponding spine switch.

- i. Log in to each spine switch, and remove the existing configuration file using the following command:

```
delete bootflash:roce_spine_switch_multi.cfg
```

For example:

```
rack1sw-roces0(config)# delete
bootflash:roce_spine_switch_multi.cfg
Do you want to delete "/roce_spine_switch_multi.cfg" ? (yes/no/
abort) [y] y
rack1sw-roces0(config)#
```

- ii. Log in to the server that contains the modified configuration files, and copy each file to its corresponding spine switch.

```
# scp roce_spine_switch_multi_R1SS.cfg admin@R1SS_IP_Address:/
# scp roce_spine_switch_multi_R2SS.cfg admin@R2SS_IP_Address:/
```

- iii. Log in to each switch again, and copy the modified configuration into flash.

On the spine switch for rack 1, you would use the following commands:

```
run-script bootflash:roce_spine_switch_multi_R1SS.cfg | grep
'none'
copy running-config startup-config
```

On the spine switch for rack 2, you would use the following commands:

```
run-script bootflash:roce_spine_switch_multi_R2SS.cfg | grep
'none'
copy running-config startup-config
```

5. Apply the multi-rack leaf switch configuration to the four leaf switches.

For each switch, complete the following steps, where *SW#* represents the values R1LL, R1UL, R2LL, or R2UL, depending on which switch you are configuring.

- a. Log in to the server that has downloaded the RDMA network switch patch ZIP file for the latest release.
- b. Make a copy of the golden configuration file for each leaf switch.

After extracting the patch ZIP file, run the following command four times from the patch directory, substituting for *SW#* the values R1LL, R1UL, R2LL, and R2UL.

```
# cp roce_switch_templates/roce_leaf_switch_multi.cfg
roce_leaf_switch_multi_SW#.cfg
```

- c. Edit each copy of the leaf switch configuration file to replace the loopback IP addresses.

Using a text editor, replace each occurrence of `%LEAF_LOOPBACK_IP0%` and `%LEAF_LOOPBACK_IP1%` with the correct IP addresses for the leaf switch, as indicated in the table below.

The scheme used for loopback IP addresses for the leaf switches in a 2-rack system is:

Switch	LEAF_LOOPBACK_IP0	LEAF_LOOPBACK_IP1
Rack 1 Lower Leaf switch (R1LL)	100.64.0.101	100.64.1.101
Rack 1 Upper Leaf switch (R1UL)	100.64.0.102	100.64.1.102
Rack 2 Lower Leaf switch (R2LL)	100.64.0.103	100.64.1.103
Rack 2 Upper Leaf switch (R2UL)	100.64.0.104	100.64.1.104

- d. Apply the updated multi-rack configuration files to each corresponding leaf switch.
 - i. Log in to each leaf switch, and remove the existing configuration file using the following command:

```
delete bootflash:roce_leaf_switch.cfg
```

For example:

```
rack1sw-rocea0(config)# delete bootflash:roce_leaf_switch.cfg
Do you want to delete "/roce_leaf_switch.cfg" ? (yes/no/abort)
[y] y
rack1sw-rocea0(config)#
```

- ii. Log in to the server that contains the modified configuration files, and copy each file to its corresponding leaf switch.

```
# scp roce_leaf_switch_multi_SW#.cfg admin@SW#_IP_Address: /
```

- iii. Log in to each switch again, and copy the modified configuration into flash.

On the upper leaf switch for rack 1, you would use the following commands:

```
run-script bootflash:roce_leaf_switch_multi_R1UL.cfg | grep
'none'
copy running-config startup-config
```

On the lower leaf switch for rack 2, you would use the following commands:

```
run-script bootflash:roce_leaf_switch_multi_R2LL.cfg | grep
'none'
copy running-config startup-config
```

6. Use `patchmgr` to verify the configuration of the RDMA Network Fabric switches against the golden configuration files.

- a. Create a file that contains the name or IP address of the leaf and spine switches on both racks.

For example, you create a file name `roce_switches.lst`. The file must contain the host name or IP address for the 2 spine switches and 4 leaf switches, with each switch on a new line.

- b. Run `patchmgr` with the `--verify_config` option.

In the following command, `roce_switches.lst` is a file that contains the switches to be queried, one per line.

```
./patchmgr --roceswitches roce_switches.lst --verify-config
```

7. Perform the physical cabling of the switches.

- a. In Rack 2, remove the eight existing inter-switch connections between the two leaf switches, R2UL and R2LL.
- b. In Rack 2, cable each leaf switch using the tables in [Two-Rack Cabling for X8M Racks](#).
- c. In Rack 1, remove the eight existing inter-switch connections between the two leaf switches, R1UL and R1LL.
- d. In Rack 1, cable each leaf switch using the tables in [Two-Rack Cabling for X8M Racks](#).

8. Confirm each switch is available and connected.

For each of the 6 switches, confirm the switch shows "connected" and "100G". In the following example, the leaf switches are ports Eth1/4 to Eth1/7, and Eth1/30 to Eth1/33. The spine switches are ports Eth1/5 to Eth1/20.

When run from a spine switch, the output should be similar to the following:

```
rack1sw-roces0# show interface status
-----
-----
Port          Name          Status      Vlan      Duplex  Speed
Type
-----
-----
```

```

mgmt0      --                connected routed    full    1000    --
-----
Port      Name                Status  Vlan    Duplex  Speed
Type
-----
...
Eth1/5    RouterPort5          connected routed    full    100G
QSFP-100G-CR4
Eth1/6    RouterPort6          connected routed    full    100G
QSFP-100G-SR4
Eth1/7    RouterPort7          connected routed    full    100G
QSFP-100G-CR4
Eth1/8    RouterPort8          connected routed    full    100G
QSFP-100G-SR4
Eth1/9    RouterPort9          connected routed    full    100G
QSFP-100G-CR4
Eth1/10   RouterPort10         connected routed    full    100G
QSFP-100G-SR4
Eth1/11   RouterPort11         connected routed    full    100G
QSFP-100G-CR4
Eth1/12   RouterPort12         connected routed    full    100G
QSFP-100G-SR4
Eth1/13   RouterPort13         connected routed    full    100G
QSFP-100G-CR4
Eth1/14   RouterPort14         connected routed    full    100G
QSFP-100G-SR4
Eth1/15   RouterPort15         connected routed    full    100G
QSFP-100G-CR4
Eth1/16   RouterPort16         connected routed    full    100G
QSFP-100G-SR4
Eth1/17   RouterPort17         connected routed    full    100G
QSFP-100G-CR4
Eth1/18   RouterPort18         connected routed    full    100G
QSFP-100G-SR4
Eth1/19   RouterPort19         connected routed    full    100G
QSFP-100G-CR4
Eth1/20   RouterPort20         connected routed    full    100G
QSFP-100G-SR4
Eth1/21   RouterPort21         xcvrAbsen  routed    full
100G      --
...

```

When run from a leaf switch, the output should be similar to the following:

```

rack1sw-rocea0# show interface status
-----
Port      Name                Status  Vlan    Duplex  Speed
Type
-----
mgmt0      --                connected routed    full    1000    --

```

```

-----
Port          Name                Status  Vlan  Duplex  Speed
Type
-----
...
Eth1/4       RouterPort1         connected routed  full   100G
QSFP-100G-CR4
Eth1/5       RouterPort2         connected routed  full   100G
QSFP-100G-CR4
Eth1/6       RouterPort3         connected routed  full   100G
QSFP-100G-CR4
Eth1/7       RouterPort4         connected routed  full   100G
QSFP-100G-CR4
Eth1/8       celadm14            connected 3888   full   100G
QSFP-100G-CR4
...
Eth1/29      celadm01            connected 3888   full   100G
QSFP-100G-CR4
Eth1/30      RouterPort5         connected routed  full   100G
QSFP-100G-SR4
Eth1/31      RouterPort6         connected routed  full   100G
QSFP-100G-SR4
Eth1/32      RouterPort7         connected routed  full   100G
QSFP-100G-SR4
Eth1/33      RouterPort8         connected routed  full   100G
QSFP-100G-SR4
...
  
```

9. Verify each switch is able to see the switches it is connected to.

Check the neighbor discovery for every switch in racks R1 and R2. Make sure that all switches are visible and check the switch ports assignment (leaf switches: ports Eth1/4 - Eth1/7, Eth1/30 - Eth1/33; spine switches: ports Eth1/5 - Eth1/20) against the tables in [Two-Rack Cabling for X8M Racks](#).

Log in to each switch and use the `show lldp neighbors` command. A spine switch should see the two leaf switches in each rack, but not the other spine switch. The output for a spine switch should be similar to the following:

```

rack1sw-roces0# show lldp neighbors
...
Device ID          Local Intf      Hold-time  Capability  Port ID
rack1-adm0         mgmt0           120        BR          Ethernet1/47
rack1sw-roceb0     Eth1/5        120        BR          Ethernet1/5
rack2sw-roceb0     Eth1/6        120        BR          Ethernet1/5
rack1sw-roceb0     Eth1/7        120        BR          Ethernet1/7
rack2sw-roceb0     Eth1/8        120        BR          Ethernet1/7
rack1sw-roceb0     Eth1/9        120        BR          Ethernet1/4
rack2sw-roceb0     Eth1/10       120        BR          Ethernet1/4
rack1sw-roceb0     Eth1/11       120        BR          Ethernet1/6
rack2sw-roceb0     Eth1/12       120        BR          Ethernet1/6
rack1sw-rocea0     Eth1/13       120        BR          Ethernet1/5
rack2sw-rocea0     Eth1/14       120        BR          Ethernet1/5
rack1sw-rocea0     Eth1/15       120        BR          Ethernet1/7
  
```

```

rack2sw-rocea0      Eth1/16    120      BR      Ethernet1/7
rack1sw-rocea0      Eth1/17    120      BR      Ethernet1/4
rack2sw-rocea0      Eth1/18    120      BR      Ethernet1/4
rack1sw-rocea0      Eth1/19    120      BR      Ethernet1/6
rack2sw-rocea0      Eth1/20    120      BR      Ethernet1/6
Total entries displayed: 17
  
```

Each leaf switch should see the two spine switches, but not the other leaf switches. The output for a leaf switch should be similar to the following:

```

rack1sw-rocea0# show lldp neighbors
...
Device ID           Local Intf      Hold-time  Capability  Port ID
switch              mgmt0          120        BR          Ethernet1/46
rack1sw-roces0      Eth1/4         120        BR          Ethernet1/17
rack1sw-roces0      Eth1/5         120        BR          Ethernet1/13
rack1sw-roces0      Eth1/6         120        BR          Ethernet1/19
rack1sw-roces0      Eth1/7         120        BR          Ethernet1/15
rack2sw-roces0      Eth1/30        120        BR          Ethernet1/17
rack2sw-roces0      Eth1/31        120        BR          Ethernet1/13
rack2sw-roces0      Eth1/32        120        BR          Ethernet1/19
rack2sw-roces0      Eth1/33        120        BR          Ethernet1/15
rocetoi-ext-sw      Eth1/36        120        BR          Ethernet1/49
Total entries displayed: 10
  
```

10. Power on all servers in racks R1 and R2.
11. For each rack, confirm the multi-rack cabling by running the `verify_roce_cables.py` script.

Refer to My Oracle Support Doc ID 2587717.1 for download and usage instructions.

 **Note:**

For the ports on the leaf and spine switches that were cabled for the RDMA Network Fabric, ignore the FAIL status in the column "CABLE OK?". For the other ports on the switches (for database servers, storage servers, etc.) the status should be OK.

The following output is a partial example of the command results:

```

# ./verify_roce_cables.py -n nodes.rack1 -s switches.rack1
SWITCH PORT (EXPECTED PEER) LEAF-1 (rack1sw-rocea0) : CABLE OK? LEAF-2 (rack1sw-roceb0) : CABLE OK?
-----
Eth1/4 (ISL peer switch) : rack1sw-roces0 Ethernet1/17 : FAIL rack1sw-roces0
Ethernet1/9 : FAIL
Eth1/5 (ISL peer switch) : rack1sw-roces0 Ethernet1/13 : FAIL rack1sw-roces0
Ethernet1/5 : FAIL
Eth1/6 (ISL peer switch) : rack1sw-roces0 Ethernet1/19 : FAIL rack1sw-roces0
Ethernet1/11: FAIL
  
```

```

Eth1/7 (ISL peer switch) : rack1sw-roces0 Ethernet1/15 : FAIL      rack1sw-roces0
Ethernet1/7 : FAIL
Eth1/12 (celadm10)      : rack1celadm10 port-1      : OK      rack1celadm10
port-2                  : OK
Eth1/13 (celadm09)     : rack1celadm09 port-1     : OK      rack1celadm09
port-2                  : OK
Eth1/14 (celadm08)     : rack1celadm08 port-1     : OK      rack1celadm08
port-2                  : OK
...
Eth1/15 (adm08)        : rack1dbadm08 port-1     : OK      rack1dbadm08
port-2                  : OK
Eth1/16 (adm07)        : rack1dbadm07 port-1     : OK      rack1dbadm07
port-2                  : OK
Eth1/17 (adm06)        : rack1dbadm06 port-1     : OK      rack1dbadm06
port-2                  : OK
...
Eth1/30 (ISL peer switch) : rack2sw-roces0 Ethernet1/17 : FAIL      rack2sw-roces0
Ethernet1/9 : FAIL
Eth1/31 (ISL peer switch) : rack2sw-roces0 Ethernet1/13 : FAIL      rack2sw-roces0
Ethernet1/5 : FAIL
Eth1/32 (ISL peer switch) : rack2sw-roces0 Ethernet1/19 : FAIL      rack2sw-roces0
Ethernet1/11: FAIL
Eth1/33 (ISL peer switch) : rack2sw-roces0 Ethernet1/15 : FAIL      rack2sw-roces0
Ethernet1/7 : FAIL

# ./verify_roce_cables.py -n nodes.rack2 -s switches.rack2
SWITCH PORT (EXPECTED PEER) LEAF-1 (rack1sw-rocea0)      : CABLE OK? LEAF-2 (rack1sw-
roceb0)      : CABLE OK?
-----
-----
Eth1/4 (ISL peer switch) : rack1sw-roces0 Ethernet1/18 : FAIL      rack1sw-roces0
Ethernet1/10: FAIL
...
    
```

12. Confirm the network status in the current cluster between database servers and storage servers using the `infinicheck` command.

Complete the steps documented in Verifying RDMA Network Fabric based on ROCE Operation.

```

# /opt/oracle.SupportTools/ibdiagtools/infinicheck -z

# /opt/oracle.SupportTools/ibdiagtools/infinicheck -g hosts.lst -c
cells.lst -b

INFINICHECK
[Network Connectivity, Configuration and Performance]

##### FABRIC TYPE TESTS #####
System type identified: RoCE
Verifying User Equivalence of user=root from all DBs to all CELLS.
##### RoCE CONFIGURATION TESTS #####
Checking for presence of RoCE devices on all DBs and CELLS
[SUCCESS]... RoCE devices on all DBs and CELLS look good
Checking for RoCE Policy Routing settings on all DBs and CELLS
    
```

```
[SUCCESS]... RoCE Policy Routing settings look good
    Checking for RoCE DSCP ToS mapping on all DBs and CELLS
[SUCCESS]... RoCE DSCP ToS settings look good
    Checking for RoCE PFC settings and DSCP mapping on all DBs and
CELLs
[SUCCESS]... RoCE PFC and DSCP settings look good
    Checking for RoCE interface MTU settings. Expected value : 2300
[SUCCESS]... RoCE interface MTU settings look good
    Verifying switch advertised DSCP on all DBs and CELLS ports ( )
[SUCCESS]... Advertised DSCP settings from RoCE switch looks good
#### CONNECTIVITY TESTS ####
[COMPUTE NODES -> STORAGE CELLS]
    (60 seconds approx.)
    (Will walk through QoS values: 0-6) [SUCCESS].....Results OK
[SUCCESS]..... All can talk to all storage cells
[COMPUTE NODES -> COMPUTE NODES]
...

```

13. After cabling the racks together, proceed to [Configuring the New Hardware](#) to finish the configuration of the new rack.

Related Topics

- [Verify RoCE Cabling on Oracle Exadata Database Machine X8M-2 and X8M-8 Servers \(My Oracle Support Doc ID 2587717.1\)](#)

2.4.2.2 Cabling Two Racks Together—X8 and Earlier

Use this procedure to cable together two racks that both use RDMA over InfiniBand Network Fabric.

This procedure assumes that the racks are adjacent to each other.

In the procedure, the existing rack is R1, and the new rack is R2.

1. Set the priority of the current, active Subnet Manager Master to 10 on the spine switch, as follows:
 - a. Log in to any RDMA Network Fabric switch on the active system.
 - b. Use the `getmaster` command to determine that the Subnet Manager Master is running on the spine switch. If it is not, then follow the procedure [Setting the Subnet Manager Master on Oracle Exadata Database Machine Full Rack and Oracle Exadata Database Machine Half Rack in *Oracle Exadata Database Machine Installation and Configuration Guide*](#).
 - c. Log in to the spine switch.
 - d. Use the `disablesm` command to stop Subnet Manager.
 - e. Use the `setsmpriority 10` command to set the priority to 10.
 - f. Use the `enablesm` command to restart Subnet Manager.
 - g. Repeat step 1.b to ensure the Subnet Manager Master is running on the spine switch.
2. Ensure the new rack is near the existing rack. The RDMA Network Fabric cables must be able to reach the servers in each rack.
3. Completely shut down the new rack (R2).

4. Cable the two leaf switches R2 IB2 and R2 IB3 in the new rack according to [Two-Rack Cabling](#). Note that you need to first remove the seven existing inter-switch connections between each leaf switch, as well as the two connections between the leaf switches and the spine switch in the new rack R2, not in the existing rack R1.
5. Verify both RDMA Network Fabric interfaces are up on all database nodes and storage cells. You can do this by running the `ibstat` command on each node and verifying both interfaces are up.
6. Power off leaf switch R1 IB2. This causes all the database servers and Exadata Storage Servers to fail over their RDMA Network Fabric traffic to R1 IB3.
7. Disconnect all seven inter-switch links between R1 IB2 and R1 IB3, as well as the one connection between R1 IB2 and the spine switch R1 IB1.
8. Cable leaf switch R1 IB2 according to [Two-Rack Cabling](#).
9. Power on leaf switch R1 IB2.
10. Wait for three minutes for R1 IB2 to become completely operational.
To check the switch, log in to the switch and run the `ibswitches` command. The output should show three switches, R1 IB1, R1 IB2, and R1 IB3.
11. Verify both RDMA Network Fabric interfaces are up on all database nodes and storage cells. You can do this by running the `ibstat` command on each node and verifying both interfaces are up.
12. Power off leaf switch R1 IB3. This causes all the database servers and storage servers to fail over their RDMA Network Fabric traffic to R1 IB2.
13. Disconnect the one connection between R1 IB3 and the spine switch R1 IB1.
14. Cable leaf switch R1 IB3 according to [Two-Rack Cabling](#).
15. Power on leaf switch R1 IB3.
16. Wait for three minutes for R1 IB3 to become completely operational.
To check the switch, log in to the switch and run the `ibswitches` command. The output should show three switches, R1 IB1, R1 IB2, and R1 IB3.
17. Power on all the InfiniBand switches in R2.
18. Wait for three minutes for the switches to become completely operational.
To check the switch, log in to the switch and run the `ibswitches` command. The output should show six switches, R1 IB1, R1 IB2, R1 IB3, R2 IB1, R2 IB2, and R2 IB3.
19. Ensure the Subnet Manager Master is running on R1 IB1 by running the `getmaster` command from any switch.
20. Power on all servers in R2.
21. Log in to spine switch R1 IB1, and lower its priority to 8 as follows:
 - a. Use the `disableesm` command to stop Subnet Manager.
 - b. Use the `setsmpriority 8` command to set the priority to 8.
 - c. Use the `enableesm` command to restart Subnet Manager.
22. Ensure Subnet Manager Master is running on one of the spine switches.

After cabling the racks together, proceed to [Configuring the New Hardware](#) to configure the racks.

2.4.3 Cabling Several Racks Together

You can cable several racks together by following a series of steps in a specific order.

This procedure assumes that the racks are adjacent to each other. The existing racks are R1, R2, ... Rn, the new rack is Rn+1. For example, if you have four racks and you are adding a fifth, the existing racks would be R1, R2, R3, and R4 and the new rack would be R5.

You can cable up to 18 racks together without additional switches.

The RDMA over RoCE Network Fabric (X8M) procedures for are different than RDMA over InfiniBand Network Fabric (X8 and earlier.)

- [Cabling Several Racks Together–X8M](#)
To create a larger engineered system, you can cable several X8M racks together.
- [Cabling Several Racks Together–X8 and Earlier](#)
You can cable several racks together by following a series of steps in a specific order.

2.4.3.1 Cabling Several Racks Together–X8M

To create a larger engineered system, you can cable several X8M racks together.

This procedure is for X8M RDMA over RoCE Network Fabric.

In this procedure, the existing racks are R1, R2, ... ,Rn, and the new rack is Rn+1. In the following steps, these example switch names are used:

- rack5sw-roces0: Rack 5 Spine switch (SS)
- rack5sw-rocea0: Rack 5 Lower Leaf switch (R5LL)
- rack5sw-roceb0: Rack 5 Upper Leaf switch (R5UL)

Note:

Cabling three or more racks together requires no downtime for the existing racks R1, R2, ..., Rn. Only the new rack, Rn+1, is powered down

1. Ensure the new rack is near the existing racks R1, R2, ..., Rn.
The RDMA Network Fabric cables must be able to reach the servers in each rack.
2. Ensure you have a backup of the current switch configuration for each switch in the existing racks and the new rack.
For each switch, complete the steps in the Oracle Exadata Database Machine Maintenance Guide, section Backing Up Settings on the RDMA over RoCE Network Fabric Switch.
3. Shut down all servers in the new rack Rn+1.
Refer to Powering Off Oracle Exadata Rack. The switches must remain online and available.

4. Apply the multi-rack spine switch configuration to the spine switch in the new rack R_{n+1} :

- a. Log in to the server that has downloaded the RDMA network switch patch ZIP file for the Oracle Exadata System Software release used by the existing racks.

If you do not have the patch ZIP file available, you can download the latest patch for your Oracle Exadata System Software release. Refer to My Oracle Support Doc ID 888828.1 for information about the latest available patches.

For example, for 19.3 release, as of October 2019, the patch is 30345643-RDMA network switch (7.0(3)17(6)) and InfiniBand network switch (2.2.13-2).

- b. Make a copy of the golden configuration file for the new spine switch.

After extracting the patch ZIP file, run these commands from patch directory, where $n+1$ is the number of the new rack:

```
# cp roce_switch_templates/roce_spine_switch_multi.cfg
roce_spine_switch_multi_Rn+1SS.cfg
```

- c. Edit the copy of the spine switch configuration file.

Using a text editor, replace the three occurrences of `%SPINE_LOOPBACK_IP0%` with the correct IP address for the switch, as indicated in the table below, using the value that matches R_{n+1} for your environment.

Switch	SPINE_LOOPBACK_IP0
Rack 3 spine switch (R3SS)	100.64.0.203
Rack 4 spine switch (R4SS)	100.64.0.204
Rack 5 spine switch (R5SS)	100.64.0.205
Rack 6 spine switch (R6SS)	100.64.0.206
Rack 7 spine switch (R7SS)	100.64.0.207
Rack 8 spine switch (R8SS)	100.64.0.208

For example, if you are adding a rack to an existing 4-rack system (where $n+1=5$), then use IP address 100.64.0.205 as the `SPINE_LOOPBACK_IP0` for the spine switch in the new rack (R5SS).

```
! Define loopback interface for underlay OSPF routing
interface loopback0
  description Routing loopback interface
  !ip address 100.64.0.201/32
  ip address 100.64.0.205/32
  ip router ospf UNDERLAY area 0.0.0.0
! Configure OSPF as the underlay network
router ospf UNDERLAY
  router-id 100.64.0.205
! change ECMP hash rotate value from default 32 to 40 for better
! router port utilization for upto parallel flows via the 8
! available router ports
ip load-sharing address source-destination port source-destination
rotate 40
! Create BGP route reflector to exchange routes across VTEPs
! Use CIDR block of IPs for neighbor range
```

```
! - log-neighbor-changes: Enables the generation of logging messages
! generated when the status of a BGP neighbor changes.
! - address-family ipv4 unicast: Enters address family configuration
! mode and Specifies IP Version 4 unicast address prefixes.
! address
router bgp 65502
  router-id 100.64.0.205
  log-neighbor-changes
```

- d. Verify the three replacements in the spine switch configuration file.

For example, if you are adding a 5th rack, then check for IP address 100.64.0.205 in the spine switch configuration file:

```
$ grep 100.64 roce_spine_switch_multi_R5SS.cfg |grep -v 'neighbor' |
grep -v '!'
```

```
ip address 100.64.0.205/32
router-id 100.64.0.205
router-id 100.64.0.205
```

- e. Apply the updated multi-rack configuration file to the spine switch in the new rack R_{n+1} :

- i. Log in to the switch in the new rack R_{n+1} , and remove the existing configuration file, if it exists. For example, if you are adding a 5th rack, you would use the following command:

```
rack5sw-roces0(config)# delete
bootflash:roce_spine_switch_multi.cfg
Do you want to delete "/roce_spine_switch_multi.cfg" ? (yes/no/
abort) [y] y
rack5sw-roces0(config)#
```

- ii. Log in to the server that contains the modified configuration file for the spine switch, and copy the file to the spine switch in the new rack. For example, if you are adding a 5th rack:

```
# scp roce_spine_switch_multi_R5SS.cfg admin@R5SS_IP_Address:/
```

- iii. Verify the modified file was copied successfully to the spine switch. For example, if you are adding a 5th rack, log in to the spine switch on the new rack R_{n+1} again and use the following command:

```
rack5sw-roces0(config)# dir
bootflash:roce_spine_switch_multi_R5SS.cfg
 27360 Nov 20 12:12:50 2019 roce_spine_switch_multi_R5SS.cfg
Usage for bootflash://sup-local
1829572608 bytes used
114893496320 bytes free
116723068928 bytes total
```

- iv. Copy the modified configuration into flash.

For example, if you are adding a 5th rack, you would use the following commands:

```
rack5sw-roces0(config)# run-script
bootflash:roce_spine_switch_multi_R5SS.cfg | grep 'none'

rack5sw-roces0(config)# copy running-config startup-config
```

 **Note:**

The `run-script` command for a spine switch can take up to 2 minutes to complete.

5. Apply the multi-rack leaf switch configuration to the leaf switches in the new rack R_{n+1} :

For each leaf switch, complete the following steps, where $SW\#$ represents the values $R_{n+1}LL$ or $R_{n+1}UL$, depending on which switch you are configuring.

- a. Log in to the server that has downloaded the RDMA network switch patch ZIP file (from Step 4.a) for the Oracle Exadata System Software release used by the existing racks.
- b. Make a copy of the golden configuration file for each leaf switch.

After extracting the patch ZIP file, run the following command twice from the patch directory, substituting for $SW\#$ the values $R_{n+1}LL$ and $R_{n+1}UL$.

```
# cp roce_switch_templates/roce_leaf_switch_multi.cfg
roce_leaf_switch_multi_ $SW\#$ .cfg
```

- c. Edit each copy of the leaf switch configuration file to replace the loopback IP addresses:

Using a text editor, replace the three occurrences of `%LEAF_LOOPBACK_IP0%` and one occurrence of `%LEAF_LOOPBACK_IP1%` with the correct IP addresses for the leaf switch, as indicated in the table below.

Switch	LEAF_LOOPBACK_IP0	LEAF_LOOPBACK_IP1
Rack 3 Lower Leaf switch (R3LL)	100.64.0.105 100.64.0.106	100.64.1.105 100.64.1.106
Rack 3 Upper Leaf switch (R3UL)		
Rack 4 Lower Leaf switch (R4LL)	100.64.0.107 100.64.0.108	100.64.1.107 100.64.1.108
Rack 4 Upper Leaf switch (R4UL)		
Rack 5 Lower Leaf switch (R5LL)	100.64.0.109 100.64.0.110	100.64.1.109 100.64.1.110
Rack 5 Upper Leaf switch (R5UL)		

Switch	LEAF_LOOPBACK_IP0	LEAF_LOOPBACK_IP1
Rack 6 Lower Leaf switch (R6LL)	100.64.0.111 100.64.0.112	100.64.1.111 100.64.1.112
Rack 6 Upper Leaf switch (R6UL)		
Rack 7 Lower Leaf switch (R7LL)	100.64.0.113 100.64.0.114	100.64.1.113 100.64.1.114
Rack 7 Upper Leaf switch (R7UL)		
Rack 8 Lower Leaf switch (R8LL)	100.64.0.115 100.64.0.116	100.64.1.115 100.64.1.116
Rack 8 Upper Leaf switch (R8UL)		

For example, if you are adding a rack to an existing 4-rack system (where $n+1=5$), then use the loopback IP addresses listed in the table above for R5LL and R5UL.

```
! Define loopback interface for IGP protocol for VTEP reachability
interface loopback0
  description Routing loopback interface
  !ip address 100.64.0.101/32
  ip address 100.64.0.109/32
  ip router ospf UNDERLAY area 0.0.0.0
! Define loopback interface for associating with local VTEP
interface loopback1
  description VTEP loopback interface
  !ip address 100.64.1.101/32
  ip address 100.64.1.109/32
  ip router ospf UNDERLAY area 0.0.0.0
! Configure OSPF as the underlay network
router ospf UNDERLAY
  router-id 100.64.0.109
! change ECMP hash rotate value from default 32 to 40 for better
! router port utilization for upto parallel flows via the 8
! available router ports
ip load-sharing address source-destination port source-destination
rotate 40
! - Create BGP route reflector to exchange routes across VTEPs
! Define max config 8 neighbor spines using their loopback IPs
! - BGP peers are located in an autonomous system (AS) that uses
! 4-byte AS numbers. Cisco recommends to pick a high value such
! as 65502 to avoid conflict with future bgp peers.
! - Create a template 'BasePolicy' that defines a peer policy
! template to define attributes for a particular address family.
router bgp 65502
  router-id 100.64.0.109
  log-neighbor-changes
```

- d. Verify the IP address replacements in the each leaf configuration file.

For example, if you are adding a 5th rack, then check for IP address 100.64.0.109 and 100.64.1.109 in the leaf switch configuration file for R5LL

and for IP addresses 100.64.0.110 and 100.64.1.110 in the leaf switch configuration file for R5UL:

```
$ grep 100.64. roce_leaf_switch_multi_R5LL.cfg | grep -v neighbor |
grep -v '!'
```

```
ip address 100.64.0.109/32
ip address 100.64.1.109/32
router-id 100.64.0.109
router-id 100.64.0.109
```

```
$ grep 100.64. roce_leaf_switch_multi_R5UL.cfg | grep -v neighbor |
grep -v '!'
```

```
ip address 100.64.0.110/32
ip address 100.64.1.110/32
router-id 100.64.0.110
router-id 100.64.0.110
```

- e. Apply the updated multi-rack configuration files to each corresponding leaf switch in the new rack:
 - i. Log in to each leaf switch, and remove the existing configuration file. For example, if you are adding a 5th rack, you would use the following commands on each leaf switch:

```
rack5sw-rocea0# delete bootflash:roce_leaf_switch.cfg
Do you want to delete "/roce_leaf_switch.cfg" ? (yes/no/abort)
[y] y
```

```
rack5sw-rocea0# delete bootflash:roce_leaf_switch_multi.cfg
No such file or directory
```

```
rack5sw-roceb0# delete bootflash:roce_leaf_switch.cfg
Do you want to delete "/roce_leaf_switch.cfg" ? (yes/no/abort)
[y] y
```

```
rack5sw-roceb0# delete bootflash:roce_leaf_switch_multi.cfg
No such file or directory
```

- ii. Log in to the server that contains the modified configuration files, and copy each file to its corresponding leaf switch.

```
# scp roce_leaf_switch_multi_R5LL.cfg admin@rack5sw-rocea0:/
User Access Verification
Password:
roce_leaf_switch_multi_R5LL.cfg 100% 167KB 487.6KB/s 00:00
```

```
# scp roce_leaf_switch_multi_R5UL.cfg admin@rack5sw-roceb0:/
User Access Verification
Password:
roce_leaf_switch_multi_R5UL.cfg
```

- iii. Verify the modified files were copied successfully to the leaf switches. For example, if you are adding a 5th rack, log in to each leaf switch again and use the following commands:

```
rack5sw-rocea0# dir bootflash:roce_leaf_switch_multi_R5LL.cfg
 171387 Nov 20 14:41:52 2019 roce_leaf_switch_multi_R5LL.cfg
Usage for bootflash://sup-local
2583580672 bytes used
114139488256 bytes free
116723068928 bytes total
```

```
rack5sw-roceb0# dir bootflash:roce_leaf_switch_multi_R5UL.cfg
 171387 Nov 20 21:41:50 2019 roce_leaf_switch_multi_R5UL.cfg
Usage for bootflash://sup-local
2579836928 bytes used
114143232000 bytes free
116723068928 bytes total
```

- iv. Copy the modified configuration file into flash.

For example, if you are adding a 5th rack, you would use the following commands:

```
rack5sw-rocea0(config)# run-script
bootflash:roce_leaf_switch_multi_R5LL.cfg | grep 'none'

rack5sw-rocea0(config)# copy running-config startup-config
```

```
rack5sw-roceb0(config)# run-script
bootflash:roce_leaf_switch_multi_R5UL.cfg | grep 'none'

rack5sw-roceb0(config)# copy running-config startup-config
```

 **Note:**

The `run-script` command for a leaf switch can take up to 6 minutes to complete.

- 6. Use `patchmgr` to verify the configuration of the RDMA Network Fabric switches against the golden configuration files.
 - a. Log in to the server that has downloaded the RDMA network switch patch ZIP file (from Step 4.a).
 - b. Create a file that contains the name or IP address of the leaf and spine switches on all racks.

For example, you create a file named `roce_switches.lst`. The file contains the host name or IP address for the spine switches and both leaf switches on each rack, with each switch on a new line.
 - c. Run `patchmgr` with the `--verify_config` option.

In the following command, `roce_switches.lst` is a file that contains the switches to be queried.

```
$ ./patchmgr --roceswitches roce_switches.lst --verify-config --
log_dir /tmp

2019-11-20 14:12:27 -0800 :Working: Initiate config verify on RoCE
switches from . Expect up to 6 minutes for each switch

2019-11-20 14:12:30 -0800 1 of 15 :Verifying config on switch
racklsw-rocea0

2019-11-20 14:12:30 -0800: [INFO ] Dumping current running config
locally as file: /tmp/run.racklsw-rocea0.cfg
2019-11-20 14:12:33 -0800: [SUCCESS ] Backed up switch config
successfully
2019-11-20 14:12:33 -0800: [INFO ] Validating running config
against template [1/3]: /tmp/patch_switch_19.3.1.0.0.191018/
roce_switch_templates/roce_leaf_switch.cfg
2019-11-20 14:12:33 -0800: [INFO ] Validating running config
against template [2/3]: /tmp/patch_switch_19.3.1.0.0.191018/
roce_switch_templates/roce_leaf_switch_multi.cfg
2019-11-20 14:12:33 -0800: [INFO ] Config matches template: /tmp/
patch_switch_19.3.1.0.0.191018/roce_switch_templates/
roce_leaf_switch_multi.cfg
2019-11-20 14:12:33 -0800: [SUCCESS ] Config validation successful!

2019-11-20 14:12:33 -0800 2 of 15 :Verifying config on switch
racklsw-roceb0
...
```

7. Perform the physical cabling of the switches in the new rack R_{n+1} .

▲ Caution:

Cabling within a live network must be done carefully in order to avoid potentially serious disruptions.

- a. Remove the eight existing inter-switch connections between each leaf switch in the new rack R_{n+1} (ports 4, 5, 6, 7 and 30, 31, 32, 33).
 - b. Cable the leaf switches in the new rack according to the appropriate table in [Multi-Rack Cabling Tables](#).

For example, if you are adding a 5th rack and rack R_{n+1} is R5, then use "[Table 4-14 Leaf Switch Connections for the Fifth Rack in a Five-Rack System](#)".
8. Add the new rack to the switches in the existing racks (R_1 to R_n).
 - a. For an existing rack (R_x), cable the lower leaf switch R_xLL according to the appropriate table in [Multi-Rack Cabling Tables](#).

- b. For the same rack, cable the upper leaf switch RxUL according to the appropriate table in [Multi-Rack Cabling Tables](#).
 - c. Repeat these steps for each existing rack, R1 to Rn.
9. Confirm each switch is available and connected.

For each switch in racks R1, R2, ..., Rn, Rn+1, confirm the output for the switch show interface status command shows connected and 100G. In the following example, the leaf switches are ports Eth1/4 to Eth1/7, and Eth1/30 to Eth1/33. The spine switches are ports Eth1/5 to Eth1/20.

When run from a spine switch, the output should be similar to the following:

```
rack1sw-roces0# show interface status
-----
-----
Port          Name          Status      Vlan      Duplex  Speed
Type
-----
-----
mgmt0         --           connected  routed   full    1000   --
-----
-----
Port          Name          Status      Vlan      Duplex  Speed
Type
-----
-----
...
Eth1/5       RouterPort5   connected  routed   full    100G
QSFP-100G-CR4
Eth1/6       RouterPort6   connected  routed   full    100G
QSFP-100G-SR4
Eth1/7       RouterPort7   connected  routed   full    100G
QSFP-100G-CR4
Eth1/8       RouterPort8   connected  routed   full    100G
QSFP-100G-SR4
Eth1/9       RouterPort9   connected  routed   full    100G
QSFP-100G-CR4
Eth1/10      RouterPort10  connected  routed   full    100G
QSFP-100G-SR4
Eth1/11      RouterPort11  connected  routed   full    100G
QSFP-100G-CR4
Eth1/12      RouterPort12  connected  routed   full    100G
QSFP-100G-SR4
Eth1/13      RouterPort13  connected  routed   full    100G
QSFP-100G-CR4
Eth1/14      RouterPort14  connected  routed   full    100G
QSFP-100G-SR4
Eth1/15      RouterPort15  connected  routed   full    100G
QSFP-100G-CR4
Eth1/16      RouterPort16  connected  routed   full    100G
QSFP-100G-SR4
Eth1/17      RouterPort17  connected  routed   full    100G
QSFP-100G-CR4
Eth1/18      RouterPort18  connected  routed   full    100G
QSFP-100G-SR4
```

```

Eth1/19      RouterPort19      connected routed    full    100G
QSFP-100G-CR4
Eth1/20      RouterPort20      connected routed    full    100G
QSFP-100G-SR4
Eth1/21      RouterPort21      xcvrAbsen    routed    full
100G      --
...

```

When run from a leaf switch, the output should be similar to the following:

```

rack1sw-rocea0# show interface status
-----
-----
Port          Name          Status   Vlan     Duplex  Speed
Type
-----
-----
mgmt0         --            connected routed    full    1000    --
-----
-----
Port          Name          Status   Vlan     Duplex  Speed
Type
-----
-----
...
Eth1/4        RouterPort1   connected routed    full    100G
QSFP-100G-CR4
Eth1/5        RouterPort2   connected routed    full    100G
QSFP-100G-CR4
Eth1/6        RouterPort3   connected routed    full    100G
QSFP-100G-CR4
Eth1/7        RouterPort4   connected routed    full    100G
QSFP-100G-CR4
Eth1/8        celadm14      connected 3888     full    100G
QSFP-100G-CR4
...
Eth1/29       celadm01      connected 3888     full    100G
QSFP-100G-CR4
Eth1/30       RouterPort5   connected routed    full    100G
QSFP-100G-SR4
Eth1/31       RouterPort6   connected routed    full    100G
QSFP-100G-SR4
Eth1/32       RouterPort7   connected routed    full    100G
QSFP-100G-SR4
Eth1/33       RouterPort8   connected routed    full    100G
QSFP-100G-SR4
...

```

10. Check the neighbor discovery for every switch in racks R1, R2, ..., Rn, Rn+1.

Make sure that all switches are visible and check the switch ports assignment (leaf switches: ports Eth1/4 - Eth1/7, Eth1/30 - Eth1/33; spine switches: ports Eth1/5 - Eth1/20) against the appropriate table in [Multi-Rack Cabling Tables](#).

Log in to each switch and use the `show lldp neighbors` command.

Each spine switch should see all the leaf switches in each rack, but not the other spine switches. The output for a spine switch should be similar to the following:

```
rack1sw-roces0# show lldp neighbors | grep roce
rack1sw-roceb0 Eth1/5 120 BR Ethernet1/5
rack2sw-roceb0 Eth1/6 120 BR Ethernet1/5
rack1sw-roceb0 Eth1/7 120 BR Ethernet1/7
rack2sw-roceb0 Eth1/8 120 BR Ethernet1/7
rack1sw-roceb0 Eth1/9 120 BR Ethernet1/4
rack2sw-roceb0 Eth1/10 120 BR Ethernet1/4
rack3sw-roceb0 Eth1/11 120 BR Ethernet1/5
rack3sw-roceb0 Eth1/12 120 BR Ethernet1/7
rack1sw-rocea0 Eth1/13 120 BR Ethernet1/5
rack2sw-rocea0 Eth1/14 120 BR Ethernet1/5
rack1sw-rocea0 Eth1/15 120 BR Ethernet1/7
rack2sw-rocea0 Eth1/16 120 BR Ethernet1/7
rack3sw-rocea0 Eth1/17 120 BR Ethernet1/5
rack2sw-rocea0 Eth1/18 120 BR Ethernet1/4
rack3sw-rocea0 Eth1/19 120 BR Ethernet1/7
rack3sw-rocea0 Eth1/20 120 BR Ethernet1/4
```

Each leaf switch should see the spine switch in every rack, but not the other leaf switches. The output for a leaf switch should be similar to the following:

```
rack1sw-rocea0# show lldp neighbors | grep roce
rack3sw-roces0 Eth1/4 120 BR Ethernet1/13
rack1sw-roces0 Eth1/5 120 BR Ethernet1/13
rack3sw-roces0 Eth1/6 120 BR Ethernet1/15
rack1sw-roces0 Eth1/7 120 BR Ethernet1/15
rack2sw-roces0 Eth1/30 120 BR Ethernet1/17
rack2sw-roces0 Eth1/31 120 BR Ethernet1/13
rack3sw-roces0 Eth1/32 120 BR Ethernet1/17
rack2sw-roces0 Eth1/33 120 BR Ethernet1/15
```

11. Power on all the servers in the new rack, R_{n+1} .
12. For each rack, confirm the multi-rack cabling by running the `verify_roce_cables.py` script.

Refer to My Oracle Support Doc ID 2587717.1 for download and usage instructions.

 **Note:**

For the ports on the leaf and spine switches that were cabled for the RDMA Network Fabric, ignore the FAIL status in the column "CABLE OK?". For the other ports on the switches (for database servers, storage servers, etc.) the status should be OK.

The following output is a partial example of the command results:

```
# ./verify_roce_cables.py -n nodes.rack1 -s switches.rack1
SWITCH PORT (EXPECTED PEER) LEAF-1 (rack1sw-rocea0) : CABLE OK? LEAF-2 (rack1sw-
```

```

roceb0)      : CABLE OK?
-----
----- : -----
Eth1/4 (ISL peer switch) : rack1sw-roces0 Ethernet1/17 : FAIL      rack1sw-roces0
Ethernet1/9 : FAIL
Eth1/5 (ISL peer switch) : rack1sw-roces0 Ethernet1/13 : FAIL      rack1sw-roces0
Ethernet1/5 : FAIL
Eth1/6 (ISL peer switch) : rack1sw-roces0 Ethernet1/19 : FAIL      rack1sw-roces0
Ethernet1/11: FAIL
Eth1/7 (ISL peer switch) : rack1sw-roces0 Ethernet1/15 : FAIL      rack1sw-roces0
Ethernet1/7 : FAIL
Eth1/12 (celadm10)      : rack1celadm10 port-1      : OK        rack1celadm10
port-2      : OK
Eth1/13 (celadm09)      : rack1celadm09 port-1      : OK        rack1celadm09
port-2      : OK
Eth1/14 (celadm08)      : rack1celadm08 port-1      : OK        rack1celadm08
port-2      : OK
...
Eth1/15 (adm08)         : rack1dbadm08 port-1      : OK        rack1dbadm08
port-2      : OK
Eth1/16 (adm07)         : rack1dbadm07 port-1      : OK        rack1dbadm07
port-2      : OK
Eth1/17 (adm06)         : rack1dbadm06 port-1      : OK        rack1dbadm06
port-2      : OK
...
Eth1/30 (ISL peer switch) : rack2sw-roces0 Ethernet1/17 : FAIL      rack2sw-roces0
Ethernet1/9 : FAIL
Eth1/31 (ISL peer switch) : rack2sw-roces0 Ethernet1/13 : FAIL      rack2sw-roces0
Ethernet1/5 : FAIL
Eth1/32 (ISL peer switch) : rack2sw-roces0 Ethernet1/19 : FAIL      rack2sw-roces0
Ethernet1/11: FAIL
Eth1/33 (ISL peer switch) : rack2sw-roces0 Ethernet1/15 : FAIL      rack2sw-roces0
Ethernet1/7 : FAIL

```

13. Confirm the network status in the current cluster between database servers and storage servers using the `infinicheck` command.

Complete the steps documented in Verifying RDMA Network Fabric based on ROCE Operation.

 **Note:**

If SSH equivalency has not been setup, first run `infinicheck -s`.

```

# /opt/oracle.SupportTools/ibdiagtools/infinicheck -z

# /opt/oracle.SupportTools/ibdiagtools/infinicheck -g hosts.lst -c
cells.lst -b

INFINICHECK
[Network Connectivity, Configuration and Performance]

#### FABRIC TYPE TESTS ####

```

```

System type identified: RoCE
Verifying User Equivalence of user=root from all DBs to all CELLS.
#### RoCE CONFIGURATION TESTS ####
Checking for presence of RoCE devices on all DBs and CELLS
[SUCCESS]... RoCE devices on all DBs and CELLS look good
Checking for RoCE Policy Routing settings on all DBs and CELLS
[SUCCESS]... RoCE Policy Routing settings look good
Checking for RoCE DSCP ToS mapping on all DBs and CELLS
[SUCCESS]... RoCE DSCP ToS settings look good
Checking for RoCE PFC settings and DSCP mapping on all DBs and
CELLS
[SUCCESS]... RoCE PFC and DSCP settings look good
Checking for RoCE interface MTU settings. Expected value : 2300
[SUCCESS]... RoCE interface MTU settings look good
Verifying switch advertised DSCP on all DBs and CELLS ports ( )
[SUCCESS]... Advertised DSCP settings from RoCE switch looks good
#### CONNECTIVITY TESTS ####
[COMPUTE NODES -> STORAGE CELLS]
(60 seconds approx.)
(Will walk through QoS values: 0-6) [SUCCESS].....Results OK
[SUCCESS]..... All can talk to all storage cells
[COMPUTE NODES -> COMPUTE NODES]
...

```

14. After cabling the racks together, proceed to [Configuring the New Hardware](#) to finish the configuration of the new rack.

Related Topics

- [Exadata Database Machine and Exadata Storage Server Supported Versions \(My Oracle Support Doc ID 888828.1\)](#)

2.4.3.2 Cabling Several Racks Together—X8 and Earlier

You can cable several racks together by following a series of steps in a specific order.

The Subnet Manager Master is assumed to be running on the first RDMA over InfiniBand Network Fabric switch on the first rack (R1 IB1).

This procedure is for X8 and earlier: RDMA over InfiniBand Network Fabric.

1. Set the priority of the current, active Subnet Manager Master to 10 on the spine switch.
 - a. Log in to any InfiniBand switch on the active system.
 - b. Use the `getmaster` command to determine that the Subnet Manager Master is running on the spine switch.

The following example shows that the Subnet Manager Master is running on the spine switch `dm01sw-ib1`.

```

# getmaster
20100701 11:46:38 OpenSM Master on Switch : 0x0021283a8516a0a0
ports 36 Sun DCS 36
QDR switch dm01sw-ib1.example.com enhanced port 0 lid 1 lmc 0

```

If the Subnet Manager Master is not running on the spine switch, then perform the following steps:

- i. Use the `getmaster` command to identify the current location of the Subnet Manager Master.
 - ii. Log in as the `root` user on the leaf switch that is the Subnet Manager Master.
 - iii. Disable Subnet Manager on the switch. The Subnet Manager Master relocates to another switch.
 - iv. Use the `getmaster` command to identify the current location of the Subnet Manager Master. If the spine switch is not the Subnet Manager Master, then repeat steps [1.b.ii](#) and [1.b.iii](#) until the spine switch is the Subnet Manager Master.
 - v. Enable Subnet Manager on the leaf switches that were disabled during this procedure.
- c. Log in to the spine switch.
 - d. Use the `disableesm` command to stop the Subnet Manager.
 - e. Use the `setsmpriority 10` command to set the priority to 10.
 - f. Use the `enableesm` command to restart the Subnet Manager.
 - g. Repeat step [1.b](#) to ensure that the Subnet Manager Master is running on the spine switch.
2. Ensure the new rack is near the existing rack.
The InfiniBand cables must be able to reach the servers in each rack.
 3. Completely shut down the new rack (R_{n+1}).
 4. Cable the leaf switch in the new rack according to the appropriate table in [Multi-Rack Cabling Tables](#).

For example, if rack R_{n+1} is R4, then use [Table 5-9](#).

▲ Caution:

Cabling within a live network must be done carefully in order to avoid potentially serious disruptions.

The cabling table that you use for your new InfiniBand topology tells you how to connect ports on the leaf switches to ports on spine switches in order to connect the racks. Some of these ports on the spine switches might be already in use to support the existing InfiniBand topology. In these cases, connect only the cable on the leaf switch in the new rack and stop there for now. Make note of which cables you were not able to terminate.

Do not unplug any cables on the spine switch in the existing rack at this point. Step 5 describes how to re-cable the leaf switches on the existing racks (one leaf switch after the other - while the leaf switch being re-cabled will be powered off), which will free up these currently in-use ports. At that point, you can connect the other end of the cable from the leaf switch in the new rack to the spine switch in the existing rack as indicated in the table.

5. Complete the following procedure for each of the original racks:

In these steps, Rx represents a rack number from R1 to Rn.

a. Power off leaf switch Rx IB2.

This causes all servers in the rack to fail over their InfiniBand traffic to Rx IB3.

b. Cable leaf switch Rx IB2 according to [Multi-Rack Cabling Tables](#).**c.** Power on leaf switch Rx IB2.**d.** Wait at least three minutes for Rx IB2 to become completely operational.

To check the switch, log in to the switch and run the `ibswitches` command. The output should show $n*3$ switches for IB1, IB2, and IB3 in racks R1, R2, ... Rn.

e. Power off leaf switch Rx IB3.

This causes all servers in the rack to fail over their InfiniBand traffic to Rx IB2.

f. Cable leaf switch Rx IB3 according to [Multi-Rack Cabling Tables](#).**g.** Power on leaf switch Rx IB3.**h.** Wait at least three minutes for Rx IB3 to become completely operational.

To check the switch, log in to the switch and run the `ibswitches` command. The output should show $n*3$ switches for IB1, IB2, and IB3 in racks R1, R2, ... Rn.

All racks should now be rewired according to [Multi-Rack Cabling Tables](#).

6. Power on all the InfiniBand switches in the new rack.**7.** Wait three minutes for the switches to become completely operational.

To check the switch, log in to the switch and run the `ibswitches` command. The output should show $(n+1)*3$ switches for IB1, IB2, and IB3 in racks R1, R2, ... Rn +1.

8. Ensure that the Subnet Manager Master is running on R1 IB1 by running the `getmaster` command from any switch.
9. Power on all servers in the new rack ($Rn+1$).
10. Log in to spine switch R1 IB1, and lower its priority to 8.
 - a. Use the `disableesm` command to stop Subnet Manager.
 - b. Use the `setsmpriority 8` command to set the priority to 8.
 - c. Use the `enableesm` command to restart Subnet Manager.
11. Ensure that the Subnet Manager Master is running on one of the spine switches using the `getmaster` command from any switch.
12. Ensure that the Subnet Manager is running on every spine switch by entering the following command from any switch:

```
ibdiagnet -r
```

Each spine switch should show as running in the `Summary Fabric SM-state-priority` section of the output. If a spine switch is not running, then log in to the switch and enable the Subnet Manager using the `enableesm` command.

13. If there are now four or more racks, then log in to the leaf switches in each rack and disable Subnet Manager using the `disableesm` command.

3

Configuring the New Hardware

This section contains the following tasks needed to configure the new hardware:

Note:

The new and existing racks must be at the same patch level for Oracle Exadata Database Servers and Oracle Exadata Storage Servers, including the operating system. Refer to [Reviewing Release and Patch Levels](#) for additional information.

- [Changing the Interface Names](#)
- [Setting Up New Servers](#)
New servers need to be configured when extending Oracle Engineered System Elastic Configurations.
- [Setting up a New Rack](#)
A new rack is configured at the factory. However, it is necessary to set up the network and configuration files for use with the existing rack.
- [Setting User Equivalence](#)
User equivalence can be configured to include all servers once the servers are online.
- [Starting the Cluster](#)
- [Adding Grid Disks to Oracle ASM Disk Groups](#)
- [Adding Servers to a Cluster](#)
This procedure describes how to add servers to a cluster.
- [Configuring Cell Alerts for New Oracle Exadata Storage Servers](#)
Cell alerts need to be configured for the new Oracle Exadata Storage Servers.
- [Adding Oracle Database Software to the New Servers](#)
- [Adding Database Instance to the New Servers](#)
- [Returning the Rack to Service](#)

3.1 Changing the Interface Names

In the X8M release, `BONDETH0` is used for the bonded Ethernet client network.

In releases up to X8-2, `BONDIB0` and `BONDETH0` are used for the bonded RDMA Network Fabric and the bonded Ethernet client network, respectively. In releases Oracle Exadata Database Machine X2-2 and earlier, (with X4170 and X4275 servers), `BOND0` and `BOND1` are the names for the bonded varref and bonded Ethernet client networks, respectively.

If you are adding new servers to an existing Oracle Engineered System, ensure the database servers use the same names for bonded configuration. You can either change the new database servers to match the existing server interface names, or change the existing server interface names and Oracle Cluster Registry (OCR) configuration to match the new servers.

Do the following after changing the interface names:

1. Edit the entries in `/etc/sysctl.conf` file on the database servers so that the entries for the RDMA Network Fabric match. The following is an example of the file entries before editing. One set of entries must be changed to match the other set.

Found in X2 node

```
net.ipv4.neigh.bondib0.locktime = 0
net.ipv4.conf.bondib0.arp_ignore = 1
net.ipv4.conf.bondib0.arp_accept = 1
net.ipv4.neigh.bondib0.base_reachable_time_ms = 10000
net.ipv4.neigh.bondib0.delay_first_probe_time = 1
```

Found in V2 node

```
net.ipv4.conf.bond0.arp_accept=1
net.ipv4.neigh.bond0.base_reachable_time_ms=10000
net.ipv4.neigh.bond0.delay_first_probe_time=1
```

2. Save the changes to the `sysctl.conf` file.
3. Use the `oifcfg` utility to change the OCR configuration, if the new names differ from what is currently in OCR. The interface names for Oracle Exadata Storage Servers do not have to be changed.
4. Continue configuring the new hardware, as follows:
 - If the hardware is new servers, then go to [Setting Up New Servers](#) to configure the servers.
 - If the hardware is a new rack, then go to [Setting up a New Rack](#) to configure the rack.



See Also:

Oracle Exadata Database Machine Maintenance Guide for information about changing the RDMA Network Fabric information

3.2 Setting Up New Servers

New servers need to be configured when extending Oracle Engineered System Elastic Configurations.

The new servers do not have any configuration information, and you cannot use Oracle Enterprise Manager Cloud Control to configure them. The servers are configured using the Oracle Exadata Deployment Assistant (OEDA) or manually.

- [Configuring Servers Using OEDA](#)
When adding servers to a non-Eighth Rack Oracle Engineered System, you can use OEDA.
- [Configuring New Servers Manually](#)
When adding servers to a non-Eighth Rack Oracle Engineered System, you can configure the servers manually instead of using OEDA.

3.2.1 Configuring Servers Using OEDA

When adding servers to a non-Eighth Rack Oracle Engineered System, you can use OEDA.

 **Note:**

In order to configure the servers with Oracle Exadata Deployment Assistant (OEDA), the new server information must be entered in OEDA, and configuration files generated.

1. Download the latest release of OEDA listed in My Oracle Support note 888828.1.
2. Enter the new server information in OEDA.

Do not include information for the existing rack.

 **Note:**

- When extending an existing rack that has database servers earlier than Oracle Engineered System X4-2, be sure to deselect the active bonding option for the RDMA over InfiniBand Network Fabric so the new database servers are configured with active-passive bonded interfaces.
- When extending an existing Oracle Engineered System X4-2 or later system with active-active bonding, select the active bonding option to configure the new database servers for active-active bonding.

3. Use OEDA to generate the configuration files.
4. Prepare the servers as follows, starting with the first database server of the new servers:
 - a. Configure the servers as described in [Preparing the Servers](#).

 **Note:**

OEDA checks the performance level of Oracle Exadata Storage Servers so it is not necessary to check them using the CellCLI `CALIBRATE` command at this time.

- b. Create the cell disks and grid disks as described in [Configuring Cells, Cell Disks, and Grid Disks with CellCLI](#).

- c. Create the flash cache and flash log as described in [Creating Flash Cache and Flash Grid Disks](#).

 **Note:**

When creating the flash cache, enable write-back flash cache.

5. Ensure the RDMA Network Fabric and bonded client Ethernet interface names are the same on the new database servers as on the existing database servers.
6. When using the same, earlier style bonding names, such as `BOND0`, for the new database servers, then update the `/opt/oracle.cellso/cell.conf` file to reflect the correct bond names.

 **Note:**

If the existing servers use the latest bonded interface names, such as `BONDIB0`, then this step can be skipped.

7. Install OEDA on the first new database server.

 **See Also:**

My Oracle Support note [888828.1](#) for information about OEDA

8. Copy the configuration files to the first database server of the *new* servers in the `/opt/oracle.SupportTools/onecommand` directory.
This is the information completed in [step 2](#).
9. Run OEDA up to, but not including, the `Create Grid Disks` step, and then run the `Configure Alerting and Setup ASR Alerting` configuration steps.

 **Note:**

- The OEDA `Validate Configuration File` step may display an error message about missing files, `pXX.zip`. This is expected behavior because the files are not used for this procedure. You can ignore the error message.
- When using capacity-on-demand, OEDA has the `Setup Capacity-on-Demand` step. This step uses the `setupResourceControl` command to set up the cores correctly.

10. Configure the storage servers, cell disks and grid disks as described in [Configuring Cells, Cell Disks, and Grid Disks with CellCLI](#).

**Note:**

Use the data collected from the existing system, as described in [Obtaining Current Configuration Information](#) to determine the grid disk names and sizes.

11. Run `reclaimdisks.sh` on each database server.

The `/opt/oracle.SupportTools/reclaimdisks.sh -free -reclaim` command reclaims disk space reserved for the deployment type not selected. The command takes less than 5 minutes, approximately. Systems are imaged with disks configured with RAID5; a RAID rebuild is no longer part of the `reclaimdisks.sh` process.

Do not skip this step. Skipping this step results in unused space that can no longer be reclaimed by `reclaimdisks.sh`.

12. Verify the time is the same on the new servers as on the existing servers.

This check is performed for the storage servers and database servers.

13. Ensure the NTP settings are the same on the new servers as on the existing servers.

This check is performed for the storage servers and database servers.

14. Configure HugePages on the new servers to match the existing servers.

15. Ensure the values in the `/etc/security/limits.conf` file for the new database servers match the existing database servers.

16. Go to [Setting User Equivalence](#) to continue the hardware configuration.

Related Topics

- [Preparing the Network Configuration](#)
When adding additional servers to your rack, you will need IP address and the current network configuration settings.
- [Exadata Database Machine and Exadata Storage Server Supported Versions \(My Oracle Support Doc ID 888828.1\)](#)

3.2.2 Configuring New Servers Manually

When adding servers to a non-Eighth Rack Oracle Engineered System, you can configure the servers manually instead of using OEDA.

Using Oracle Exadata Deployment Assistant (OEDA) is the recommended method.

1. Prepare the servers using the procedure described in [Preparing the Servers](#).
2. Ensure the RDMA Network Fabric and bonded client Ethernet interface names are the same on the new database servers as on the existing database servers.
3. Configure the storage servers, cell disks and grid disks as described in [Configuring Cells, Cell Disks, and Grid Disks with CellCLI](#).
4. Configure the database servers as described in [Setting Up Configuration Files for a Database Server Host](#).
5. Run `reclaimdisks.sh` on each database server.

The `/opt/oracle.SupportTools/reclaimdisks.sh -free -reclaim` command reclaims disk space reserved for the deployment type not selected. The command takes less than 5 minutes, approximately. Systems are imaged with disks configured with RAID5; a RAID rebuild is no longer part of the `reclaimdisks.sh` process.

Do not skip this step. Skipping this step results in unused space that can no longer be reclaimed by `reclaimdisks.sh`.

6. Verify the time is the same on the new servers as on the existing servers.
This check is performed for the storage servers and database servers.
7. Ensure the NTP settings are the same on the new servers as on the existing servers.
This check is performed for the storage servers and database servers.
8. Configure HugePages on the new servers to match the existing servers.
9. Go to [Setting User Equivalence](#) to continue the hardware configuration.

Related Topics

- [Preparing the Network Configuration](#)
When adding additional servers to your rack, you will need IP address and the current network configuration settings.
- [Exadata Database Machine and Exadata Storage Server Supported Versions \(My Oracle Support Doc ID 888828.1\)](#)

3.3 Setting up a New Rack

A new rack is configured at the factory. However, it is necessary to set up the network and configuration files for use with the existing rack.

1. Configure the new rack and servers as described in *Configuring Oracle Exadata Database Machine* in the *Oracle Exadata Database Machine Installation and Configuration Guide*.
Complete the appropriate tasks to configure the rack and its components, but do not complete the task for installing the Exadata configuration information and software on the servers. This task will be completed later in this procedure.
2. Verify the time is the same on the new servers as on the existing servers. This check is performed for storage servers and database servers.
3. Ensure the NTP settings are the same on the new servers as on the existing servers. This check is performed for storage servers and database servers.
4. Configure HugePages on the new servers to match the existing servers.
5. Ensure the RDMA Network Fabric and bonded client Ethernet interface names on the new database servers match the existing database servers.
6. Configure the rack as described in *Loading the Configuration Information and Installing the Software* in *Oracle Exadata Database Machine Installation and Configuration Guide*. You can use either the Oracle Exadata Deployment Assistant (OEDA) or Oracle Enterprise Manager Cloud Control to configure the rack.

 **Note:**

- Only run OEDA up to the `Create Grid Disks` step, then configure storage servers as described in `Configuring Cells, Cell Disks, and Grid Disks with CellCLI` in *Oracle Exadata System Software User's Guide*.
- When adding servers with 3 TB High Capacity (HC) disks to existing servers with 2TB disks, it is recommended to follow the procedure in My Oracle Support Doc ID 1476336.1 to properly define the grid disks and disk groups. At this point of setting up the rack, it is only necessary to define the grid disks. The disk groups are created after the cluster has been extended on to the new nodes.
- If the existing storage servers are Extreme Flash (EF) and you are adding High Capacity (HC) storage servers, or if the existing storage servers are HC and you are adding EF storage servers, then you must place the new disks in new disk groups. You cannot mix EF and HC disks within the same disk group.

7. Go to [Setting User Equivalence](#) to continue the hardware configuration.

Related Topics

- [How to Add Exadata Storage Servers Using 3 TB \(or larger\) Disks to an Existing Database Machine \(My Oracle Support Doc ID 1476336.1\)](#)

3.4 Setting User Equivalence

User equivalence can be configured to include all servers once the servers are online.

This procedure must be done before running the post-cabling utilities.

1. Log in to each new server manually using SSH to verify that each server can accept log ins and that the passwords are correct.
2. Modify the `db_group` and `cell_group` files on all servers to include all servers.
 - a. Create the new directories on the first existing database server.

```
# mkdir /root/new_group_files
# mkdir /root/old_group_files
# mkdir /root/group_files
```

- b. Copy the group files for the new servers to the `/root/new_group_files` directory.
- c. Copy the group files for the existing servers to the `/root/old_group_files` directory.
- d. Copy the group files for the existing servers to the `/root/group_files` directory.
- e. Update the group files to include the existing and new servers.

```
cat /root/new_group_files/db_group >> /root/group_files/db_group
cat /root/new_group_files/cell_group >> /root/group_files/cell_group
```

```
cat /root/new_group_files/all_group >> /root/group_files/all_group
cat /root/new_group_files/dbs_ib_group >> /root/group_files/
dbs_ib_group
cat /root/new_group_files/cell_ib_group >> /root/group_files/
cell_ib_group
cat /root/new_group_files/all_ib_group >> /root/group_files/
all_ib_group
```

- f. Make the updated group files the default group files. The updated group files contain the existing and new servers.

```
cp /root/group_files/* /root
cp /root/group_files/* /opt/oracle.SupportTools/onecommand
```

- g. Put a copy of the updated group files in the `root` user, `oracle` user, and Oracle Grid Infrastructure user home directories, and ensure that the files are owned by the respective users.
3. Modify the `/etc/hosts` file on the existing and new database server to include the existing RDMA Network Fabric IP addresses for the database servers and storage servers. The existing and new `priv_ib_hosts` files can be used for this step.

 **Note:**

Do not copy the `/etc/hosts` file from one server to the other servers. Edit the file on each server.

4. Run the `setssh-Linux.sh` script as the `root` user on one of the existing database servers to configure user equivalence for all servers using the following command. Oracle recommends using the first database server.

```
# /opt/oracle.SupportTools/onecommand/setssh-Linux.sh -s -c N -h \  
/path_to_file/all_group -n N
```

In the preceding command, `path_to_file` is the directory path for the `all_group` file containing the names for the existing and new servers.

 **Note:**

For Oracle Exadata Database Machine X2-2 (with X4170 and X4275 servers) systems, use the `setssh.sh` command to configure user equivalence.

The command line options for the `setssh.sh` command differ from the `setssh-Linux.sh` command. Run `setssh.sh` without parameters to see the proper syntax.

5. Add the known hosts using RDMA Network Fabric. This step requires that all database servers are accessible by way of their InfiniBand interfaces.

```
# /opt/oracle.SupportTools/onecommand/setssh-Linux.sh -s -c N -h \
/path_to_file/all_ib_group -n N -p password
```

6. Verify equivalence is configured.

```
# dcli -g all_group -l root date
# dcli -g all_ib_group -l root date
```

7. Run the `setssh-Linux.sh` script as the `oracle` user on one of the existing database servers to configure user equivalence for all servers using the following command. Oracle recommends using the first database server. If there are separate owners for the Oracle Grid Infrastructure software, then run a similar command for each owner.

```
$ /opt/oracle.SupportTools/onecommand/setssh-Linux.sh -s -c N -h \
/path_to_file/dbs_group -n N
```

In the preceding command, *path_to_file* is the directory path for the `dbs_group` file. The file contains the names for the existing and new servers.

 **Note:**

- For Oracle Exadata Database Machine X2-2 (with X4170 and X4275 servers) systems, use the `setssh.sh` command to configure user equivalence.
- It may be necessary to temporarily change the permissions on the `setssh-Linux.sh` file to 755 for this step. Change the permissions back to the original settings after completing this step.

8. Add the known hosts using RDMA Network Fabric. This step requires that all database servers are accessible by way of their InfiniBand interfaces.

```
$ /opt/oracle.SupportTools/onecommand/setssh-Linux.sh -s -c N -h \
/root/group_files/dbs_ib_group -n N
```

9. Verify equivalence is configured.

```
$ dcli -g dbs_group -l oracle date
$ dcli -g dbs_ib_group -l oracle date
```

If there is a separate Oracle Grid Infrastructure user, then also run the preceding commands for that user, substituting the `grid` user name for the `oracle` user.

3.5 Starting the Cluster

The following procedure describes how to start the cluster if it was stopped earlier for cabling an additional rack.

Note:

- Oracle recommends you start one server, and let it come up fully before starting Oracle Clusterware on the rest of the servers.
- It is not necessary to stop a cluster when extending Oracle Exadata Database Machine Half Rack to a Full Rack, or a Quarter Rack to a Half Rack or Full Rack.

1. Log in as the `root` user on the original cluster.
2. Start one server of the cluster.

```
# Grid_home/grid/bin/crsctl start cluster
```

3. Check the status of the server.

```
Grid_home/grid/bin/crsctl stat res -t
```

Run the preceding command until it shows that the first server has started.

4. Start the other servers in the cluster.

```
# Grid_home/grid/bin/crsctl start cluster -all
```

5. Check the status of the servers.

```
Grid_home/grid/bin/crsctl stat res -t
```

It may take several minutes for all servers to start and join the cluster.

3.6 Adding Grid Disks to Oracle ASM Disk Groups

Grid disks can be added to Oracle ASM disk groups before or after the new servers are added to the cluster. The advantage of adding the grid disks before adding the new servers is that the rebalance operation can start earlier. The advantage of adding the grid disks after adding the new servers is that the rebalance operation can be done on the new servers so less load is placed on the existing servers.

The following procedure describes how to add grid disk to existing Oracle ASM disk groups.

 **Note:**

- It is assumed in the following examples that the newly-installed storage servers have the same grid disk configuration as the existing storage servers, and that the additional grid disks will be added to existing disk groups.

The information gathered about the current configuration should be used when setting up the grid disks.

- If the existing storage servers have High Performance (HP) disks and you are adding storage servers with High Capacity (HC) disks or the existing storage servers have HC disks and you are adding storage servers HP disks, then you must place the new disks in new disk groups. It is not permitted to mix HP and HC disks within the same disk group.

1. Ensure the new storage servers are running the same version of software as storage servers already in use. Run the following command on the first database server:

```
dcli -g dbs_group -l root "imageinfo -ver"
```

 **Note:**

If the Oracle Exadata System Software on the storage servers does not match, then upgrade or patch the software to be at the same level. This could be patching the existing servers or new servers. Refer to [Reviewing Release and Patch Levels](#) for additional information.

2. Modify the `/etc/oracle/cell/network-config/cellip.ora` file on all database servers to have a complete list of all storage servers. This can be done by modifying the file for one database server, and then copying the file to the other database servers. The `cellip.ora` file should be identical on all database servers.

When adding Oracle Exadata Storage Server X4-2L servers, the `cellip.ora` file contains two IP addresses listed for each cell. Copy each line completely to include the two IP addresses, and merge the addresses in the `cellip.ora` file of the existing cluster.

The following is an example of the `cellip.ora` file after expanding Oracle Exadata Database Machine X3-2 Half Rack to Full Rack using Oracle Exadata Storage Server X4-2L servers:

```
cell="192.168.10.9"  
cell="192.168.10.10"  
cell="192.168.10.11"  
cell="192.168.10.12"  
cell="192.168.10.13"  
cell="192.168.10.14"  
cell="192.168.10.15"  
cell="192.168.10.17;192.168.10.18"  
cell="192.168.10.19;192.168.10.20"
```

```
cell="192.168.10.21;192.168.10.22"  
cell="192.168.10.23;192.168.10.24"  
cell="192.168.10.25;192.168.10.26"  
cell="192.168.10.27;192.168.10.28"  
cell="192.168.10.29;192.168.10.30"
```

In the preceding example, lines 1 through 7 are for the original servers, and lines 8 through 14 are for the new servers. Oracle Exadata Storage Server X4-2L servers have two IP addresses each.

3. Ensure the updated `cellip.ora` file is on all database servers. The updated file must include a complete list of all storage servers.
4. Verify accessibility of all grid disks from one of the original database servers. The following command can be run as the `root` user or the `oracle` user.

```
$ Grid_home/grid/bin/kfod disks=all dscvgroup=true
```

The output from the command shows grid disks from the original and new storage servers.

5. Add the grid disks from the new storage servers to the existing disk groups using commands similar to the following. You cannot have both high performance disks and high capacity disks in the same disk group.

```
$ .oraenv  
ORACLE_SID = [oracle] ? +ASM1  
The Oracle base for ORACLE_HOME=/u01/app/11.2.0/grid is /u01/app/oracle  
  
$ sqlplus / as sysasm  
SQL> ALTER DISKGROUP data ADD DISK  
2> 'o/*/DATA*dm02*'  
3> rebalance power 11;
```

In the preceding commands, a Full Rack was added to an existing Oracle Exadata Rack. The prefix for the new rack is `dm02`, and the grid disk prefix is `DATA`.

The following is an example in which an Oracle Exadata Database Machine Half Rack was upgraded to a Full Rack. The cell host names in the original system were named `dm01cel01` through `dm01cel07`. The new cell host names are `dm01cel08` through `dm01cel14`.

```
$ .oraenv  
ORACLE_SID = [oracle] ? +ASM1  
The Oracle base for ORACLE_HOME=/u01/app/11.2.0/grid is /u01/app/oracle  
  
$ SQLPLUS / AS sysasm  
SQL> ALTER DISKGROUP data ADD DISK  
2> 'o/*/DATA*dm01cel08*',  
3> 'o/*/DATA*dm01cel09*',  
4> 'o/*/DATA*dm01cel10*',  
5> 'o/*/DATA*dm01cel11*',  
6> 'o/*/DATA*dm01cel12*',  
7> 'o/*/DATA*dm01cel13*';
```

```
8> 'o/*/DATA*dm01cell14*'
9> rebalance power 11;
```

 **Note:**

- If your system is running Oracle Database 11g release 2 (11.2.0.1), then Oracle recommends a power limit of 11 so that the rebalance completes as quickly as possible. If your system is running Oracle Database 11g release 2 (11.2.0.2), then Oracle recommends a power limit of 32. The power limit does have an impact on any applications that are running during the rebalance.
- Ensure the `ALTER DISKGROUP` commands are run from different Oracle ASM instances. That way, the rebalance operation for multiple disk groups can run in parallel.
- Add disks to all disk groups including `SYSTEMDG` or `DBFS_DG`.
- When adding servers with 3 TB High Capacity (HC) disks to existing servers with 2 TB disks, it is recommended to follow the procedure in My Oracle Support note 1476336.1 to properly define the grid disks and disk groups. At this point of setting up the rack, the new grid disks should be defined, but need to be placed into disk groups. Refer to the steps in My Oracle Support note 1476336.1.
- If the existing storage servers have High Performance (HP) disks and you are adding storage servers with High Capacity (HC) disks, or the existing storage servers have HC disks and you are adding storage servers with HP disks, then you must place the new disks in new disk groups. It is not permitted to mix HP and HC disks within the same disk group.

6. Monitor the status of the rebalance operation using a query similar to the following from any Oracle ASM instance:

```
SQL> SELECT * FROM GV$ASM_OPERATION WHERE STATE = 'RUN';
```

The remaining tasks can be done while the rebalance is in progress.

 **See Also:**

- [Obtaining Current Configuration Information](#) for information about the existing grid disks.
- [Setting Up New Servers](#) for information about configuring the grid disks.
- *Oracle Automatic Storage Management Administrator's Guide* for information about the `ASM_POWER_LIMIT` parameter.

3.7 Adding Servers to a Cluster

This procedure describes how to add servers to a cluster.

For adding nodes to an Oracle VM cluster, refer to Expanding an Oracle VM RAC Cluster on Exadata in *Oracle Exadata Database Machine Maintenance Guide*.

▲ Caution:

If Oracle Clusterware manages additional services that are not yet installed on the new nodes, such as Oracle GoldenGate, then note the following:

- It may be necessary to stop those services on the existing node before running the `addNode.sh` script.
- It is necessary to create any users and groups on the new database servers that run these additional services.
- It may be necessary to disable those services from auto-start so that Oracle Clusterware does not try to start the services on the new nodes.

✎ Note:

To prevent problems with transferring files between existing and new nodes, you need to set up SSH equivalence. See Step 4 in Expanding an Oracle VM Oracle RAC Cluster on Exadata in for details.

1. Ensure the `/etc/oracle/cell/network-config/*.ora` files are correct and consistent on all database servers. The `cellip.ora` file all database server should include the older and newer database servers and storage servers.
2. Ensure the `ORACLE_BASE` and `diag` destination directories have been created on the Oracle Grid Infrastructure destination home.

The following is an example for Oracle Grid Infrastructure 11g:

```
# dcli -g /root/new_group_files/dbs_group -l root mkdir -p \
/u01/app/11.2.0/grid /u01/app/oraInventory /u01/app/grid/diag

# dcli -g /root/new_group_files/dbs_group -l root chown -R
grid:oinstall \
/u01/app/11.2.0 /u01/app/oraInventory /u01/app/grid

# dcli -g /root/new_group_files/dbs_group -l root chmod -R 770 \
/u01/app/oraInventory

# dcli -g /root/new_group_files/dbs_group -l root chmod -R 755 \
/u01/app/11.2.0 /u01/app/11.2.0/grid
```

The following is an example for Oracle Grid Infrastructure 12c:

```
# cd /
# rm -rf /u01/app/*
# mkdir -p /u01/app/12.1.0.2/grid
# mkdir -p /u01/app/oracle/product/12.1.0.2/dbhome_1
# chown -R oracle:oinstall /u01
```

3. Ensure the `inventory` directory and Grid home directories have been created and have the proper permissions. The directories should be owned by the Grid user and the `OINSTALL` group. The `inventory` directory should have 770 permission, and the Oracle Grid Infrastructure home directories should have 755.

If you are running Oracle Grid Infrastructure 12c or later:

- Make sure `oraInventory` does not exist inside `/u01/app`.
 - Make sure `/etc/oraInst.loc` does not exist.
4. Create users and groups on the new nodes with the same user identifiers and group identifiers as on the existing nodes.

 **Note:**

If Oracle Exadata Deployment Assistant (OEDA) was used earlier, then these users and groups should have been created. Check that they do exist, and have the correct UID and GID values.

5. Log in as the Grid user on an existing host.
6. Verify the Oracle Cluster Registry (OCR) backup exists.

```
ocrconfig -showbackup
```

7. Verify that the additional database servers are ready to be added to the cluster using commands similar to following:

```
$ cluvfy stage -post hwos -n \
dm02db01, dm02db02, dm02db03, dm02db04, dm02db05, dm02db06, dm02db07, dm02db08
\
-verbose

$ cluvfy comp peer -refnode dm01db01 -n \
dm02db01, dm02db02, dm02db03, dm02db04, dm02db05, dm02db06, dm02db07, dm02db08
\
-orainv oinstall -osdba dba | grep -B 3 -A 2 mismatched

$ cluvfy stage -pre nodeadd -n \
dm02db01, dm02db02, dm02db03, dm02db04, dm02db05, dm02db06, dm02db07, dm02db08
\
-verbose -fixup -fixupdir /home/grid_owner_name/fixup.d
```

In the preceding commands, *grid_owner_name* is the name of the Oracle Grid Infrastructure software owner, *dm02db01* through *db02db08* are the new database servers, and *refnode* is an existing database server.

 **Note:**

- The second and third commands do not display output if the commands complete correctly.
- An error about a voting disk, similar to the following, may be displayed:

```
ERROR:
PRVF-5449 : Check of Voting Disk location "o/
192.168.73.102/ \
DATA_CD_00_dm01cel07(o/192.168.73.102/
DATA_CD_00_dm01cel07)" \
failed on the following nodes:
Check failed on nodes:
    dm01db01
    dm01db01:No such file or directory
...
PRVF-5431 : Oracle Cluster Voting Disk configuration check
```

If such an error occurs:

- If you are running Oracle Grid Infrastructure 11g, set the environment variable as follows:

```
$ export IGNORE_PREADDNODE_CHECKS=Y
```

Setting the environment variable does not prevent the error when running the `cluvfy` command, but it does allow the `addNode.sh` script to complete successfully.

- If you are running Oracle Grid Infrastructure 12c or later, use the following `addnode` parameters: `-ignoreSysPrereqs -ignorePrereq`

In Oracle Grid Infrastructure 12c and later, `addnode` does not use the `IGNORE_PREADDNODE_CHECKS` environment variable.

- If a database server was installed with a certain image and subsequently patched to a later image, then some operating system libraries may be older than the version expected by the `cluvfy` command. This causes the `cluvfy` command and possibly the `addNode.sh` script to fail.

It is permissible to have an earlier version as long as the difference in versions is minor. For example, `glibc-common-2.5-81.el5_8.2` versus `glibc-common-2.5-49`. The versions are different, but both are at version 2.5, so the difference is minor, and it is permissible for them to differ.

Set the environment variable `IGNORE_PREADDNODE_CHECKS=Y` before running the `addNode.sh` script or use the `addnode` parameters `-ignoreSysPrereqs -ignorePrereq` with the `addNode.sh` script to workaround this problem.

8. Ensure that all directories inside the Oracle Grid Infrastructure home on the existing server have their executable bits set. Run the following commands as the root user.

```
find /u01/app/11.2.0/grid -type d -user root ! -perm /u+x ! \
-perm /g+x ! -perm o+x
```

```
find /u01/app/11.2.0/grid -type d -user grid_owner_name ! -perm /u
+x ! \
-perm /g+x ! -perm o+x
```

In the preceding commands, *grid_owner_name* is the name of the Oracle Grid Infrastructure software owner, and */u01/app/11.2.0/grid* is the Oracle Grid Infrastructure home directory.

If any directories are listed, then ensure the group and others permissions are *+x*. The *Grid_home/network/admin/samples*, *\$GI_HOME/crf/admin/run/crfmond*, and *Grid_home/crf/admin/run/crflogd* directories may need the *+x* permissions set.

If you are running Oracle Grid Infrastructure 12c or later, run commands similar to the following:

```
# chmod -R u+x /u01/app/12.1.0.2/grid/gpnp/gpnp_bcp*

# chmod -R o+rx /u01/app/12.1.0.2/grid/gpnp/gpnp_bcp*

# chmod o+r /u01/app/12.1.0.2/grid/bin/oradaemonagent /u01/app/12.1.0.2/
grid/srvm/admin/logging.properties

# chmod a+r /u01/app/oracle/product/12.1.0.2/dbhome_1/bin/*0

# chmod a+r /u01/app/oracle/product/12.1.0.2/dbhome_1/bin/*0

# chown -f gi_owner_name:dba /u01/app/12.1.0.2/grid/OPatch/ocm/bin/
emocmrsp
```

The *Grid_home/network/admin/samples* directory needs the *+x* permission:

```
chmod -R a+x /u01/app/12.1.0.2/grid/network/admin/samples
```

9. Run the following command. It is assumed that the Oracle Grid Infrastructure home is owned by the Grid user.

```
$ dcli -g old_db_nodes -l root chown -f grid_owner_name:dba \
/u01/app/11.2.0/grid/OPatch/ocm/bin/emocmrsp
```

10. This step is needed only if you are running Oracle Grid Infrastructure 11g. In Oracle Grid Infrastructure 12c, no response file is needed because the values are specified on the command line.

Create a response file, `add-cluster-nodes.rsp`, as the Grid user to add the new servers similar to the following:

```
RESPONSEFILE_VERSION=2.2.1.0.0

CLUSTER_NEW_NODES={dm02db01,dm02db02, \
dm02db03,dm02db04,dm02db05,dm02db06,dm02db07,dm02db08}

CLUSTER_NEW_VIRTUAL_HOSTNAMES={dm0201-vip,dm0202-vip,dm0203-vip,dm0204-
vip, \
dm0205-vip,dm0206-vip,dm0207-vip,dm0208-vip}
```

In the preceding file, the host names `dm02db01` through `dm02db08` are the new nodes being added to the cluster.

 **Note:**

The lines listing the server names should appear on one continuous line. They are wrapped in the documentation due to page limitations.

11. Ensure most of the files in the `Grid_home/rdbms/audit` and `Grid_home/log/diag/*` directories have been moved or deleted before extending a cluster.
12. Refer to My Oracle Support note 744213.1 if the installer runs out of memory. The note describes how to edit the `Grid_home/oui/ora-param.ini` file, and change the `JRE_MEMORY_OPTIONS` parameter to `-Xms512m-Xmx2048m`.
13. Add the new servers by running the `addNode.sh` script from an existing server as the Grid user.

- If you are running Oracle Grid Infrastructure 11g:

```
$ cd Grid_home/oui/bin
$ ./addNode.sh -silent -responseFile /path/to/add-cluster-nodes.rsp
```

- If you are running Oracle Grid Infrastructure 12c or later, run the `addnode.sh` command with the `CLUSTER_NEW_NODES` and `CLUSTER_NEW_VIRTUAL_HOSTNAMES` parameters. The syntax is:

```
$ ./addnode.sh -silent
"CLUSTER_NEW_NODES={comma_delimited_new_nodes}"
"CLUSTER_NEW_VIRTUAL_HOSTNAMES={comma_delimited_new_node_vips}"
```

For example:

```
$ cd Grid_home/addnode/

$ ./addnode.sh -silent
"CLUSTER_NEW_NODES={dm02db01,dm02db02,dm02db03,dm02db04,dm02db05,
dm02db06,dm02db07,dm02db08}"
"CLUSTER_NEW_VIRTUAL_HOSTNAMES={dm02db01-vip,dm02db02-vip,
dm02db03-vip,dm02db04-vip,dm02db05-vip,dm02db06-vip,dm02db07-
```

```
vip, dm02db08-vip}"  
-ignoreSysPrereqs -ignorePrereq
```

14. Verify the grid disks are visible from each of the new database servers.

```
$ Grid_home/grid/bin/kfod disks=all dscvgroup=true
```

15. Run the `orainstRoot.sh` script as the `root` user when prompted using the `dcli` utility.

```
$ dcli -g new_db_nodes -l root \  
/u01/app/oraInventory/orainstRoot.sh
```

16. Disable HAIP on the new servers.

Before running the `root.sh` script, on each new server, set the `HAIP_UNSUPPORTED` environment variable to `TRUE`.

```
$ export HAIP_UNSUPPORTED=true
```

17. Run the `Grid_home/root.sh` script on each server sequentially. This simplifies the process, and ensures that any issues can be clearly identified and addressed.

 **Note:**

The node identifier is set in order of the nodes where the `root.sh` script is run. Typically, the script is run from the lowest numbered node name to the highest.

18. Check the log file from the `root.sh` script and verify there are no problems on the server before proceeding to the next server. If there are problems, then resolve them before continuing.
19. Check the status of the cluster after adding the servers.

```
$ cluvfy stage -post nodeadd -n \  
  
dm02db01, dm02db02, dm02db03, dm02db04, dm02db05, dm02db06, dm02db07, dm02db08  
\  
-verbose
```

20. Check that all servers have been added and have basic services running.

```
crsctl stat res -t
```

 **Note:**

It may be necessary to mount disk groups on the new servers. The following commands must be run as the `oracle` user.

```
$ srvctl start diskgroup -g data
$ srvctl start diskgroup -g reco
```

21. If you are running Oracle Grid Infrastructure releases 11.2.0.2 and later, then perform the following steps:
 - a. Manually add the `CLUSTER_INTERCONNECTS` parameter to the SPFILE for each Oracle ASM instance.


```
ALTER SYSTEM SET cluster_interconnects = '192.168.10.x' \
sid='+ASMx' scope=spfile
```
 - b. Restart the cluster on each new server.
 - c. Verify the parameters were set correctly.

3.8 Configuring Cell Alerts for New Oracle Exadata Storage Servers

Cell alerts need to be configured for the new Oracle Exadata Storage Servers.

The configuration depends on the type of installation.

- When extending Oracle Exadata Database Machine Quarter Rack to Half Rack, or Half Rack to Full Rack:

Manually configure cell alerts on the new storage servers. Use the settings on the original storage servers as a guide. To view the settings on the original storage servers, use a command similar to the following:

```
dcli -g new_cells_nodes -l celladmin cellcli -e list cell detail
```

To view the alerts on the new storage servers, use a command similar to the following:

```
dcli -g new_cell_nodes -l root "cellcli -e ALTER CELL \
smtpServer='mailserver.example.com' \
smtpPort=25, \
smtpUseSSL=false,smtpFrom='DBM dm01\ ', \
smtpFromAddr='storecell@example.com\ ', \
smtpToAddr='dbm-admins@example.com\ ', \
notificationMethod='mail,snmp\ ', \
notificationPolicy='critical,warning,clear\ ', \
snmpSubscriber=\\(host='snmpserver.example.com, port=162\')\)"
```

 **Note:**

The backslash character (\) is used as an escape character for the `dcli` utility, and as a line continuation character in the preceding command.

- When cabling racks:
Use Oracle Exadata Deployment Assistant (OEDA) to set up e-mail alerts for storage servers as the `root` user from the original rack to the new rack. The utility includes the `SetupCellEmailAlerts` step to configure alerts.

3.9 Adding Oracle Database Software to the New Servers

It is necessary to add the Oracle Database software directory `ORACLE_HOME` to the database servers after the cluster modifications are complete, and all the database servers are in the cluster.

1. Check the `Oracle_home/bin` directory for files ending in zero (0), such as `nmb0`, that are owned by the `root` user and do not have `oinstall` or world read privileges. Use the following command to modify the file privileges:

```
# chmod a+r $ORACLE_HOME/bin/*0
```

If you are running Oracle Database release 12c or later, you also have to change permissions for files ending in uppercase O, in addition to files ending in zero.

```
# chmod a+r $ORACLE_HOME/bin/*O
```

2. This step is required for Oracle Database 11g only. If you are running Oracle Database 12c, you can skip this step because the directory has already been created.

Create the `ORACLE_BASE` directory for the database owner, if it is different from the Oracle Grid Infrastructure software owner (Grid user) using the following commands:

```
# dcli -g root/new_group_files/dbs_group -l root mkdir -p /u01/app/oracle
# dcli -g root/new_group_files/dbs_group -l root chown oracle:oinstall \
/u01/app/oracle
```

3. Run the following command to set ownership of the `emocrmsp` file in the Oracle Database `$ORACLE_HOME` directory:

```
# dcli -g old_db_nodes -l root chown -f oracle:dba \
/u01/app/11.2.0/grid/OPatch/ocm/bin/emocrmsp
```

4. This step is required for Oracle Database 11g only. If you are running Oracle Database 12c, then you can skip this step because the values are entered on the command line.

Create a response file, `add-db-nodes.rsp`, as the `oracle` owner to add the new servers similar to the following:

```
RESPONSEFILE_VERSION=2.2.1.0.0

CLUSTER_NEW_NODES={dm02db01,dm02db02,dm02db03,dm02db04,dm02db05, \
dm02db06,dm02db07,dm02db08}
```

 **Note:**

The lines listing the server names should appear on one continuous line. The are wrapped in the document due to page limitations.

5. Add the Oracle Database `ORACLE_HOME` directory to the new servers by running the `addNode.sh` script from an existing server as the database owner user.

- If you are running Oracle Grid Infrastructure 11g:

```
$ cd $ORACLE_HOME/oui/bin
$ ./addNode.sh -silent -responseFile /path/to/add-db-nodes.rsp
```

- If you are running Oracle Grid Infrastructure 12c, then you specify the nodes on the command line. The syntax is:

```
./addnode.sh -silent "CLUSTER_NEW_NODES={comma_delimited_new_nodes}"
```

For example:

```
$ cd $Grid_home/addnode

$ ./addnode.sh -silent
"CLUSTER_NEW_NODES={dm02db01,dm02db02,dm02db03,dm02db04,dm02db05,
dm02db06,dm02db07,dm02db08}" -ignoreSysPrereqs -ignorePrereq
```

6. Ensure the `$ORACLE_HOME/oui/oraparam.ini` file has the memory settings that match the parameters set in the Oracle Grid Infrastructure home.
7. Run the `root.sh` script on each server when prompted as the `root` user using the `dcli` utility.

```
$ dcli -g new_db_nodes -l root $ORACLE_HOME/root.sh
```

In the preceding command, `new_db_nodes` is the file with the list of new database servers.

8. Verify the `ORACLE_HOME` directories have been added to the new servers.

```
# dcli -g /root/all_group -l root du -sm \
/u01/app/oracle/product/11.2.0/dbhome_1
```

3.10 Adding Database Instance to the New Servers

Before adding the database instances to the new servers, check the following:

- **Maximum file size:** If any data files have reached their maximum file size, then the `addInstance` command may fail with an ORA-00740 error. Oracle recommends you check that none of the files listed in `DBA_DATA_FILES` have reached their maximum size. Files that have reached their maximum should be corrected.
 - **Online redo logs:** If the online redo logs are kept in the directory specified by the `DB_RECOVERY_FILE_DEST` parameter, then ensure the space allocated is sufficient for the additional redo logs for the new instances being added. If necessary, then increase the size for the `DB_RECOVERY_FILE_DEST_SIZE` parameter.
 - **Total number of instances in the cluster:** Set the value of the initialization parameter `cluster_database_instances` in the SPFILE for each database to the total number of instances that will be in the cluster after adding the new servers.
 - **The HugePages settings are correctly configured on the new servers to match the existing servers.**
1. Use a command similar the following from an existing database server to add instances to the new servers. In the command, the instance, `dbm9`, is being added for server `dm02db01`.

```
dbca -silent -addInstance -gdbName dbm -nodeList dm02db01 -instanceName  
dbm9 \  
-sysDBAUsername sys
```

The command must be run for all servers and instances, substituting the server name and instance name, as appropriate.

Note:

If the command fails, then ensure any files that were created, such as redo log files, are cleaned up. The `deleteInstance` command does not clean log files or data files that were created by the `addInstance` command.

2. Add the `CLUSTER_INTERCONNECTS` parameter to each new instance.
 - a. Manually add the `CLUSTER_INTERCONNECTS` parameter to the SPFILE for each new database instance. The additions are similar to the existing entries, but are the RDMA Network Fabric addresses corresponding to the server that each instance runs on.
 - b. Restart the instance on each new server.
 - c. Verify the parameters were set correctly.

3.11 Returning the Rack to Service

Use the following procedure to ensure the new hardware is correctly configured and ready for use:

1. Verify the RDMA Network Fabric cables are connected and secure.
 - For RoCE, run the `verify_roce_cables.py` script, available from My Oracle Support.
 - For InfiniBand, run the `/opt/oracle.SupportTools/ibdiagtools/verify-topology` command.
2. Run the Oracle Exadata Database Machine HealthCheck utility using the steps described in My Oracle Support note 1070954.1.
3. Verify the instance additions using the following commands:

```
srvctl config database -d dbm
srvctl status database -d dbm
```

4. Check the cluster resources using the following command:

```
crsctl stat res -t
```

5. Ensure the original configuration summary report from the original cluster deployment is updated to include all servers. This document should include the calibrate and network verifications for the new rack, and the RDMA Network Fabric cable checks.
6. Conduct a power-off test, if possible. If the new Exadata Storage Servers cannot be powered off, then verify that the new database servers with the new instances can be powered off and powered on, and that all processes start automatically.

 **Note:**

Ensure the Oracle ASM disk rebalance process has completed for all disk groups. Use SQL*Plus to connect to an Oracle ASM instance and issue the following command:

```
SELECT * FROM gv$asm_operation;
```

No rows should be returned by the command.

7. Review the configuration settings, such as the following:
 - All parallelism settings
 - Backup configurations
 - Standby site, if any
 - Service configuration
 - Oracle Database File System (DBFS) configuration, and mount points on new servers (not required for X7 and later servers)
 - Installation of Oracle Enterprise HugePage Manager agents on new database servers
 - HugePages settings
8. Incorporate the new cell and database servers into Oracle Auto Service Request (ASR).

9. Update Oracle Enterprise Manager Cloud Control to include the new nodes.

Related Topics

- [Verifying InfiniBand Network Configuration](#)
- [About Oracle Auto Service Request](#)
- [Verify RoCE Cabling on Oracle Exadata Database Machine X8M-2 and X8M-8 Servers \(My Oracle Support Doc ID 2587717.1\)](#)
- [Oracle Exadata Database Machine EXAchk or HealthCheck \(My Oracle Support Doc ID 1070954.1\)](#)

4

Multi-Rack Cabling Tables for Oracle Engineered System Rack X8M

This appendix contains the tables for multi-rack cabling Oracle Engineered System Rack X8M, which uses the RDMA over RoCE Network Fabric.

- [Understanding Multi-Rack Cabling for X8M Racks](#)
Up to eight racks can be cabled together without external RDMA Network Fabric switches.
- [Two-Rack Cabling for X8M Racks](#)
This section provides the cabling tables to connect two Oracle Engineered System Racks together, both of which use RDMA over RoCE Network Fabric
- [Three-Rack Cabling for X8M Racks](#)
This section provides the cabling tables to connect three Oracle Engineered System Racks together using the RDMA over RoCE Network Fabric.
- [Four-Rack Cabling for X8M Racks](#)
This section provides the cabling tables to connect four Oracle Engineered System Racks together, all of which use RDMA over RoCE Network Fabric.
- [Five-Rack Cabling for X8M Racks](#)
This section provides the cabling tables to connect five (5) Oracle Engineered System Racks together, all of which use RDMA over RoCE Network Fabric.
- [Six-Rack Cabling for X8M Racks](#)
This section provides the cabling tables to connect six (6) Oracle Engineered System Racks together, all of which use RDMA over RoCE Network Fabric.
- [Seven-Rack Cabling for X8M Racks](#)
This section provides the cabling tables to connect seven (7) Oracle Engineered System Racks together, all of which use RDMA over RoCE Network Fabric.
- [Eight-Rack Cabling for X8M Racks](#)
This section provides the cabling tables to connect eight (8) Oracle Engineered System Racks together, all of which use RDMA over RoCE Network Fabric.

4.1 Understanding Multi-Rack Cabling for X8M Racks

Up to eight racks can be cabled together without external RDMA Network Fabric switches.

Three RDMA Network Fabric switches are needed when cabling racks together. If any rack does not include a third switch (spine switch), then order the expansion switch kit. These switches attach to standard RDMA Network Fabric connectors at the end of the cables. The procedures in this section assume the racks are adjacent to each other, standard routing in raised floor is used, and there are no obstacles in the raised floor. If these assumptions are not correct for your environment, then longer cables may be required for the connections.

The switch at rack unit 1 (U1) is referred to as the spine switch.

The following switches are referred to as leaf switches:

- The switches at rack unit 21 (U21) and 23 (U23) in Oracle Engineered System X8M-8.
- The switches at rack unit 20 (U20) and 22 (U22) in Oracle Engineered System X8M-2.

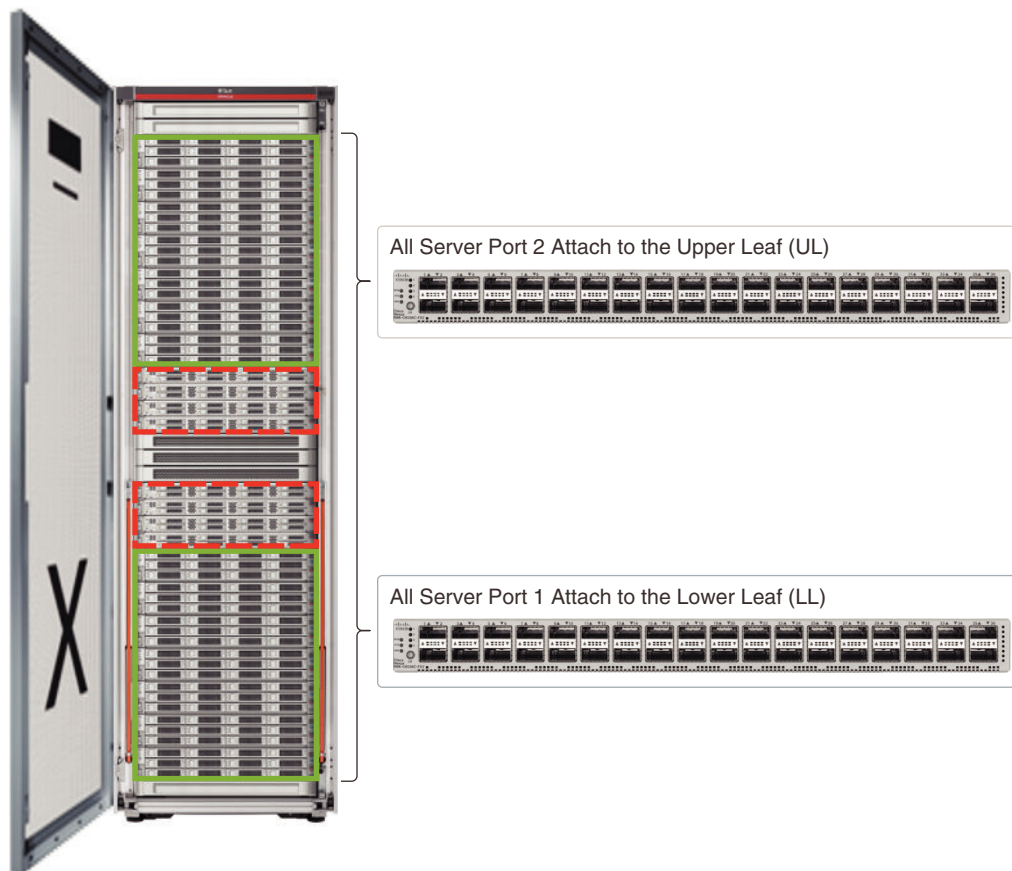
 **Note:**

Oracle Exadata Database Machine X8M racks by default do not include spare cables or a third Cisco Nexus 9336C-FX2 Switch. To extend these racks, you must order cables and a Cisco Nexus 9336C-FX2 Switch. Or simply order the correct cables to extend the rack if the Cisco Nexus 9336C-FX2 Switch is already installed in U1.

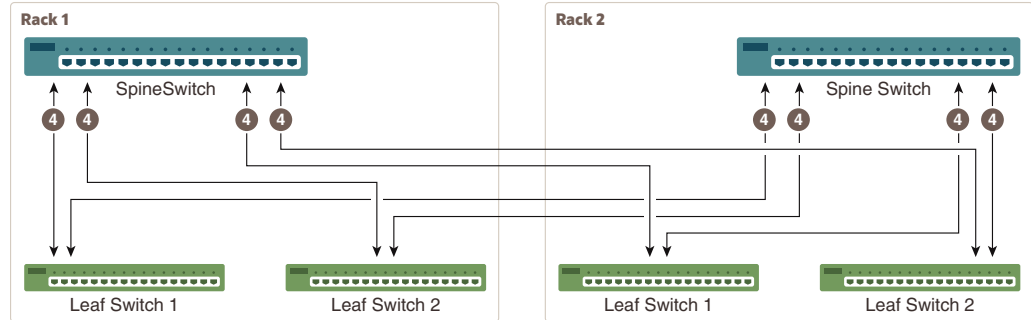
In a single rack, the two leaf switches are interconnected using eight connections.

The database servers and storage servers connect to the leaf switches as shown in the following graphic:

Figure 4-1 RDMA Network Fabric Connections Between Database Servers and Storage Servers and Leaf Switches



When connecting up to eight racks together, remove the eight existing inter-switch connections between each leaf switch on each rack. From each leaf switch, distribute eight connections over the spine switches in all racks. In multi-rack environments, the leaf switches inside a rack are no longer directly interconnected, as shown in the following graphic:



As shown in the preceding graphic, each leaf switch in rack 1 has the following connections:

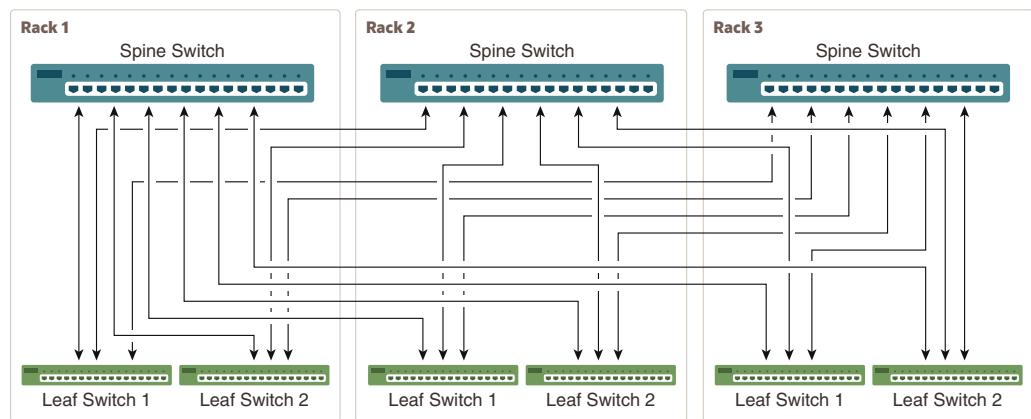
- Four connections to its internal spine switch
- Four connections to the spine switch in rack 2

The spine switch in rack 1 has the following connections:

- Four connections to each leaf switch in rack 1
- Four connections to each leaf switch in rack 2

As the number of racks increases from two to eight, the pattern continues as shown in the following graphic:

Figure 4-2 Connections Between Spine Switches and Leaf Switches for up to 8 Racks



As shown in the preceding graphic, each leaf switch has eight inter-switch connections distributed over all spine switches. Each spine switch has 16 inter-switch connections distributed over all leaf switches. The leaf switches are not directly interconnected with other leaf switches, and the spine switches are not directly interconnected with the other spine switches.

- [Preparing to Cable Racks Together](#)
- [Cabling Multiple Oracle Engineered System Racks](#)

4.1.1 Preparing to Cable Racks Together

Racks can be added together to increase system capacity and performance. When cabling racks together, note the following:

- Oracle recommends that the names for the servers include the rack unit number. This helps identify the server during diagnostics.
- When completing Oracle Exadata Deployment Assistant (OEDA) for the additional rack, you are prompted for SCAN addresses. However, these SCAN addresses are not used because the SCAN address from the original rack are used. Manually remove the new SCAN addresses from the generated installation files.
- The software owner account names and group names, as well as their identifiers, must match the names and identifiers of the original rack.
- If the additional grid disks are used with existing disk groups, then ensure the grid disk sizes for the new rack are the same as the original rack.



Note:

Oracle Engineered System Eighth Racks, Quarter Racks, and Elastic Configurations are connected to other racks in the same fashion as larger racks are connected to each other. In other words, **a spine switch must exist in each rack in order to Multi-rack with other racks.**

Perform the following tasks before cabling racks together:

1. Determine the number of racks that will be cabled together.
2. Order the parts needed to connect the racks.

To extend Oracle Engineered System X8M racks, for each rack being added you must order extra cables, transceivers for longer cables, and a Cisco Nexus C9336C-FX2 switch, if one is not already available.

When connecting four or more racks, or if you need longer cables for your environment, you must purchase additional 10 meter fiber cables with two QSFP SR transceivers to connect each end. The QSFP SR transceivers are needed for fiber cables over 5 meters in length. The following table lists the number of racks, and cables needed to interconnect the racks

Number of Racks	3 Meter Cables Needed	5 Meter Cables Needed	10 Meter Cables Needed
2	16	16	0
3	18	30	0
4	16	40	8
5	20	42	18
6	24	46	26
7	28	44	40

Number of Racks	3 Meter Cables Needed	5 Meter Cables Needed	10 Meter Cables Needed
8	16	52	60

3. Gather the following tools:

- Pen
- Note pad
- Flashlight
- Labels for cables and rack
- Cable ties (Oracle recommends hook and loop straps)

 **See Also:**

Cables and Cable Accessories for Oracle Exadata Rack for information about cable labels

4. Determine a naming method for the rack prefixes. For example, if the original rack has the prefix `dm01`, then use the prefix `dm02` for the second rack, the prefix `dm03` for the third rack, and so on.

5. Verify the racks have unique host names and IP addresses. All servers interconnected in the racks must have unique names and IP addresses.

Server names and IP addresses conventions may differ in the following cases:

- **Initial installation of all Oracle Engineered System Racks:** System address assignments and host names should be complete.
 - **New Oracle Engineered System Racks are added to an existing cluster:** The new rack configuration should require unique host names and IP addresses for the new Oracle Engineered System. The IP addresses on the same subnet cannot conflict with the existing systems.
 - **Two existing Oracle Engineered System Racks are clustered together:** You can assign host names and IP addresses only if Oracle Engineered Systems are already assigned unique host names and IP addresses, or the entire cluster must be reconfigured. The machines must be on the same subnet and not have conflicting IP addresses.
6. Ensure the IP addresses for the new servers are in the same subnet, and do not overlap with the currently-installed servers.
7. Ensure the firmware on the original switches are at the same level as the new switches using the `sh ver` command. If the firmware is not at the same level, then apply a firmware patch.

4.1.2 Cabling Multiple Oracle Engineered System Racks

A spine switch must exist in the Oracle Engineered System rack, regardless of size, to multi-rack with other racks.

 **Note:**

To extend Oracle Engineered System X8M racks, you must order cables, transceivers if needed, and a Cisco Nexus C9336C-FX2 switch if they are not already available.

In the following steps, the number in parentheses also indicates the number of cables required.

1. Split each leaf switch uplink bundle by the number of spine switches (or racks) in such a way that the total count adds up to 8. This split is represented in parentheses for each example.

Example 1: For two racks, take 8 uplinks from each leaf switch and split evenly by 2. Four uplinks from each leaf switch go to `rack1-spine` switch, and four uplinks from each leaf switch go to `rack2-spine` switch (4 + 4 for each leaf switch).

Example 2: For three racks, take 8 uplinks from each leaf switch and split evenly by 3. Three uplinks go to `rack1-spine` switch, three uplinks go to `rack2-spine` switch, two uplinks go to `rack3-spine` switch (3 + 3 + 2 for each leaf switch).

2. Starting from the first available port on a different spine switch, round-robin the above split scheme for each leaf switch and spine switch.

For example, for three racks:

- `rack1-leaf1` switch starts from `rack1-spine` switch for first split, `rack2-spine` switch for second split, `rack3-spine` switch for third split
 - `rack2-leaf1` switch starts from `rack2-spine` switch for first split, `rack3-spine` switch for second split, `rack1-spine` for third split
 - `rack3-leaf1` switch starts from `rack3-spine` switch for first split, `rack1-spine` switch for second split, `rack2-spine` switch for third split
 - and so on...
3. After walking through all leaf switch uplinks in each case, you will have used all spine switch ports between port 5 and 20 inclusive.

The remaining topics in this section provide detailed cabling information for cabling up to 8 racks together.

4.2 Two-Rack Cabling for X8M Racks

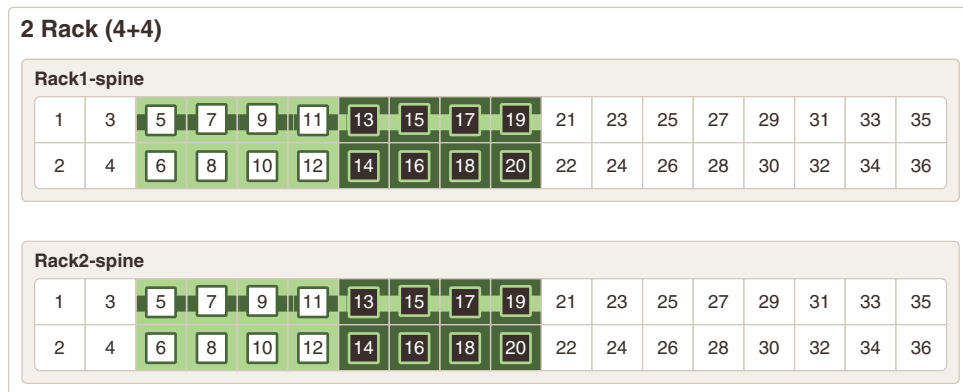
This section provides the cabling tables to connect two Oracle Engineered System Racks together, both of which use RDMA over RoCE Network Fabric

 **Note:**

The following conventions were used in the cabling notation for connecting multiple racks together.

- The spine switch (also referred to as SS) is in U1 for all racks.
- The leaf switches are referred to as Lower Leaf (LL) and Upper Leaf (UL).
- The leaf switches are located as follows:
 - At rack unit 20 (U20) and 22 (U22) in Oracle Engineered System X8M-2 racks or Storage Expansion Rack X8M-2
 - At rack unit 21 (U21) and rack unit 23 (U23) in Oracle Engineered System X8M-8
- The cable lengths shown in the following lists assume that the racks are adjacent to each other, the cables are routed through a raised floor, and there are no obstacles in the routing between the racks. If the racks are not adjacent, or use overhead cabling trays, then they may require longer cable lengths. Cable lengths up to 100 meters are supported.
- Only optical cables (with additional transceivers) are supported for lengths greater than 5 meters.

The following illustration shows the cable connections for the two spine switches (R1 SS and R2 SS) when cabling two racks together:



The following table describes the cable connections for the first spine switch (R1 SS) when cabling two racks together:

Table 4-1 Leaf Switch Connections for the First Rack in a Two-Rack System

Leaf Switch	Connection	Cable Length
R1 UL within Rack 1	R1-UL-P5 to R1-SS-P5 R1-UL-P7 to R1-SS-P7 R1-UL-P4 to R1-SS-P9 R1-UL-P6 to R1-SS-P11	3 meters
R1 UL to Rack 2	R1-UL-P31 to R2-SS-P5 R1-UL-P33 to R2-SS-P7 R1-UL-P30 to R2-SS-P9 R1-UL-P32 to R2-SS-P11	5 meters
R1 LL within Rack 1	R1-LL-P5 to R1-SS-P13 R1-LL-P7 to R1-SS-P15 R1-LL-P4 to R1-SS-P17 R1-LL-P6 to R1-SS-P19	3 meters
R1 LL to Rack 2	R1-LL-P31 to R2-SS-P13 R1-LL-P33 to R2-SS-P15 R1-LL-P30 to R2-SS-P17 R1-LL-P32 to R2-SS-P19	5 meters

The following table describes the cable connections for the second spine switch (R2 SS) when cabling two racks together:

Table 4-2 Leaf Switch Connections for the Second Rack in a Two-Rack System

Leaf Switch	Connection	Cable Length
R2 UL to Rack 1	R2-UL-P5 to R1-SS-P6 R2-UL-P7 to R1-SS-P8 R2-UL-P4 to R1-SS-P10 R2-UL-P6 to R1-SS-P12	5 meters
R2 UL within Rack 2	R2-UL-P31 to R2-SS-P6 R2-UL-P33 to R2-SS-P8 R2-UL-P30 to R2-SS-P10 R2-UL-P32 to R2-SS-P12	3 meters
R2 LL to Rack 1	R2-LL-P5 to R1-SS-P14 R2-LL-P7 to R1-SS-P16 R2-LL-P4 to R1-SS-P18 R2-LL-P6 to R1-SS-P20	5 meters
R2 LL within Rack 2	R2-LL-P31 to R2-SS-P14 R2-LL-P33 to R2-SS-P16 R2-LL-P30 to R2-SS-P18 R2-LL-P32 to R2-SS-P20	3 meters

4.3 Three-Rack Cabling for X8M Racks

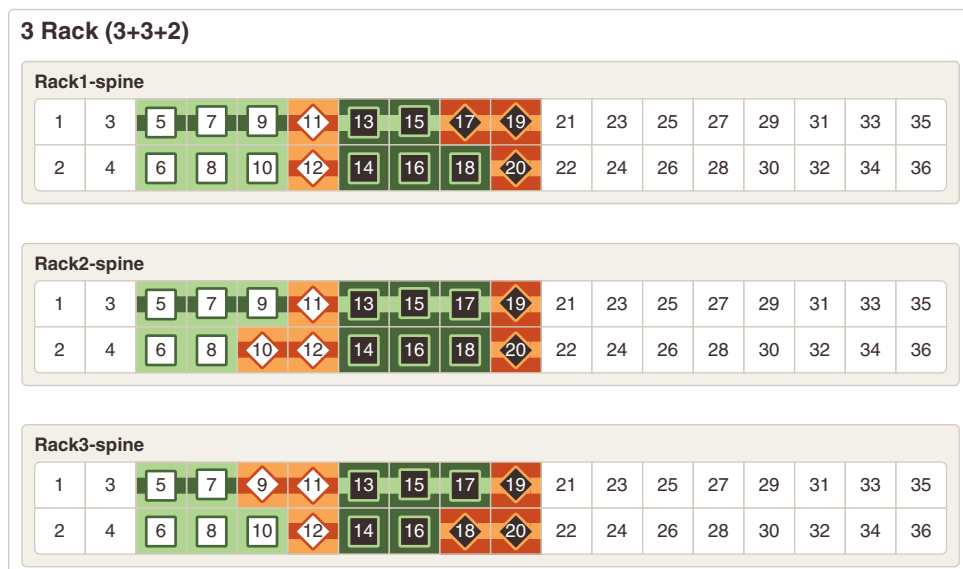
This section provides the cabling tables to connect three Oracle Engineered System Racks together using the RDMA over RoCE Network Fabric.

 **Note:**

The following conventions were used in the cabling notation for connecting multiple racks together.

- The spine switch (also referred to as SS) is in U1 for all racks.
- The leaf switches are referred to as Lower Leaf (LL) and Upper Leaf (UL).
- The leaf switches are located as follows:
 - At rack unit 20 (U20) and 22 (U22) in Oracle Engineered System X8M-2 racks or Storage Expansion Rack X8M-2
 - At rack unit 21 (U21) and rack unit 23 (U23) in Oracle Engineered System X8M-8
- The cable lengths shown in the following lists assume that the racks are adjacent to each other, the cables are routed through a raised floor, and there are no obstacles in the routing between the racks. If the racks are not adjacent, or use overhead cabling trays, then they may require longer cable lengths. Cable lengths up to 100 meters are supported.
- Only optical cables (with additional transceivers) are supported for lengths greater than 5 meters.

The following illustration shows the cable connections for the three spine switches (Rack1-spine, Rack2-spine, and Rack3-spine) when cabling three racks together:



The following table describes the cable connections for the first spine switch (R1-SS) when cabling three racks together:

Table 4-3 Leaf Switch Connections for the First Rack in a Three-Rack System

Leaf Switch	Connection	Cable Length
R1 UL within Rack 1	R1-UL-P5 to R1-SS-P5 R1-UL-P7 to R1-SS-P7 R1-UL-P4 to R1-SS-P9	3 meters
R1 UL to Rack 2	R1-UL-P31 to R2-SS-P5 R1-UL-P33 to R2-SS-P7 R1-UL-P30 to R2-SS-P9	5 meters
R1 UL to Rack 3	R1-UL-P6 to R3-SS-P5 R1-UL-P32 to R3-SS-P7	5 meters
R1 LL within Rack 1	R1-LL-P5 to R1-SS-P13 R1-LL-P7 to R1-SS-P15	3 meters
R1 LL to Rack 2	R1-LL-P31 to R2-SS-P13 R1-LL-P33 to R2-SS-P15 R1-LL-P30 to R2-SS-P17	5 meters
R1 LL to Rack 3	R1-LL-P4 to R3-SS-P13 R1-LL-P6 to R3-SS-P15 R1-LL-P32 to R3-SS-P17	5 meters

The following table describes the cable connections for the second spine switch (R2-SS) when cabling three racks together:

Table 4-4 Leaf Switch Connections for the Second Rack in a Three-Rack System

Leaf Switch	Connection	Cable Length
R2 UL to Rack 1	R2-UL-P5 to R1-SS-P6 R2-UL-P7 to R1-SS-P8 R2-UL-P4 to R1-SS-P10	5 meters
R2 UL within Rack 2	R2-UL-P31 to R2-SS-P6 R2-UL-P33 to R2-SS-P8	3 meters
R2 UL to Rack 3	R2-UL-P6 to R3-SS-P6 R2-UL-P30 to R3-SS-P8 R2-UL-P32 to R3-SS-P10	5 meters
R2 LL to Rack 1	R2-LL-P5 to R1-SS-P14 R2-LL-P7 to R1-SS-P16 R2-LL-P4 to R1-SS-P18	5 meters
R2 LL within Rack 2	R2-LL-P31 to R2-SS-P14 R2-LL-P33 to R2-SS-P16 R2-LL-P30 to R2-SS-P18	3 meters

Table 4-4 (Cont.) Leaf Switch Connections for the Second Rack in a Three-Rack System

Leaf Switch	Connection	Cable Length
R2 LL to Rack 3	R2-LL-P6 to R3-SS-P14 R2-LL-P32 to R3-SS-P16	5 meters

The following table describes the cable connections for the third spine switch (R3-SS) when cabling three racks together:

Table 4-5 Leaf Switch Connections for the Third Rack in a Three-Rack System

Leaf Switch	Connection	Cable Length
R3 UL to Rack 1	R3-UL-P5 to R1-SS-P11 R3-UL-P7 to R1-SS-P12	5 meters
R3 UL to Rack 2	R3-UL-P4 to R2-SS-P10 R3-UL-P6 to R2-SS-P11 R3-UL-P31 to R2-SS-P12	5 meters
R3 UL within Rack 3	R3-UL-P33 to R3-SS-P9 R3-UL-P30 to R3-SS-P11 R3-UL-P32 to R3-SS-P12	3 meters
R3 LL to Rack 1	R3-LL-P5 to R1-SS-P17 R3-LL-P7 to R1-SS-P19 R3-LL-P4 to R1-SS-P20	5 meters
R3 LL to Rack 2	R3-LL-P6 to R2-SS-P19 R3-LL-P31 to R2-SS-P20	5 meters
R3 LL within Rack 3	R3-LL-P33 to R3-SS-P18 R3-LL-P30 to R3-SS-P19 R3-LL-P32 to R3-SS-P20	3 meters

4.4 Four-Rack Cabling for X8M Racks

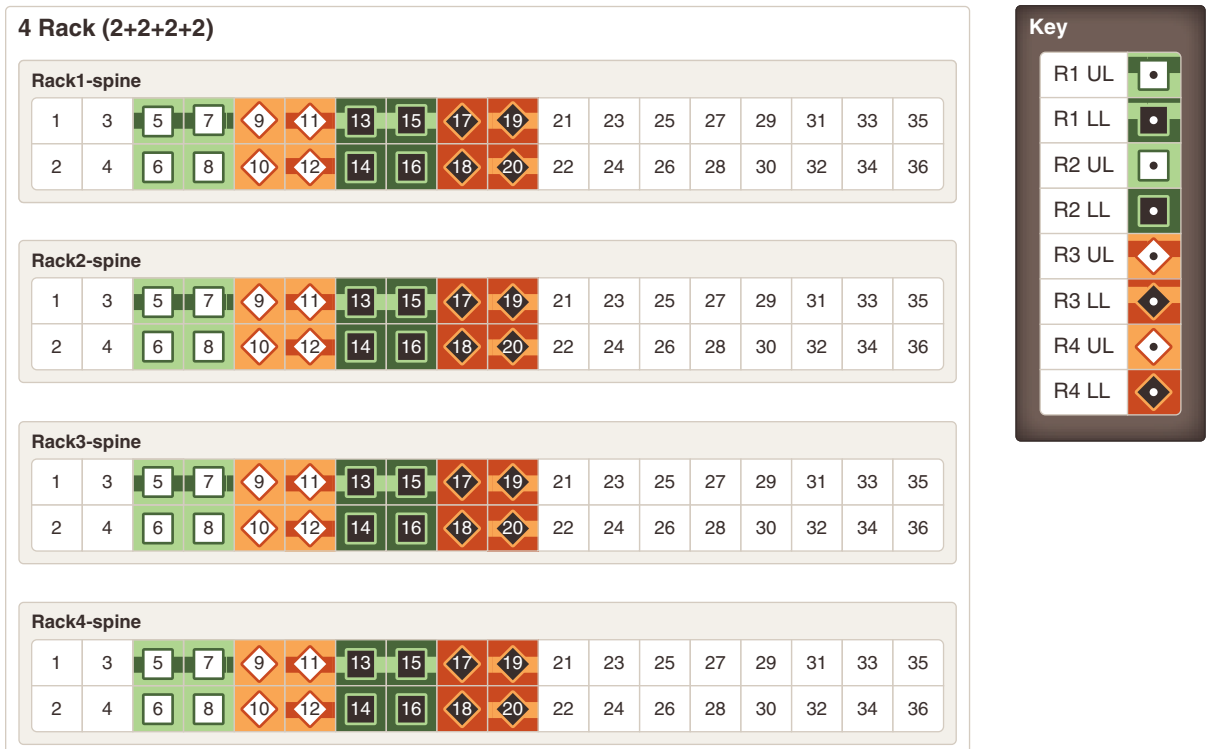
This section provides the cabling tables to connect four Oracle Engineered System Racks together, all of which use RDMA over RoCE Network Fabric.

 **Note:**

The following conventions were used in the cabling notation for connecting multiple racks together.

- The spine switch (also referred to as SS) is in U1 for all racks.
- The leaf switches are referred to as Lower Leaf (LL) and Upper Leaf (UL).
- The leaf switches are located as follows:
 - At rack unit 20 (U20) and 22 (U22) in Oracle Engineered System X8M-2 racks or Storage Expansion Rack X8M-2
 - At rack unit 21 (U21) and rack unit 23 (U23) in Oracle Engineered System X8M-8
- The cable lengths shown in the following lists assume that the racks are adjacent to each other, the cables are routed through a raised floor, and there are no obstacles in the routing between the racks. If the racks are not adjacent, or use overhead cabling trays, then they may require longer cable lengths. Cable lengths up to 100 meters are supported.
- Only optical cables (with additional transceivers) are supported for lengths greater than 5 meters.

The following illustration shows the cable connections for the four spine switches (Rack1-spine, Rack2-spine, Rack3-spine, and Rack4-spine) when cabling two racks together:



The following table describes the cable connections for the first spine switch (R1-SS) when cabling four racks together:

Table 4-6 Leaf Switch Connections for the First Rack in a Four-Rack System

Leaf Switch	Connection	Cable Length
R1 UL within Rack 1	R1-UL-P5 to R1-SS-P5 R1-UL-P7 to R1-SS-P7	3 meters
R1 UL to Rack 2	R1-UL-P31 to R2-SS-P5 R1-UL-P33 to R2-SS-P7	5 meters
R1 UL to Rack 3	R1-UL-P6 to R3-SS-P5 R1-UL-P32 to R3-SS-P7	5 meters
R1 UL to Rack 4	R1-UL-P4 to R4-SS-P5 R1-UL-P30 to R4-SS-P7	10 meters
R1 LL within Rack 1	R1-LL-P5 to R1-SS-P13 R1-LL-P7 to R1-SS-P15	3 meters
R1 LL to Rack 2	R1-LL-P31 to R2-SS-P13 R1-LL-P33 to R2-SS-P15	5 meters
R1 LL to Rack 3	R1-LL-P4 to R3-SS-P13 R1-LL-P6 to R3-SS-P15	5 meters
R1 LL to Rack 4	R1-LL-P30 to R4-SS-P13 R1-LL-P32 to R4-SS-P15	10 meters

The following table describes the cable connections for the second spine switch (R2-SS) when cabling four full racks together:

Table 4-7 Leaf Switch Connections for the Second Rack in a Four-Rack System

Leaf Switch	Connection	Cable Length
R2 UL to Rack 1	R2-UL-P5 to R1-SS-P6 R2-UL-P7 to R1-SS-P8	5 meters
R2 UL within Rack 2	R2-UL-P31 to R2-SS-P6 R2-UL-P33 to R2-SS-P8	3 meters
R2 UL to Rack 3	R2-UL-P6 to R3-SS-P6 R2-UL-P30 to R3-SS-P8	5 meters
R2 UL to Rack 4	R2-UL-P4 to R4-SS-P6 R2-UL-P32 to R4-SS-P8	5 meters
R2 LL to Rack 1	R2-LL-P5 to R1-SS-P14 R2-LL-P7 to R1-SS-P16	5 meters
R2 LL within Rack 2	R2-LL-P31 to R2-SS-P14 R2-LL-P33 to R2-SS-P16	3 meters
R2 LL to Rack 3	R2-LL-P6 to R3-SS-P14 R2-LL-P32 to R3-SS-P16	5 meters
R2 LL to Rack 4	R2-LL-P4 to R4-SS-P14 R2-LL-P30 to R4-SS-P16	5 meters

The following table describes the cable connections for the third spine switch (R3-SS) when cabling four full racks together:

Table 4-8 Leaf Switch Connections for the Third Rack in a Four-Rack System

Leaf Switch	Connection	Cable Length
R3 UL to Rack 1	R3-UL-P5 to R1-SS-P11 R3-UL-P7 to R1-SS-P12	5 meters
R3 UL to Rack 2	R3-UL-P6 to R2-SS-P11 R3-UL-P31 to R2-SS-P12	5 meters
R3 UL within Rack 3	R3-UL-P30 to R3-SS-P11 R3-UL-P32 to R3-SS-P12	3 meters
R3 UL to Rack 4	R3-UL-P4 to R4-SS-P11 R3-UL-P33 to R4-SS-P12	5 meters
R3 LL to Rack 1	R3-LL-P7 to R1-SS-P19 R3-LL-P4 to R1-SS-P20	5 meters
R3 LL to Rack 2	R3-LL-P6 to R2-SS-P19 R3-LL-P31 to R2-SS-P20	5 meters
R3 LL within Rack 3	R3-LL-P30 to R3-SS-P19 R3-LL-P32 to R3-SS-P20	3 meters
R3 LL to Rack 4	R3-LL-P5 to R4-SS-P19 R3-LL-P33 to R4-SS-P20	5 meters


The following table describes the cable connections for the fourth spine switch (R4-SS) when cabling four full racks together:

Table 4-9 Leaf Switch Connections for the Fourth Rack in a Four-Rack System

Leaf Switch	Connection	Cable Length
R4 UL to Rack 1	R4-UL-P5 to R1-SS-P9 R4-UL-P7 to R1-SS-P10	10 meters
R4 UL to Rack 2	R4-UL-P4 to R2-SS-P9 R4-UL-P6 to R2-SS-P10	5 meters
R4 UL to Rack 3	R4-UL-P31 to R3-SS-P9 R4-UL-P33 to R3-SS-P10	5 meters
R4 UL within Rack 4	R4-UL-P30 to R4-SS-P9 R4-UL-P32 to R4-SS-P10	3 meters
R4 LL to Rack 1	R4-LL-P5 to R1-SS-P17 R4-LL-P7 to R1-SS-P18	10 meters
R4 LL to Rack 2	R4-LL-P4 to R2-SS-P17 R4-LL-P6 to R2-SS-P18	5 meters
R4 LL to Rack 3	R4-LL-P31 to R3-SS-P17 R4-LL-P33 to R3-SS-P18	5 meters
R4 LL within Rack 4	R4-LL-P30 to R4-SS-P17 R4-LL-P32 to R4-SS-P18	3 meters

4.5 Five-Rack Cabling for X8M Racks

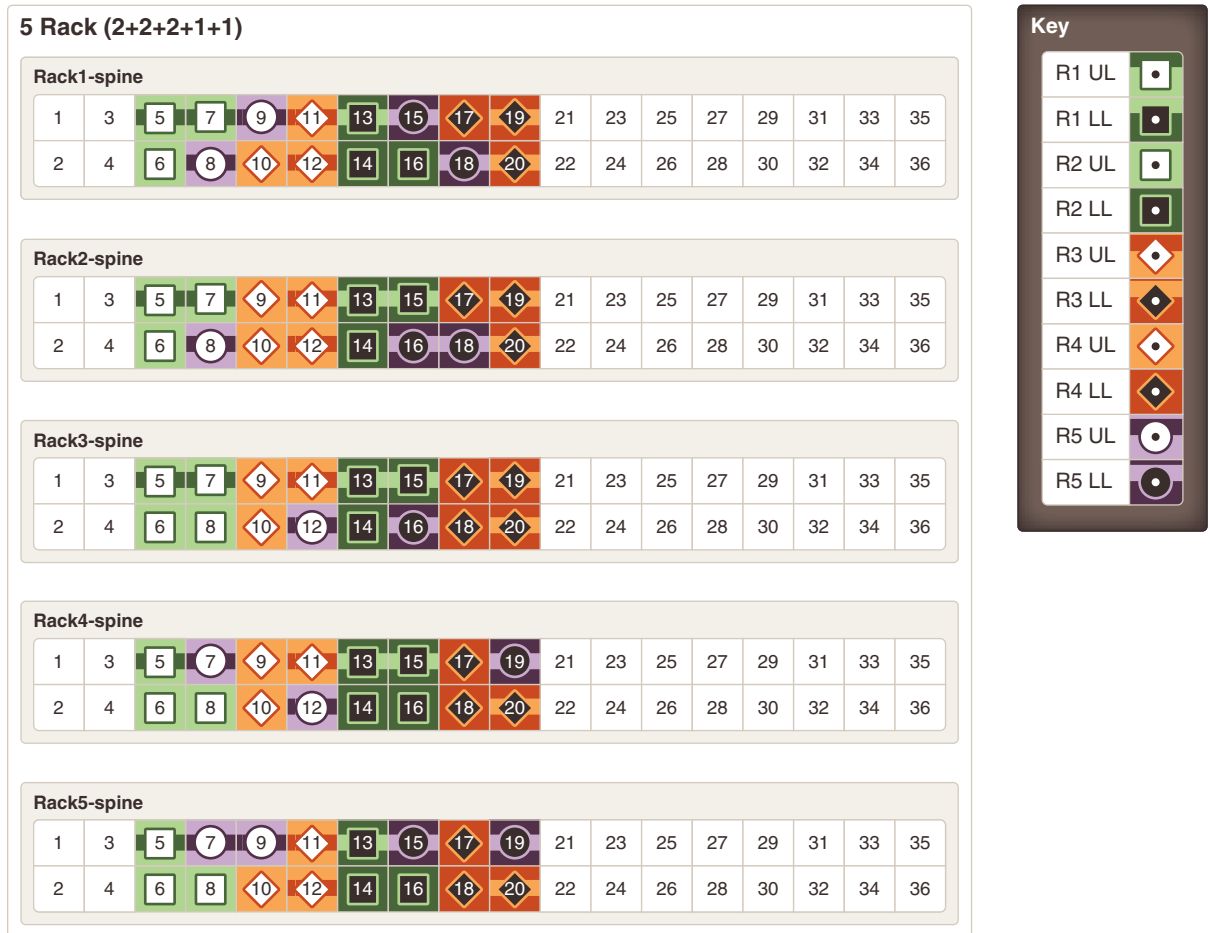
This section provides the cabling tables to connect five (5) Oracle Engineered System Racks together, all of which use RDMA over RoCE Network Fabric.

 **Note:**

The following conventions were used in the cabling notation for connecting multiple racks together.

- The spine switch (also referred to as SS) is in U1 for all racks.
- The leaf switches are referred to as Lower Leaf (LL) and Upper Leaf (UL).
- The leaf switches are located as follows:
 - At rack unit 20 (U20) and 22 (U22) in Oracle Engineered System X8M-2 racks or Storage Expansion Rack X8M-2
 - At rack unit 21 (U21) and rack unit 23 (U23) in Oracle Engineered System X8M-8
- The cable lengths shown in the following lists assume that the racks are adjacent to each other, the cables are routed through a raised floor, and there are no obstacles in the routing between the racks. If the racks are not adjacent, or use overhead cabling trays, then they may require longer cable lengths. Cable lengths up to 100 meters are supported.
- Only optical cables (with additional transceivers) are supported for lengths greater than 5 meters.

The following illustration shows the cable connections for the five spine switches when cabling five racks together:



The following table describes the cable connections for the first spine switch (R1-SS) when cabling five racks together:

Table 4-10 Leaf Switch Connections for the First Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R1 UL within Rack 1	R1-UL-P5 to R1-SS-P5 R1-UL-P7 to R1-SS-P7	3 meters
R1 UL to Rack 2	R1-UL-P31 to R2-SS-P5 R1-UL-P33 to R2-SS-P7	5 meters
R1 UL to Rack 3	R1-UL-P6 to R3-SS-P5 R1-UL-P32 to R3-SS-P7	5 meters
R1 UL to Rack 4	R1-UL-P4 to R4-SS-P5	10 meters
R1 UL to Rack 5	R1-UL-P30 to R5-SS-P5	10 meters
R1 LL within Rack 1	R1-LL-P5 to R1-SS-P13	3 meters
R1 LL to Rack 2	R1-LL-P31 to R2-SS-P13 R1-LL-P33 to R2-SS-P15	5 meters
R1 LL to Rack 3	R1-LL-P4 to R3-SS-P13 R1-LL-P6 to R3-SS-P15	5 meters

Table 4-10 (Cont.) Leaf Switch Connections for the First Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R1 LL to Rack 4	R1-LL-P30 to R4-SS-P13 R1-LL-P32 to R4-SS-P15	10 meters
R1 LL to Rack 5	R1-LL-P7 to R5-SS-P13	10 meters

The following table describes the cable connections for the second spine switch (R2-SS) when cabling five full racks together:

Table 4-11 Leaf Switch Connections for the Second Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R2 UL to Rack 1	R2-UL-P5 to R1-SS-P6	5 meters
R2 UL within Rack 2	R2-UL-P31 to R2-SS-P6	3 meters
R2 UL to Rack 3	R2-UL-P6 to R3-SS-P6 R2-UL-P30 to R3-SS-P8	5 meters
R2 UL to Rack 4	R2-UL-P4 to R4-SS-P6 R2-UL-P32 to R4-SS-P8	5 meters
R2 UL to Rack 5	R2-UL-P7 to R5-SS-P6 R2-UL-P33 to R5-SS-P8	10 meters
R2 LL to Rack 1	R2-LL-P5 to R1-SS-P14 R2-LL-P7 to R1-SS-P16	5 meters
R2 LL within Rack 2	R2-LL-P31 to R2-SS-P14	3 meters
R2 LL to Rack 3	R2-LL-P6 to R3-SS-P14	5 meters
R2 LL to Rack 4	R2-LL-P4 to R4-SS-P14 R2-LL-P30 to R4-SS-P16	5 meters
R2 LL to Rack 5	R2-LL-P33 to R5-SS-P14 R2-LL-P32 to R5-SS-P16	10 meters

The following table describes the cable connections for the third spine switch (R3-SS) when cabling five full racks together:

Table 4-12 Leaf Switch Connections for the Third Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R3 UL to Rack 1	R3-UL-P5 to R1-SS-P11 R3-UL-P7 to R1-SS-P12	5 meters
R3 UL to Rack 2	R3-UL-P6 to R2-SS-P11 R3-UL-P31 to R2-SS-P12	5 meters
R3 UL within Rack 3	R3-UL-P30 to R3-SS-P11	3 meters
R3 UL to Rack 4	R3-UL-P4 to R4-SS-P11	5 meters

Table 4-12 (Cont.) Leaf Switch Connections for the Third Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R3 UL to Rack 5	R3-UL-P32 to R5-SS-P11 R3-UL-P33 to R5-SS-P12	5 meters
R3 LL to Rack 1	R3-LL-P7 to R1-SS-P19 R3-LL-P4 to R1-SS-P20	5 meters
R3 LL to Rack 2	R3-LL-P6 to R2-SS-P19 R3-LL-P31 to R2-SS-P20	5 meters
R3 LL within Rack 3	R3-LL-P30 to R3-SS-P19 R3-LL-P32 to R3-SS-P20	3 meters
R3 LL to Rack 4	R3-LL-P33 to R4-SS-P20	5 meters
R3 LL to Rack 5	R3-LL-P5 to R5-SS-P20	5 meters

The following table describes the cable connections for the fourth spine switch (R4-SS) when cabling five full racks together:

Table 4-13 Leaf Switch Connections for the Fourth Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R4 UL to Rack 1	R4-UL-P7 to R1-SS-P10	10 meters
R4 UL to Rack 2	R4-UL-P4 to R2-SS-P9 R4-UL-P6 to R2-SS-P10	5 meters
R4 UL to Rack 3	R4-UL-P31 to R3-SS-P9 R4-UL-P33 to R3-SS-P10	5 meters
R4 UL within Rack 4	R4-UL-P30 to R4-SS-P9 R4-UL-P32 to R4-SS-P10	3 meters
R4 UL to Rack 5	R4-UL-P5 to R5-SS-P10	5 meters
R4 LL to Rack 1	R4-LL-P5 to R1-SS-P17	10 meters
R4 LL to Rack 2	R4-LL-P4 to R2-SS-P17	5 meters
R4 LL to Rack 3	R4-LL-P31 to R3-SS-P17 R4-LL-P33 to R3-SS-P18	5 meters
R4 LL within Rack 4	R4-LL-P30 to R4-SS-P17 R4-LL-P32 to R4-SS-P18	3 meters
R4 LL to Rack 5	R4-LL-P7 to R5-SS-P17 R4-LL-P6 to R5-SS-P18	5 meters

The following table describes the cable connections for the fifth spine switch (R5-SS) when cabling five full racks together:

Table 4-14 Leaf Switch Connections for the Fifth Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R5 UL to Rack 1	R5-UL-P5 to R1-SS-P8 R5-UL-P7 to R1-SS-P9	10 meters
R5 UL to Rack 2	R5-UL-P4 to R2-SS-P8	10 meters
R5 UL to Rack 3	R5-UL-P6 to R3-SS-P12	5 meters
R5 UL to Rack 4	R5-UL-P31 to R4-SS-P7 R5-UL-P33 to R4-SS-P12	5 meters
R5 UL within Rack 5	R5-UL-P30 to R5-SS-P7 R5-UL-P32 to R5-SS-P9	3 meters
R5 LL to Rack 1	R5-LL-P5 to R1-SS-P15 R5-LL-P7 to R1-SS-P18	10 meters
R5 LL to Rack 2	R5-LL-P4 to R2-SS-P16 R5-LL-P6 to R2-SS-P18	10 meters
R5 LL to Rack 3	R5-LL-P31 to R3-SS-P16	5 meters
R5 LL to Rack 4	R5-LL-P33 to R4-SS-P19	5 meters
R5 LL within Rack 5	R5-LL-P30 to R5-SS-P15 R5-LL-P32 to R5-SS-P19	3 meters

4.6 Six-Rack Cabling for X8M Racks

This section provides the cabling tables to connect six (6) Oracle Engineered System Racks together, all of which use RDMA over RoCE Network Fabric.

 **Note:**

The following conventions were used in the cabling notation for connecting multiple racks together.

- The spine switch (also referred to as SS) is in U1 for all racks.
- The leaf switches are referred to as Lower Leaf (LL) and Upper Leaf (UL).
- The leaf switches are located as follows:
 - At rack unit 20 (U20) and 22 (U22) in Oracle Engineered System X8M-2 racks or Storage Expansion Rack X8M-2
 - At rack unit 21 (U21) and rack unit 23 (U23) in Oracle Engineered System X8M-8
- The cable lengths shown in the following lists assume that the racks are adjacent to each other, the cables are routed through a raised floor, and there are no obstacles in the routing between the racks. If the racks are not adjacent, or use overhead cabling trays, then they may require longer cable lengths. Cable lengths up to 100 meters are supported.
- Only optical cables (with additional transceivers) are supported for lengths greater than 5 meters.

The following illustration shows the cable connections for the 6 spine switches when cabling six racks together:



The following table describes the cable connections for the first spine switch (R1-SS) when cabling six racks together:

Table 4-15 Leaf Switch Connections for the First Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R1 UL within Rack 1	R1-UL-P5 to R1-SS-P5 R1-UL-P7 to R1-SS-P7	3 meters
R1 UL to Rack 2	R1-UL-P31 to R2-SS-P5 R1-UL-P33 to R2-SS-P7	5 meters
R1 UL to Rack 3	R1-UL-P6 to R3-SS-P5	5 meters
R1 UL to Rack 4	R1-UL-P4 to R4-SS-P5	10 meters
R1 UL to Rack 5	R1-UL-P30 to R5-SS-P5	10 meters
R1 UL to Rack 6	R1-UL-P32 to R6-SS-P5	10 meters
R1 LL within Rack 1	R1-LL-P5 to R1-SS-P13	3 meters

Table 4-15 (Cont.) Leaf Switch Connections for the First Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R1 LL to Rack 2	R1-LL-P31 to R2-SS-P13 R1-LL-P33 to R2-SS-P15	5 meters
R1 LL to Rack 3	R1-LL-P4 to R3-SS-P13 R1-LL-P6 to R3-SS-P15	5 meters
R1 LL to Rack 4	R1-LL-P30 to R4-SS-P13	10 meters
R1 LL to Rack 5	R1-LL-P7 to R5-SS-P13	10 meters
R1 LL to Rack 6	R1-LL-P32 to R6-SS-P13	10 meters

The following table describes the cable connections for the second spine switch (R2-SS) when cabling six full racks together:

Table 4-16 Leaf Switch Connections for the Second Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R2 UL to Rack 1	R2-UL-P5 to R1-SS-P6	5 meters
R2 UL within Rack 2	R2-UL-P31 to R2-SS-P6	3 meters
R2 UL to Rack 3	R2-UL-P6 to R3-SS-P6 R2-UL-P30 to R3-SS-P8	5 meters
R2 UL to Rack 4	R2-UL-P4 to R4-SS-P6 R2-UL-P32 to R4-SS-P8	5 meters
R2 UL to Rack 5	R2-UL-P7 to R5-SS-P6	10 meters
R2 UL to Rack 6	R2-UL-P33 to R6-SS-P6	10 meters
R2 LL to Rack 1	R2-LL-P5 to R1-SS-P14	5 meters
R2 LL within Rack 2	R2-LL-P31 to R2-SS-P14	3 meters
R2 LL to Rack 3	R2-LL-P6 to R3-SS-P14	5 meters
R2 LL to Rack 4	R2-LL-P4 to R4-SS-P14 R2-LL-P30 to R4-SS-P16	5 meters
R2 LL to Rack 5	R2-LL-P33 to R5-SS-P14 R2-LL-P32 to R5-SS-P16	10 meters
R2 LL to Rack 6	R2-LL-P7 to R6-SS-P14	10 meters

The following table describes the cable connections for the third spine switch (R3-SS) when cabling six full racks together:

Table 4-17 Leaf Switch Connections for the Third Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R3 UL to Rack 1	R3-UL-P5 to R1-SS-P11	5 meters
R3 UL to Rack 2	R3-UL-P6 to R2-SS-P11	5 meters

Table 4-17 (Cont.) Leaf Switch Connections for the Third Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R3 UL within Rack 3	R3-UL-P30 to R3-SS-P11	3 meters
R3 UL to Rack 4	R3-UL-P4 to R4-SS-P11	5 meters
R3 UL to Rack 5	R3-UL-P32 to R5-SS-P11 R3-UL-P33 to R5-SS-P12	5 meters
R3 UL to Rack 6	R3-UL-P7 to R6-SS-P11 R3-UL-P31 to R6-SS-P12	10 meters
R3 LL to Rack 1	R3-LL-P7 to R1-SS-P19 R3-LL-P4 to R1-SS-P20	5 meters
R3 LL to Rack 2	R3-LL-P31 to R2-SS-P20	5 meters
R3 LL within Rack 3	R3-LL-P32 to R3-SS-P20	3 meters
R3 LL to Rack 4	R3-LL-P33 to R4-SS-P20	5 meters
R3 LL to Rack 5	R3-LL-P5 to R5-SS-P20	5 meters
R3 LL to Rack 6	R3-LL-P6 to R6-SS-P19 R3-LL-P30 to R6-SS-P20	10 meters

The following table describes the cable connections for the fourth spine switch (R4-SS) when cabling six full racks together:

Table 4-18 Leaf Switch Connections for the Fourth Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R4 UL to Rack 1	R4-UL-P7 to R1-SS-P10	10 meters
R4 UL to Rack 2	R4-UL-P4 to R2-SS-P9 R4-UL-P6 to R2-SS-P10	5 meters
R4 UL to Rack 3	R4-UL-P31 to R3-SS-P9 R4-UL-P33 to R3-SS-P10	5 meters
R4 UL within Rack 4	R4-UL-P32 to R4-SS-P10	3 meters
R4 UL to Rack 5	R4-UL-P5 to R5-SS-P10	5 meters
R4 UL to Rack 6	R4-UL-P30 to R6-SS-P10	5 meters
R4 LL to Rack 1	R4-LL-P5 to R1-SS-P17	10 meters
R4 LL to Rack 2	R4-LL-P4 to R2-SS-P17	5 meters
R4 LL to Rack 3	R4-LL-P31 to R3-SS-P17 R4-LL-P33 to R3-SS-P18	5 meters
R4 LL within Rack 4	R4-LL-P30 to R4-SS-P17 R4-LL-P32 to R4-SS-P18	3 meters
R4 LL to Rack 5	R4-LL-P7 to R5-SS-P17	5 meters
R4 LL to Rack 6	R4-LL-P6 to R6-SS-P17	5 meters

The following table describes the cable connections for the fifth spine switch (R5-SS) when cabling six full racks together:

Table 4-19 Leaf Switch Connections for the Fifth Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R5 UL to Rack 1	R5-UL-P5 to R1-SS-P8	10 meters
R5 UL to Rack 2	R5-UL-P4 to R2-SS-P8	10 meters
R5 UL to Rack 3	R5-UL-P6 to R3-SS-P12	5 meters
R5 UL to Rack 4	R5-UL-P31 to R4-SS-P7 R5-UL-P33 to R4-SS-P12	5 meters
R5 UL within Rack 5	R5-UL-P30 to R5-SS-P7 R5-UL-P32 to R5-SS-P9	3 meters
R5 UL to Rack 6	R5-UL-P7 to R6-SS-P7	5 meters
R5 LL to Rack 1	R5-LL-P7 to R1-SS-P18	10 meters
R5 LL to Rack 2	R5-LL-P6 to R2-SS-P18	10 meters
R5 LL to Rack 3	R5-LL-P31 to R3-SS-P16	5 meters
R5 LL to Rack 4	R5-LL-P33 to R4-SS-P19	5 meters
R5 LL within Rack 5	R5-LL-P30 to R5-SS-P15 R5-LL-P32 to R5-SS-P19	3 meters
R5 LL to Rack 6	R5-LL-P5 to R6-SS-P9 R5-LL-P4 to R6-SS-P15	5 meters

The following table describes the cable connections for the sixth spine switch (R6-SS) when cabling six full racks together:

Table 4-20 Leaf Switch Connections for the Sixth Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R6 UL to Rack 1	R6-UL-P5 to R1-SS-P9 R6-UL-P7 to R1-SS-P16	10 meters
R6 UL to Rack 2	R6-UL-P4 to R2-SS-P16	10 meters
R6 UL to Rack 3	R6-UL-P6 to R3-SS-P19	10 meters
R6 UL to Rack 4	R6-UL-P31 to R4-SS-P15	5 meters
R6 UL to Rack 5	R6-UL-P33 to R5-SS-P18	5 meters
R6 UL within Rack 6	R6-UL-P30 to R6-SS-P16 R6-UL-P32 to R6-SS-P18	3 meters
R6 LL to Rack 1	R6-LL-P5 to R1-SS-P12 R6-LL-P7 to R1-SS-P15	10 meters
R6 LL to Rack 2	R6-LL-P4 to R2-SS-P12 R6-LL-P6 to R2-SS-P19	10 meters
R6 LL to Rack 3	R6-LL-P31 to R3-SS-P7	10 meters
R6 LL to Rack 4	R6-LL-P33 to R4-SS-P9	5 meters
R6 LL to Rack 5	R6-LL-P30 to R5-SS-P8	5 meters

Table 4-20 (Cont.) Leaf Switch Connections for the Sixth Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R6 LL within Rack 6	R6-LL-P32 to R6-SS-P8	3 meters

4.7 Seven-Rack Cabling for X8M Racks

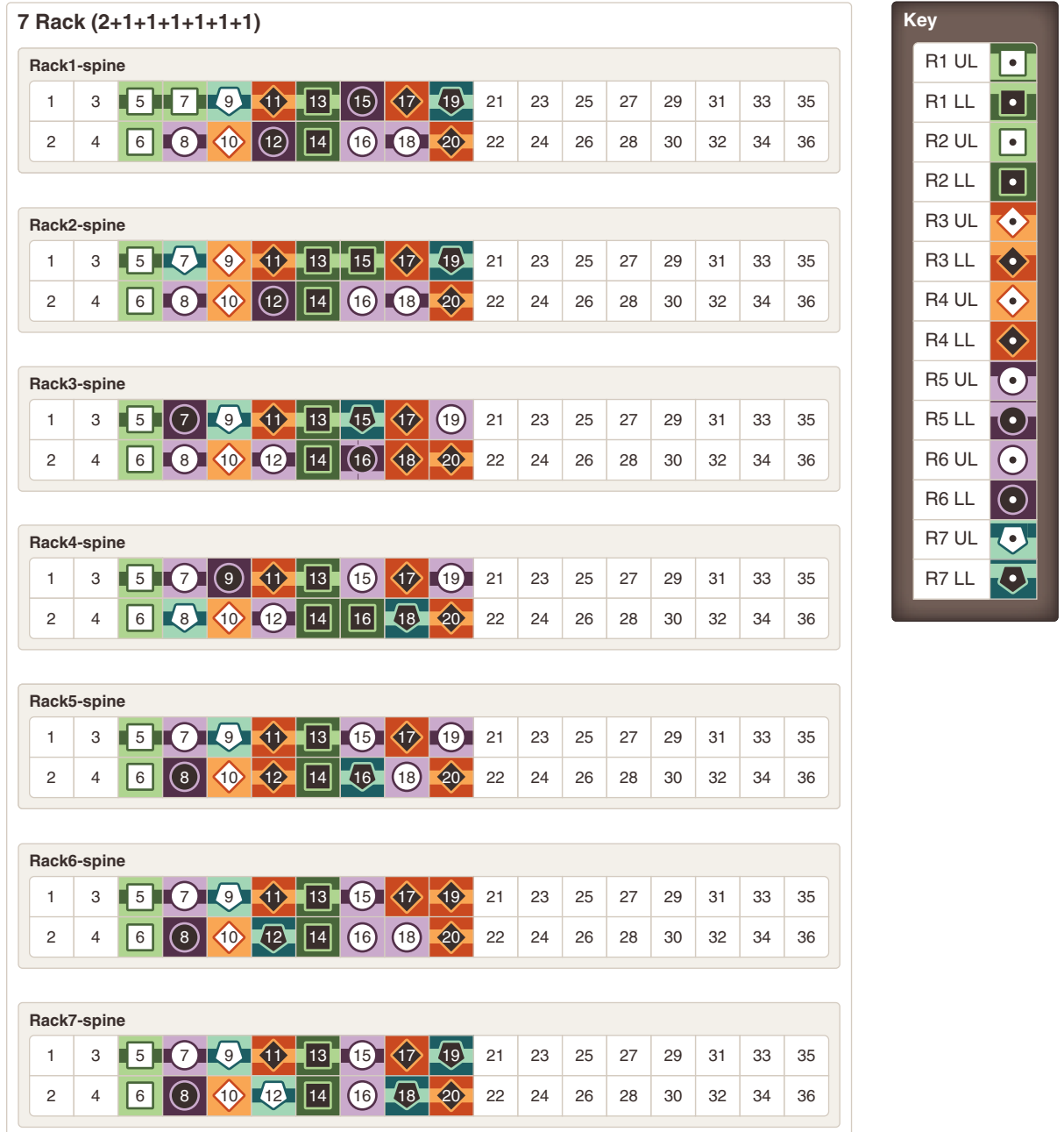
This section provides the cabling tables to connect seven (7) Oracle Engineered System Racks together, all of which use RDMA over RoCE Network Fabric.

Note:

The following conventions were used in the cabling notation for connecting multiple racks together.

- The spine switch (also referred to as SS) is in U1 for all racks.
- The leaf switches are referred to as Lower Leaf (LL) and Upper Leaf (UL).
- The leaf switches are located as follows:
 - At rack unit 20 (U20) and 22 (U22) in Oracle Engineered System X8M-2 racks or Storage Expansion Rack X8M-2
 - At rack unit 21 (U21) and rack unit 23 (U23) in Oracle Engineered System X8M-8
- The cable lengths shown in the following lists assume that the racks are adjacent to each other, the cables are routed through a raised floor, and there are no obstacles in the routing between the racks. If the racks are not adjacent, or use overhead cabling trays, then they may require longer cable lengths. Cable lengths up to 100 meters are supported.
- Only optical cables (with additional transceivers) are supported for lengths greater than 5 meters.

The following illustration shows the cable connections for the 7 spine switches when cabling seven racks together:



The following table describes the cable connections for the first spine switch (R1-SS) when cabling seven racks together:

Table 4-21 Leaf Switch Connections for the First Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R1 UL within Rack 1	R1-UL-P5 to R1-SS-P5 R1-UL-P7 to R1-SS-P7	3 meters
R1 UL to Rack 2	R1-UL-P31 to R2-SS-P5	5 meters
R1 UL to Rack 3	R1-UL-P6 to R3-SS-P5	5 meters
R1 UL to Rack 4	R1-UL-P4 to R4-SS-P5	10 meters

Table 4-21 (Cont.) Leaf Switch Connections for the First Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R1 UL to Rack 5	R1-UL-P30 to R5-SS-P5	10 meters
R1 UL to Rack 6	R1-UL-P32 to R6-SS-P5	10 meters
R1 UL to Rack 7	R1-UL-P33 to R7-SS-P5	10 meters
R1 LL within Rack 1	R1-LL-P5 to R1-SS-P13	3 meters
R1 LL to Rack 2	R1-LL-P31 to R2-SS-P13 R1-LL-P33 to R2-SS-P15	5 meters
R1 LL to Rack 3	R1-LL-P4 to R3-SS-P13	5 meters
R1 LL to Rack 4	R1-LL-P30 to R4-SS-P13	10 meters
R1 LL to Rack 5	R1-LL-P7 to R5-SS-P13	10 meters
R1 LL to Rack 6	R1-LL-P32 to R6-SS-P13	10 meters
R1 LL to Rack 7	R1-LL-P6 to R7-SS-P13	10 meters

The following table describes the cable connections for the second spine switch (R2-SS) when cabling seven full racks together:

Table 4-22 Leaf Switch Connections for the Second Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R2 UL to Rack 1	R2-UL-P5 to R1-SS-P6	5 meters
R2 UL within Rack 2	R2-UL-P31 to R2-SS-P6	3 meters
R2 UL to Rack 3	R2-UL-P6 to R3-SS-P6 R2-UL-P30 to R3-SS-P8	5 meters
R2 UL to Rack 4	R2-UL-P4 to R4-SS-P6	5 meters
R2 UL to Rack 5	R2-UL-P7 to R5-SS-P6	10 meters
R2 UL to Rack 6	R2-UL-P33 to R6-SS-P6	10 meters
R2 UL to Rack 7	R2-UL-P32 to R7-SS-P6	10 meters
R2 LL to Rack 1	R2-LL-P5 to R1-SS-P14	5 meters
R2 LL within Rack 2	R2-LL-P31 to R2-SS-P14	3 meters
R2 LL to Rack 3	R2-LL-P6 to R3-SS-P14	5 meters
R2 LL to Rack 4	R2-LL-P4 to R4-SS-P14 R2-LL-P30 to R4-SS-P16	5 meters
R2 LL to Rack 5	R2-LL-P33 to R5-SS-P14	10 meters
R2 LL to Rack 6	R2-LL-P7 to R6-SS-P14	10 meters
R2 LL to Rack 7	R2-LL-P32 to R7-SS-P14	10 meters

The following table describes the cable connections for the third spine switch (R3-SS) when cabling seven full racks together:

Table 4-23 Leaf Switch Connections for the Third Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R3 UL to Rack 1	R3-UL-P5 to R1-SS-P11	5 meters
R3 UL to Rack 2	R3-UL-P6 to R2-SS-P11	5 meters
R3 UL within Rack 3	R3-UL-P30 to R3-SS-P11	3 meters
R3 UL to Rack 4	R3-UL-P4 to R4-SS-P11	5 meters
R3 UL to Rack 5	R3-UL-P32 to R5-SS-P11 R3-UL-P33 to R5-SS-P12	5 meters
R3 UL to Rack 6	R3-UL-P7 to R6-SS-P11	10 meters
R3 UL to Rack 7	R3-UL-P31 to R7-SS-P11	10 meters
R3 LL to Rack 1	R3-LL-P4 to R1-SS-P20	5 meters
R3 LL to Rack 2	R3-LL-P31 to R2-SS-P20	5 meters
R3 LL within Rack 3	R3-LL-P32 to R3-SS-P20	3 meters
R3 LL to Rack 4	R3-LL-P33 to R4-SS-P20	5 meters
R3 LL to Rack 5	R3-LL-P5 to R5-SS-P20	5 meters
R3 LL to Rack 6	R3-LL-P6 to R6-SS-P19 R3-LL-P30 to R6-SS-P20	10 meters
R3 LL to Rack 7	R3-LL-P7 to R7-SS-P20	10 meters

The following table describes the cable connections for the fourth spine switch (R4-SS) when cabling seven full racks together:

Table 4-24 Leaf Switch Connections for the Fourth Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R4 UL to Rack 1	R4-UL-P7 to R1-SS-P10	10 meters
R4 UL to Rack 2	R4-UL-P4 to R2-SS-P9 R4-UL-P6 to R2-SS-P10	5 meters
R4 UL to Rack 3	R4-UL-P33 to R3-SS-P10	5 meters
R4 UL within Rack 4	R4-UL-P32 to R4-SS-P10	3 meters
R4 UL to Rack 5	R4-UL-P5 to R5-SS-P10	5 meters
R4 UL to Rack 6	R4-UL-P30 to R6-SS-P10	5 meters
R4 UL to Rack 7	R4-UL-P31 to R7-SS-P10	10 meters
R4 LL to Rack 1	R4-LL-P5 to R1-SS-P17	10 meters
R4 LL to Rack 2	R4-LL-P4 to R2-SS-P17	5 meters
R4 LL to Rack 3	R4-LL-P31 to R3-SS-P17 R4-LL-P33 to R3-SS-P18	5 meters
R4 LL within Rack 4	R4-LL-P30 to R4-SS-P17	3 meters
R4 LL to Rack 5	R4-LL-P7 to R5-SS-P17	5 meters

Table 4-24 (Cont.) Leaf Switch Connections for the Fourth Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R4 LL to Rack 6	R4-LL-P6 to R6-SS-P17	5 meters
R4 LL to Rack 7	R4-LL-P32 to R7-SS-P17	10 meters

The following table describes the cable connections for the fifth spine switch (R5-SS) when cabling seven full racks together:

Table 4-25 Leaf Switch Connections for the Fifth Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R5 UL to Rack 1	R5-UL-P5 to R1-SS-P8	10 meters
R5 UL to Rack 2	R5-UL-P4 to R2-SS-P8	10 meters
R5 UL to Rack 3	R5-UL-P6 to R3-SS-P12	5 meters
R5 UL to Rack 4	R5-UL-P31 to R4-SS-P7 R5-UL-P33 to R4-SS-P12	5 meters
R5 UL within Rack 5	R5-UL-P30 to R5-SS-P7	3 meters
R5 UL to Rack 6	R5-UL-P7 to R6-SS-P7	5 meters
R5 UL to Rack 7	R5-UL-P32 to R7-SS-P7	5 meters
R5 LL to Rack 1	R5-LL-P7 to R1-SS-P18	10 meters
R5 LL to Rack 2	R5-LL-P6 to R2-SS-P18	10 meters
R5 LL to Rack 3	R5-LL-P31 to R3-SS-P16	5 meters
R5 LL to Rack 4	R5-LL-P33 to R4-SS-P19	5 meters
R5 LL within Rack 5	R5-LL-P30 to R5-SS-P15 R5-LL-P32 to R5-SS-P19	3 meters
R5 LL to Rack 6	R5-LL-P4 to R6-SS-P15	5 meters
R5 LL to Rack 7	R5-LL-P5 to R7-SS-P15	5 meters

The following table describes the cable connections for the sixth spine switch (R6-SS) when cabling seven full racks together:

Table 4-26 Leaf Switch Connections for the Sixth Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R6 UL to Rack 1	R6-UL-P7 to R1-SS-P16	10 meters
R6 UL to Rack 2	R6-UL-P4 to R2-SS-P16	10 meters
R6 UL to Rack 3	R6-UL-P6 to R3-SS-P19	10 meters
R6 UL to Rack 4	R6-UL-P31 to R4-SS-P15	5 meters
R6 UL to Rack 5	R6-UL-P33 to R5-SS-P18	5 meters

Table 4-26 (Cont.) Leaf Switch Connections for the Sixth Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R6 UL within Rack 6	R6-UL-P30 to R6-SS-P16 R6-UL-P32 to R6-SS-P18	3 meters
R6 UL to Rack 7	R6-UL-P5 to R7-SS-P16	5 meters
R6 LL to Rack 1	R6-LL-P5 to R1-SS-P12 R6-LL-P7 to R1-SS-P15	10 meters
R6 LL to Rack 2	R6-LL-P4 to R2-SS-P12	10 meters
R6 LL to Rack 3	R6-LL-P31 to R3-SS-P7	10 meters
R6 LL to Rack 4	R6-LL-P33 to R4-SS-P9	5 meters
R6 LL to Rack 5	R6-LL-P30 to R5-SS-P8	5 meters
R6 LL within Rack 6	R6-LL-P32 to R6-SS-P8	3 meters
R6 LL to Rack 7	R6-LL-P6 to R7-SS-P8	5 meters

The following table describes the cable connections for the seventh spine switch (R7-SS) when cabling seven full racks together:

Table 4-27 Leaf Switch Connections for the Seventh Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R7 UL to Rack 1	R7-UL-P5 to R1-SS-P9	10 meters
R7 UL to Rack 2	R7-UL-P7 to R2-SS-P7	10 meters
R7 UL to Rack 3	R7-UL-P4 to R3-SS-P9	10 meters
R7 UL to Rack 4	R7-UL-P6 to R4-SS-P8	10 meters
R7 UL to Rack 5	R7-UL-P31 to R5-SS-P9	5 meters
R7 UL to Rack 6	R7-UL-P33 to R6-SS-P9	5 meters
R7 UL within Rack 7	R7-UL-P30 to R7-SS-P9 R7-UL-P32 to R7-SS-P12	3 meters
R7 LL to Rack 1	R7-LL-P5 to R1-SS-P19	10 meters
R7 LL to Rack 2	R7-LL-P7 to R2-SS-P19	10 meters
R7 LL to Rack 3	R7-LL-P4 to R3-SS-P15	10 meters
R7 LL to Rack 4	R7-LL-P6 to R4-SS-P18	10 meters
R7 LL to Rack 5	R7-LL-P31 to R5-SS-P16	5 meters
R7 LL to Rack 6	R7-LL-P33 to R6-SS-P12	5 meters
R7 LL within Rack 7	R7-LL-P30 to R7-SS-P18 R7-LL-P32 to R7-SS-P19	3 meters

4.8 Eight-Rack Cabling for X8M Racks

This section provides the cabling tables to connect eight (8) Oracle Engineered System Racks together, all of which use RDMA over RoCE Network Fabric.

Note:

The following conventions were used in the cabling notation for connecting multiple racks together.

- The spine switch (also referred to as SS) is in U1 for all racks.
- The leaf switches are referred to as Lower Leaf (LL) and Upper Leaf (UL).
- The leaf switches are located as follows:
 - At rack unit 20 (U20) and 22 (U22) in Oracle Engineered System X8M-2 racks or Storage Expansion Rack X8M-2
 - At rack unit 21 (U21) and rack unit 23 (U23) in Oracle Engineered System X8M-8
- The cable lengths shown in the following lists assume that the racks are adjacent to each other, the cables are routed through a raised floor, and there are no obstacles in the routing between the racks. If the racks are not adjacent, or use overhead cabling trays, then they may require longer cable lengths. Cable lengths up to 100 meters are supported.
- Only optical cables (with additional transceivers) are supported for lengths greater than 5 meters.

The following illustration shows the cable connections for the 8 spine switches when cabling eight racks together:

8 Rack (1+1+1+1+1+1+1+1)

Rack1-spine

1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36

Rack2-spine

1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36

Rack3-spine

1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36

Rack4-spine

1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36

Rack5-spine

1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36

Rack6-spine

1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36

Rack7-spine

1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36

Rack8-spine

1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36

Key

R1 UL	
R1 LL	
R2 UL	
R2 LL	
R3 UL	
R3 LL	
R4 UL	
R4 LL	
R5 UL	
R5 LL	
R6 UL	
R6 LL	
R7 UL	
R7 LL	
R8 UL	
R8 LL	

The following table describes the cable connections for the first spine switch (R1-SS) when cabling eight racks together:

Table 4-28 Leaf Switch Connections for the First Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R1 UL within Rack 1	R1-UL-P5 to R1-SS-P5	3 meters
R1 UL to Rack 2	R1-UL-P31 to R2-SS-P5	5 meters
R1 UL to Rack 3	R1-UL-P6 to R3-SS-P5	5 meters
R1 UL to Rack 4	R1-UL-P4 to R4-SS-P5	10 meters
R1 UL to Rack 5	R1-UL-P30 to R5-SS-P5	10 meters
R1 UL to Rack 6	R1-UL-P32 to R6-SS-P5	10 meters
R1 UL to Rack 7	R1-UL-P33 to R7-SS-P5	10 meters
R1 UL to Rack 8	R1-UL-P7 to R8-SS-P5	10 meters
R1 LL within Rack 1	R1-LL-P5 to R1-SS-P13	3 meters
R1 LL to Rack 2	R1-LL-P31 to R2-SS-P13	5 meters
R1 LL to Rack 3	R1-LL-P4 to R3-SS-P13	5 meters
R1 LL to Rack 4	R1-LL-P30 to R4-SS-P13	10 meters
R1 LL to Rack 5	R1-LL-P7 to R5-SS-P13	10 meters
R1 LL to Rack 6	R1-LL-P32 to R6-SS-P13	10 meters
R1 LL to Rack 7	R1-LL-P6 to R7-SS-P13	10 meters
R1 LL to Rack 8	R1-LL-P33 to R8-SS-P13	10 meters

The following table describes the cable connections for the second spine switch (R2-SS) when cabling eight full racks together:

Table 4-29 Leaf Switch Connections for the Second Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R2 UL to Rack 1	R2-UL-P5 to R1-SS-P6	5 meters
R2 UL within Rack 2	R2-UL-P31 to R2-SS-P6	3 meters
R2 UL to Rack 3	R2-UL-P6 to R3-SS-P6	5 meters
R2 UL to Rack 4	R2-UL-P4 to R4-SS-P6	5 meters
R2 UL to Rack 5	R2-UL-P7 to R5-SS-P6	10 meters
R2 UL to Rack 6	R2-UL-P33 to R6-SS-P6	10 meters
R2 UL to Rack 7	R2-UL-P32 to R7-SS-P6	10 meters
R2 UL to Rack 8	R2-UL-P30 to R8-SS-P6	10 meters
R2 LL to Rack 1	R2-LL-P5 to R1-SS-P14	5 meters
R2 LL within Rack 2	R2-LL-P31 to R2-SS-P14	3 meters
R2 LL to Rack 3	R2-LL-P6 to R3-SS-P14	5 meters
R2 LL to Rack 4	R2-LL-P4 to R4-SS-P14	5 meters
R2 LL to Rack 5	R2-LL-P33 to R5-SS-P14	10 meters
R2 LL to Rack 6	R2-LL-P7 to R6-SS-P14	10 meters

Table 4-29 (Cont.) Leaf Switch Connections for the Second Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R2 LL to Rack 7	R2-LL-P32 to R7-SS-P14	10 meters
R2 LL to Rack 8	R2-LL-P30 to R8-SS-P14	10 meters

The following table describes the cable connections for the third spine switch (R3-SS) when cabling eight full racks together:

Table 4-30 Leaf Switch Connections for the Third Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R3 UL to Rack 1	R3-UL-P5 to R1-SS-P11	5 meters
R3 UL to Rack 2	R3-UL-P6 to R2-SS-P11	5 meters
R3 UL within Rack 3	R3-UL-P30 to R3-SS-P11	3 meters
R3 UL to Rack 4	R3-UL-P4 to R4-SS-P11	5 meters
R3 UL to Rack 5	R3-UL-P32 to R5-SS-P11	5 meters
R3 UL to Rack 6	R3-UL-P7 to R6-SS-P11	10 meters
R3 UL to Rack 7	R3-UL-P31 to R7-SS-P11	10 meters
R3 UL to Rack 8	R3-UL-P33 to R8-SS-P11	10 meters
R3 LL to Rack 1	R3-LL-P4 to R1-SS-P20	5 meters
R3 LL to Rack 2	R3-LL-P31 to R2-SS-P20	5 meters
R3 LL within Rack 3	R3-LL-P32 to R3-SS-P20	3 meters
R3 LL to Rack 4	R3-LL-P33 to R4-SS-P20	5 meters
R3 LL to Rack 5	R3-LL-P5 to R5-SS-P20	5 meters
R3 LL to Rack 6	R3-LL-P30 to R6-SS-P20	10 meters
R3 LL to Rack 7	R3-LL-P7 to R7-SS-P20	10 meters
R3 LL to Rack 8	R3-LL-P6 to R8-SS-P20	10 meters

The following table describes the cable connections for the fourth spine switch (R4-SS) when cabling eight full racks together:

Table 4-31 Leaf Switch Connections for the Fourth Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R4 UL to Rack 1	R4-UL-P7 to R1-SS-P10	10 meters
R4 UL to Rack 2	R4-UL-P6 to R2-SS-P10	5 meters
R4 UL to Rack 3	R4-UL-P33 to R3-SS-P10	5 meters
R4 UL within Rack 4	R4-UL-P32 to R4-SS-P10	3 meters
R4 UL to Rack 5	R4-UL-P5 to R5-SS-P10	5 meters
R4 UL to Rack 6	R4-UL-P30 to R6-SS-P10	5 meters

Table 4-31 (Cont.) Leaf Switch Connections for the Fourth Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R4 UL to Rack 7	R4-UL-P31 to R7-SS-P10	10 meters
R4 UL to Rack 8	R4-UL-P4 to R8-SS-P10	10 meters
R4 LL to Rack 1	R4-LL-P5 to R1-SS-P17	10 meters
R4 LL to Rack 2	R4-LL-P4 to R2-SS-P17	5 meters
R4 LL to Rack 3	R4-LL-P31 to R3-SS-P17	5 meters
R4 LL within Rack 4	R4-LL-P30 to R4-SS-P17	3 meters
R4 LL to Rack 5	R4-LL-P7 to R5-SS-P17	5 meters
R4 LL to Rack 6	R4-LL-P6 to R6-SS-P17	5 meters
R4 LL to Rack 7	R4-LL-P32 to R7-SS-P17	10 meters
R4 LL to Rack 8	R4-LL-P33 to R8-SS-P17	10 meters

The following table describes the cable connections for the fifth spine switch (R5-SS) when cabling eight full racks together:

Table 4-32 Leaf Switch Connections for the Fifth Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R5 UL to Rack 1	R5-UL-P5 to R1-SS-P8	10 meters
R5 UL to Rack 2	R5-UL-P4 to R2-SS-P8	10 meters
R5 UL to Rack 3	R5-UL-P6 to R3-SS-P12	5 meters
R5 UL to Rack 4	R5-UL-P33 to R4-SS-P12	5 meters
R5 UL within Rack 5	R5-UL-P30 to R5-SS-P7	3 meters
R5 UL to Rack 6	R5-UL-P7 to R6-SS-P7	5 meters
R5 UL to Rack 7	R5-UL-P32 to R7-SS-P7	5 meters
R5 UL to Rack 8	R5-UL-P31 to R8-SS-P7	10 meters
R5 LL to Rack 1	R5-LL-P7 to R1-SS-P18	10 meters
R5 LL to Rack 2	R5-LL-P6 to R2-SS-P18	10 meters
R5 LL to Rack 3	R5-LL-P31 to R3-SS-P16	5 meters
R5 LL to Rack 4	R5-LL-P33 to R4-SS-P19	5 meters
R5 LL within Rack 5	R5-LL-P30 to R5-SS-P15	3 meters
R5 LL to Rack 6	R5-LL-P4 to R6-SS-P15	5 meters
R5 LL to Rack 7	R5-LL-P5 to R7-SS-P15	5 meters
R5 LL to Rack 8	R5-LL-P32 to R8-SS-P15	10 meters

The following table describes the cable connections for the sixth spine switch (R6-SS) when cabling eight full racks together:

Table 4-33 Leaf Switch Connections for the Sixth Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R6 UL to Rack 1	R6-UL-P7 to R1-SS-P16	10 meters
R6 UL to Rack 2	R6-UL-P4 to R2-SS-P16	10 meters
R6 UL to Rack 3	R6-UL-P6 to R3-SS-P19	10 meters
R6 UL to Rack 4	R6-UL-P31 to R4-SS-P15	5 meters
R6 UL to Rack 5	R6-UL-P33 to R5-SS-P18	5 meters
R6 UL within Rack 6	R6-UL-P30 to R6-SS-P16	3 meters
R6 UL to Rack 7	R6-UL-P5 to R7-SS-P16	5 meters
R6 UL to Rack 8	R6-UL-P32 to R8-SS-P16	5 meters
R6 LL to Rack 1	R6-LL-P5 to R1-SS-P12	10 meters
R6 LL to Rack 2	R6-UL-P4 to R2-SS-P12	10 meters
R6 LL to Rack 3	R6-LL-P31 to R3-SS-P7	10 meters
R6 LL to Rack 4	R6-LL-P33 to R4-SS-P9	5 meters
R6 LL to Rack 5	R6-LL-P30 to R5-SS-P8	5 meters
R6 LL within Rack 6	R6-LL-P32 to R6-SS-P8	3 meters
R6 LL to Rack 7	R6-LL-P6 to R7-SS-P8	5 meters
R6 LL to Rack 8	R6-LL-P7 to R8-SS-P8	5 meters

The following table describes the cable connections for the seventh spine switch (R7-SS) when cabling eight full racks together:

Table 4-34 Leaf Switch Connections for the Seventh Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R7 UL to Rack 1	R7-UL-P5 to R1-SS-P9	10 meters
R7 UL to Rack 2	R7-UL-P7 to R2-SS-P7	10 meters
R7 UL to Rack 3	R7-UL-P4 to R3-SS-P9	10 meters
R7 UL to Rack 4	R7-UL-P6 to R4-SS-P8	10 meters
R7 UL to Rack 5	R7-UL-P31 to R5-SS-P9	5 meters
R7 UL to Rack 6	R7-UL-P33 to R6-SS-P9	5 meters
R7 UL within Rack 7	R7-UL-P30 to R7-SS-P9	3 meters
R7 UL to Rack 8	R7-UL-P32 to R8-SS-P9	5 meters
R7 LL to Rack 1	R7-LL-P5 to R1-SS-P19	10 meters
R7 LL to Rack 2	R7-LL-P7 to R2-SS-P19	10 meters
R7 LL to Rack 3	R7-LL-P4 to R3-SS-P15	10 meters
R7 LL to Rack 4	R7-LL-P6 to R4-SS-P18	10 meters
R7 LL to Rack 5	R7-LL-P31 to R5-SS-P16	5 meters
R7 LL to Rack 6	R7-LL-P33 to R6-SS-P12	5 meters

Table 4-34 (Cont.) Leaf Switch Connections for the Seventh Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R7 LL within Rack 7	R7-LL-P30 to R7-SS-P18	3 meters
R7 LL to Rack 8	R7-LL-P32 to R8-SS-P12	5 meters

The following table describes the cable connections for the eighth spine switch (R8-SS) when cabling eight full racks together:

Table 4-35 Leaf Switch Connections for the Eighth Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R8 UL to Rack 1	R8-UL-P5 to R1-SS-P15	10 meters
R8 UL to Rack 2	R8-UL-P7 to R2-SS-P15	10 meters
R8 UL to Rack 3	R8-UL-P4 to R3-SS-P18	10 meters
R8 UL to Rack 4	R8-UL-P6 to R4-SS-P16	10 meters
R8 UL to Rack 5	R8-UL-P31 to R5-SS-P19	10 meters
R8 UL to Rack 6	R8-UL-P33 to R6-SS-P19	5 meters
R8 UL to Rack 7	R8-UL-P30 to R7-SS-P19	5 meters
R8 UL within Rack 8	R8-UL-P32 to R8-SS-P19	3 meters
R8 LL to Rack 1	R8-LL-P5 to R1-SS-P7	10 meters
R8 LL to Rack 2	R8-LL-P7 to R2-SS-P9	10 meters
R8 LL to Rack 3	R8-LL-P4 to R3-SS-P12	10 meters
R8 LL to Rack 4	R8-LL-P6 to R4-SS-P7	10 meters
R8 LL to Rack 5	R8-LL-P31 to R5-SS-P12	10 meters
R8 LL to Rack 6	R8-LL-P33 to R6-SS-P12	5 meters
R8 LL to Rack 7	R8-LL-P30 to R7-SS-P12	5 meters
R8 LL within Rack 8	R8-LL-P32 to R8-SS-P18	3 meters

5

Multi-Rack Cabling Tables for Oracle Engineered System Rack X2 to X8

This appendix contains the multi-rack cabling tables for Oracle Engineered System Racks X2 to X8, which use a RDMA over InfiniBand Network Fabric network.

- [Understanding Multi-Rack Cabling](#)
Up to eight racks can be cabled together without external RDMA Network Fabric switches.
- [Two-Rack Cabling](#)
Review this information before cabling two racks together.
- [Three-Rack Cabling](#)
- [Four-Rack Cabling](#)
- [Five-Rack Cabling](#)
- [Six-Rack Cabling](#)
- [Seven-Rack Cabling](#)
- [Eight-Rack Cabling](#)

5.1 Understanding Multi-Rack Cabling

Up to eight racks can be cabled together without external RDMA Network Fabric switches.

Three RDMA Network Fabric switches are needed when cabling racks together. If any rack does not include a third switch, then order the expansion switch kit. These switches attach to standard RDMA Network Fabric connectors at the end of the cables. The procedures in this section assume the racks are adjacent to each other. If they are not, then longer cables may be required for the connections.

Note:

Only for RDMA over InfiniBand Network Fabric (X8 and earlier).

- For Eighth or Quarter Racks, which are the smallest Elastic Configurations, follow the instructions in "[Cabling Oracle Exadata Quarter Racks and Oracle Exadata Eighth Racks](#)" for direct connection without spine switch.
- For other racks (Half Rack, Full Rack, Elastic Configurations larger than Eighth or Quarter Rack) install a spine switch and follow the standard *N*-rack cabling using fat tree topology for two or more interconnected racks, for example "[Two-Rack Cabling](#)."

The switch at rack unit 1 (U1) is referred to as the spine switch.

The following switches are referred to as leaf switches:

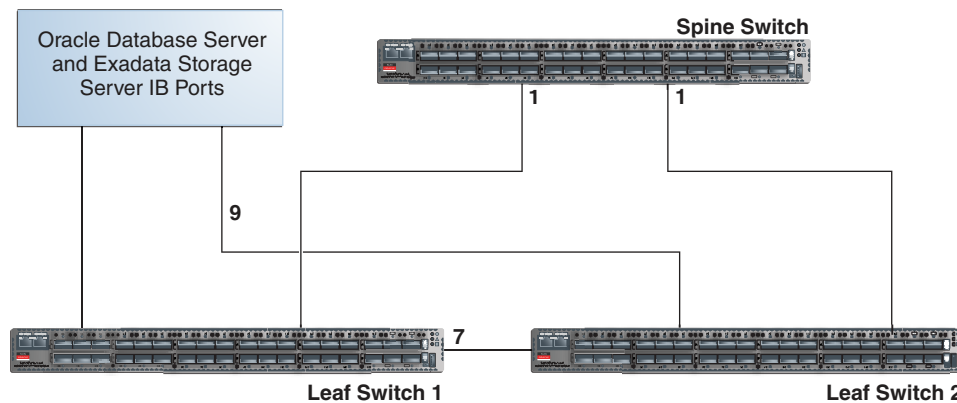
- The switches at rack unit 20 (U20) and rack unit 24 (U24) in Oracle Engineered System X2-2 racks and Oracle Exadata Storage Expansion Racks
- The switches at rack unit 21 (U21) and rack unit 23 (U23) in Oracle Engineered System X2-8 and later.
- The switches at rack unit 20 (U20) and 22 (U22) in Oracle Engineered System X3-2 and later racks or Storage Expansion Rack X3-2 and later.

 **Note:**

Oracle Exadata Database Machine X4-2 and later racks or Oracle Exadata Database Machine X3-8 Full Racks with Exadata Storage Server X4-2L Servers do not include spare cables or a third Sun Datacenter InfiniBand Switch 36 switch. To extend Oracle Exadata Database Machine X4-2 and later racks or Oracle Exadata Database Machine X3-8 Full Racks with Exadata Storage Server X4-2L Servers, you must order cables and a Sun Datacenter InfiniBand Switch 36 switch.

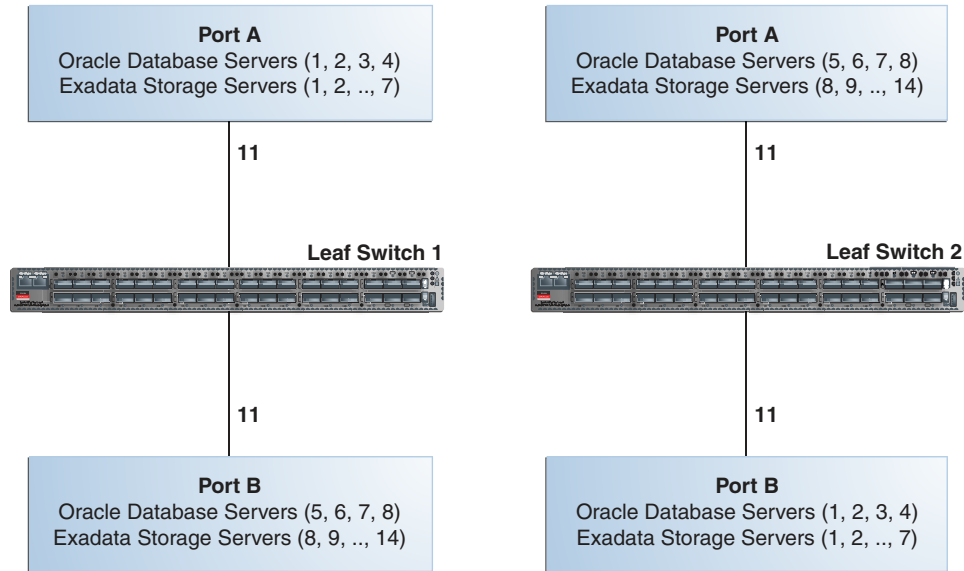
In a single rack, the two leaf switches are interconnected using seven connections. In addition, each leaf switch has one connection to the spine switch. The leaf switches connect to the spine switch as shown in the following graphic:

Figure 5-1 Connections Between Spine Switch and Leaf Switches in a Single Rack



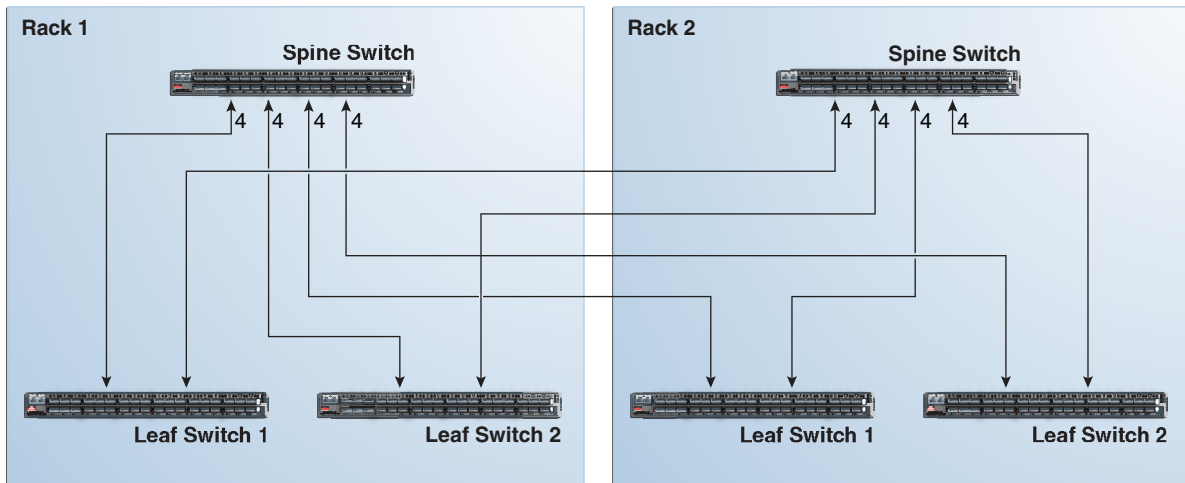
The Oracle Database servers and Exadata Storage Servers connect to the leaf switches as shown in the following graphic:

Figure 5-2 Connections Between Database Servers and Storage Servers and Leaf Switches



When connecting up to eight racks together, remove the seven existing inter-switch connections between each leaf switch, as well as the two connections between the leaf switches and the spine switch. From each leaf switch, distribute eight connections over the spine switches in all racks. In multi-rack environments, the leaf switches inside a rack are no longer directly inter-connected, as shown in the following graphic:

Figure 5-3 Connections Between Spine Switches and Leaf Switches Across Two Racks



As shown in the preceding graphic, each leaf switch in rack 1 connects to the following switches:

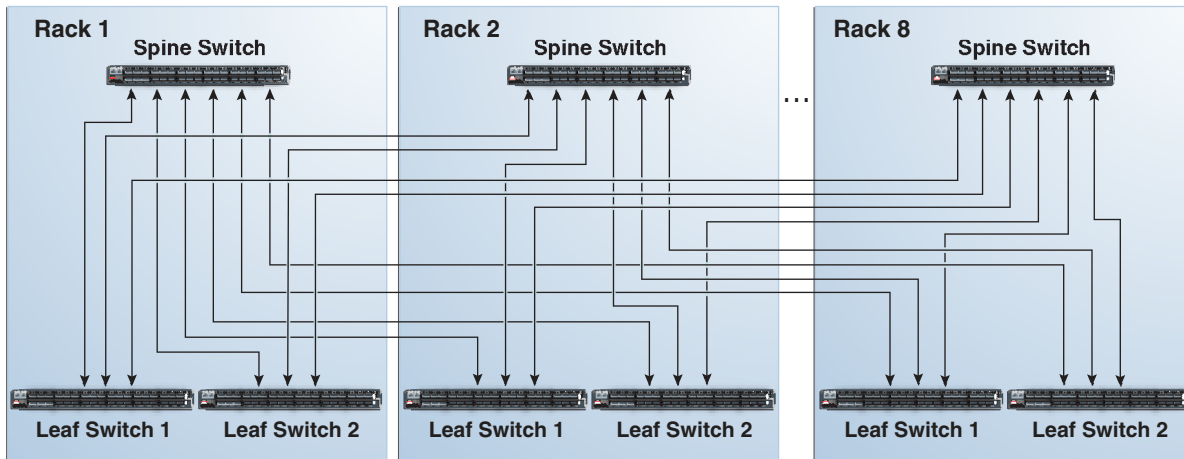
- Four connections to its internal spine switch
- Four connections to the spine switch in rack 2

The spine switch in rack 1 connects to the following switches:

- Eight connections to both internal leaf switches
- Eight connections to both leaf switches in rack 2

As the number of racks increases from two to eight, the pattern continues as shown in the following graphic:

Figure 5-4 Connections Between Spine Switches and Leaf Switches for up to 8 Racks



As shown in the preceding graphic, each leaf switch has eight inter-switch connections distributed over all spine switches. Each spine switch has 16 inter-switch connections distributed over all leaf switches. The leaf switches are not directly interconnected with other leaf switches, and the spine switches are not directly interconnected with the other spine switches.

Note:

Cable lengths are specified for racks 1 through 8.

- [Preparing to Cable Racks Together](#)
- [Cabling Oracle Exadata Quarter Racks and Oracle Exadata Eighth Racks](#)

5.1.1 Preparing to Cable Racks Together

Racks can be added together to increase system capacity and performance. When cabling racks together, note the following:

- Oracle recommends that the names for the servers include the rack unit number. This helps identify the server during diagnostics.
- When completing Oracle Exadata Deployment Assistant for the additional rack, you are prompted for SCAN addresses. However, these SCAN addresses are not used because the SCAN address from the original rack are used. Manually remove the new SCAN addresses from the generated installation files.
- The software owner account names and group names, as well as their identifiers, must match the names and identifiers of the original rack.

- If the additional grid disks are used with existing disk groups, then ensure the grid disk sizes for the new rack are the same as the original rack.
- If the InfiniBand network consists of four or more racks cabled together, then disable the Subnet Manager on the leaf switches.
- Verify the Master Subnet Manager is located on the spine switch.
- Oracle Exadata Database Machine Quarter Racks can be extended as follows:
 - Connect two Oracle Exadata Database Machine Quarter Racks together. At least four of the six ports reserved for external connectivity are open on each leaf switch. The six ports are 5B, 6A, 6B, 7A, 7B, and 12A in each leaf switch. Maintain the existing seven inter-switch links between the leaf switches within each rack. Connect the leaf switches between the racks with two links each, using the ports reserved for external connectivity.
 - Connect one Oracle Exadata Database Machine Quarter Rack with one Oracle Exadata Database Machine Half Rack or one Oracle Exadata Database Machine Full Rack. At least four ports reserved for external connectivity are open on each leaf switch. The spine switch in the Oracle Exadata Database Machine Half Rack or Oracle Exadata Database Machine Full Rack remains as the spine switch. Maintain the existing seven inter-switch links between the leaf switches within each rack. Connect the leaf switches between the racks with two links each, using the ports reserved for external connectivity.
 - Connect one Oracle Exadata Database Machine Quarter Rack with two or more Oracle Exadata Database Machine Half Racks or Oracle Exadata Database Machine Full Racks. The racks are interconnected using a fat-tree topology. Connect each leaf switch in the quarter rack to the spine switch of each half rack or full rack using two links each. If there are more than four racks, then use one link instead of two. The seven inter-switch links between the leaf switches in the quarter rack are removed.

 **Note:**

To connect more than one quarter rack to additional racks, it is necessary to purchase Sun Datacenter InfiniBand Switch 36 switches for the quarter racks.

- If you are extending Oracle Exadata Database Machine X4-2 or later, or Oracle Exadata Database Machine X3-8 Full Rack, or Oracle Exadata Database Machine X2-2 (with X4170 and X4275 servers) half rack, then order the expansion kit that includes a Sun Datacenter InfiniBand Switch 36 switch.

Perform the following tasks before cabling racks together:

1. Determine the number of racks that will be cabled together.
2. Count the spare cables from the kit, and existing inter-switch cables.

 **Note:**

Oracle Exadata Database Machine X4-2 and later racks or Oracle Exadata Database Machine X3-8 Full Racks with Exadata Storage Server X4-2L Servers do not include spare cables or a third Sun Datacenter InfiniBand Switch 36 switch. To extend Oracle Exadata Database Machine X4-2 and later racks or Oracle Exadata Database Machine X3-8 Full Racks with Exadata Storage Server X4-2L Servers, you must order cables and a Sun Datacenter InfiniBand Switch 36 switch.

For Oracle Exadata Racks earlier than Oracle Exadata Database Machine X4-2, no additional InfiniBand cables need to be purchased when connecting up to three Oracle Exadata Database Machine Full Racks. The following table lists the spare cables for the switch:

Cable	Spare	Inter-switch	Total
InfiniBand 2 meter cable	0	7	7
InfiniBand 3 meter cable	6	2	8
InfiniBand 5 meter cable	10	0	10

When connecting four or more racks, it is necessary to purchase additional 10 meter optical QSFP-to-QSFP QDR InfiniBand cables. Two QSFP SR transceivers are needed for each optical cable. The following table lists the number of racks, and cables needed to interconnect the racks.

Number of Racks	3 Meter Cables Needed	5 Meter Cables Needed	10 Meter Cables Needed
2	16	16	0
3	18	30	0
4	16	40	8
5	20	42	18
6	24	46	26
7	28	44	40
8	16	52	60

- Gather the following tools:
 - Pen
 - Note pad
 - Flashlight
 - Labels for cables and rack
 - Cable ties (Oracle recommends hook and loop straps)

 **See Also:**

Oracle Exadata Database Machine Maintenance Guide for information about cable labels

4. Determine a naming method for the rack prefixes. For example, if the original rack has the prefix `dm01`, then use the prefix `dm02` for the second rack, the prefix `dm03` for the third rack, and so on.
5. Verify the racks have unique host names and IP addresses. All servers interconnected in the racks must have unique names and IP addresses.

Server names and IP addresses conventions may differ in the following cases:

- Initial installation of all Oracle Exadata Database Machine Full Racks: System address assignments and host names should be complete.
 - New Oracle Exadata Database Machine Full Racks are added to an existing cluster: The new rack configuration should require unique host names and IP addresses for the new Oracle Exadata Database Machines. The IP addresses on the same subnet cannot conflict with the existing systems.
 - Two existing Oracle Exadata Database Machine Full Racks are clustered together: You can assign host names and IP addresses only if Oracle Exadata Database Machines are already assigned unique host names and IP addresses, or the entire cluster must be reconfigured. The machines must be on the same subnet and not have conflicting IP addresses.
6. Ensure the IP addresses for the new servers are in the same subnet, and do not overlap with the currently-installed servers.
 7. Ensure the firmware on the original switches are at the same level as the new switches using the `nm2version` command. If the firmware is not at the same level, then apply a firmware patch.

5.1.2 Cabling Oracle Exadata Quarter Racks and Oracle Exadata Eighth Racks

Oracle Exadata Quarter Racks and Oracle Exadata Eighth Racks can be cabled as follows:

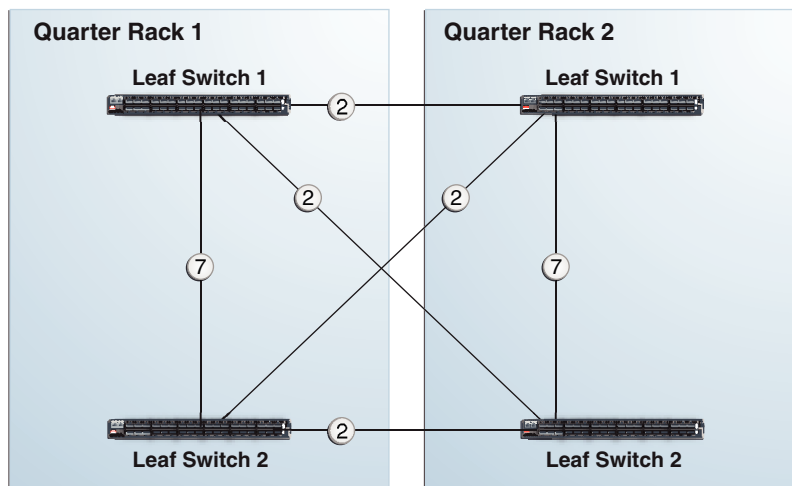
- Oracle Exadata Quarter Rack to Oracle Exadata Quarter Rack
- Oracle Exadata Quarter Rack to Oracle Exadata Half Rack, or multiple Oracle Exadata Half Racks or Oracle Exadata Full Racks
- Oracle Exadata Quarter Rack to Oracle Exadata Full Rack, or multiple Oracle Exadata Full Racks or Oracle Exadata Half Racks
- Oracle Exadata Eighth Rack to Oracle Exadata Eighth Rack
- Oracle Exadata Eighth Rack to Oracle Exadata Half Rack, or multiple Oracle Exadata Half Racks or Oracle Exadata Full Racks
- Oracle Exadata Eighth Rack to Oracle Exadata Full Rack, or multiple Oracle Exadata Full Racks or Oracle Exadata Half Racks

 **Note:**

- To cable additional Oracle Exadata Quarter Racks or Oracle Exadata Eighth Racks, it is necessary to purchase additional Sun Datacenter InfiniBand Switch 36 switches.
- It is assumed that four of the six ports dedicated for external connectivity in Oracle Exadata Half Rack or Oracle Exadata Full Rack are unused and available for switch interconnections with Oracle Exadata Quarter Rack or Oracle Exadata Eighth Rack. The six ports are 5B, 6A, 6B, 7A, 7B, and 12A in each leaf switch.

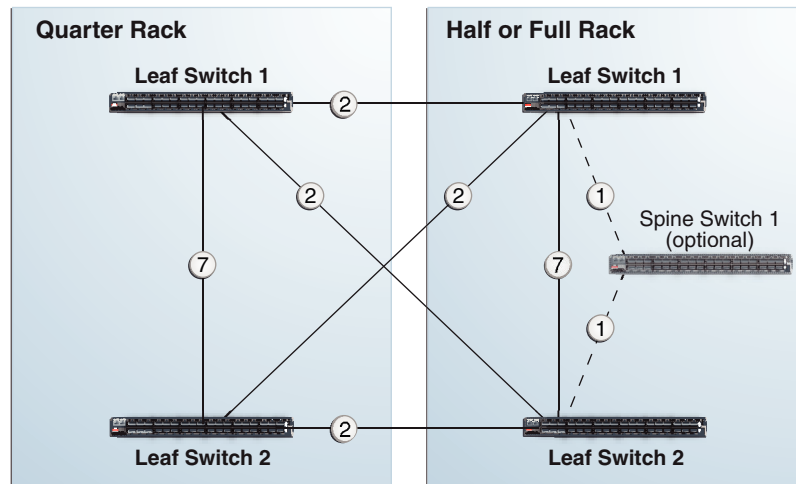
The following graphic shows the cable connections for two Oracle Exadata Quarter Racks. The leaf switches within each rack maintain their existing seven connections. The leaf switches interconnect between the racks with two links each using the ports reserved for external connectivity.

Figure 5-5 Leaf Switch Connections Between 2 Quarter Racks



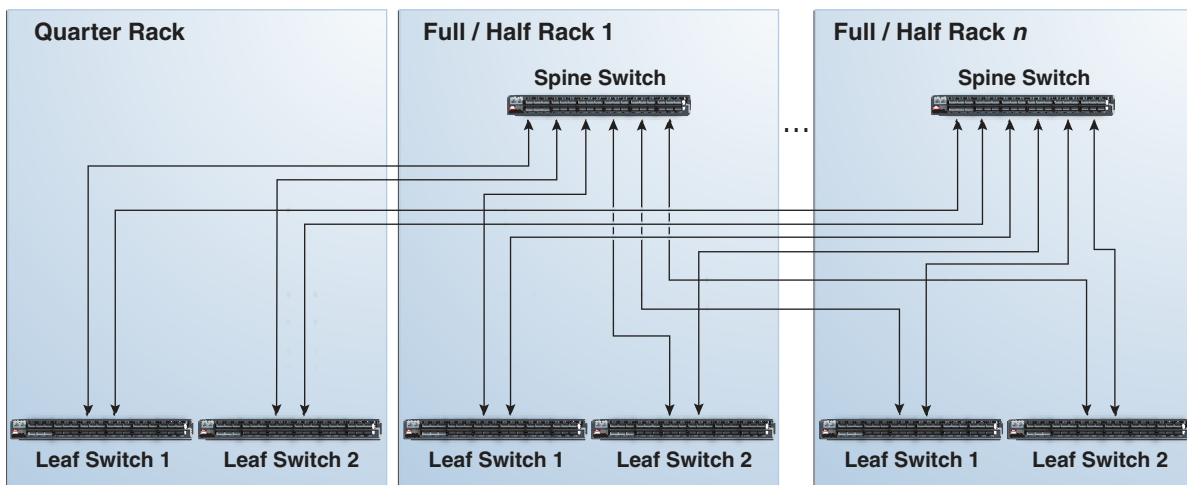
The following graphic shows the cable connections from Oracle Exadata Quarter Rack to Oracle Exadata Half Rack or Oracle Exadata Full Rack. The leaf switches within each rack maintain their existing seven connections. The leaf switches interconnect between the racks with two links each using the ports reserved for external connectivity.

Figure 5-6 Leaf and Spine Switch Connections Between a Quarter Rack and a Half or Full Rack



The following graphic shows the cable connections from Oracle Exadata Quarter Rack to two or more racks. The racks that connect to Oracle Exadata Quarter Rack must be all Oracle Exadata Half Racks or Oracle Exadata Full Racks, interconnected using a fat-tree topology. Each leaf switch in Oracle Exadata Quarter Rack connects to the spine switches in the other half racks or full racks with two links each. If there are more than four racks, then use one link instead of two. The seven inter-switch links between the leaf switches in the quarter rack are removed.

Figure 5-7 Leaf and Spine Switch Connections for a Quarter Rack Connected to One or More Half or Full Racks



5.2 Two-Rack Cabling

Review this information before cabling two racks together.

- The spine switch is in U1 (also referred to as IB1) for all racks.
- In the following lists, the leaf switches are referred to as IB2 and IB3. Use the rack unit that is appropriate for your system.
- In Oracle Exadata Database Machine X2-2 racks and Oracle Exadata Storage Expansion Racks with Exadata Storage Server with Sun Fire X4270 M2 Servers, the leaf switches are in U20 and U24, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine 8-socket (X8-8, X7-8, X6-8, X5-8, X4-8, X3-8 and X2-8) Full Rack systems, the leaf switches are in U21 and U23, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X4-2 and later racks, Oracle Exadata Database Machine X3-2 Full Racks and Oracle Exadata Storage Expansion Rack X3-2 racks, the leaf switches are in U20 and U22, also referred to as IB2 and IB3, respectively.
- The cable lengths shown in the following lists assume that the racks are adjacent to each other. If the racks are not adjacent or use overhead cabling trays, then they may require longer cables lengths. Cables lengths up to 100 meters are supported.

The following table shows the cable connections for the first spine switch (R1-U1) when cabling two full racks together.

Table 5-1 Leaf Switch Connections for the First Rack in a Two-Rack System

Leaf Switch	Connection	Cable Length
R1 IB3 within Rack 1	R1-IB3-P8A to R1-U1-P3A R1-IB3-P8B to R1-U1-P4A R1-IB3-P9A to R1-U1-P5A R1-IB3-P9B to R1-U1-P6A	3 meters
R1 IB3 to Rack 2	R1-IB3-P10A to R2-U1-P7A R1-IB3-P10B to R2-U1-P8A R1-IB3-P11A to R2-U1-P9A R1-IB3-P11B to R2-U1-P10A	5 meters
R1 IB2 within Rack 1	R1-IB2-P8A to R1-U1-P3B R1-IB2-P8B to R1-U1-P4B R1-IB2-P9A to R1-U1-P5B R1-IB2-P9B to R1-U1-P6B	3 meters

Table 5-1 (Cont.) Leaf Switch Connections for the First Rack in a Two-Rack System

Leaf Switch	Connection	Cable Length
R1 IB2 to Rack 2	R1-IB2-P10A to R2-U1-P7B R1-IB2-P10B to R2-U1-P8B R1-IB2-P11A to R2-U1-P9B R1-IB2-P11B to R2-U1-P10B	5 meters

The following table shows the cable connections for the second spine switch (R2-U1) when cabling two full racks together.

Table 5-2 Leaf Switch Connections for the Second Rack in a Two-Rack System

Leaf Switch	Connection	Cable Length
R2 IB3 within Rack 2	R2-IB3-P8A to R2-U1-P3A R2-IB3-P8B to R2-U1-P4A R2-IB3-P9A to R2-U1-P5A R2-IB3-P9B to R2-U1-P6A	3 meters
R2 IB3 to Rack 1	R2-IB3-P10A to R1-U1-P7A R2-IB3-P10B to R1-U1-P8A R2-IB3-P11A to R1-U1-P9A R2-IB3-P11B to R1-U1-P10A	5 meters
R2 IB2 within Rack 2	R2-IB2-P8A to R2-U1-P3B R2-IB2-P8B to R2-U1-P4B R2-IB2-P9A to R2-U1-P5B R2-IB2-P9B to R2-U1-P6B	3 meters
R2 IB2 to Rack 1	R2-IB2-P10A to R1-U1-P7B R2-IB2-P10B to R1-U1-P8B R2-IB2-P11A to R1-U1-P9B R2-IB2-P11B to R1-U1-P10B	5 meters

Related Topics

- [Cabling Two Racks Together](#)
The simplest case of extending an Engineered System rack is to cable two racks together.

5.3 Three-Rack Cabling

Note the following when cabling three racks together:

- The spine switch is in U1 (also referred to as IB1) for all racks.
- In the following tables, the leaf switches are referred to as IB2 and IB3. Use the rack unit that is appropriate for your system.
- In Oracle Exadata Database Machine X2-2 racks and Oracle Exadata Storage Expansion Racks with Exadata Storage Server with Sun Fire X4270 M2 Servers, the leaf switches are in U20 and U24, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X2-8 and later, the leaf switches are in U21 and U23, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X4-2 and later racks, or Oracle Exadata Database Machine X3-2 Full Racks or Oracle Exadata Storage Expansion Rack X3-2 racks, the leaf switches are in U20 and U22, also referred to as IB2 and IB3, respectively.
- The cable lengths shown in the tables assume the racks are adjacent to each other. If the racks are not adjacent or use overhead cabling trays, then they may require longer cables lengths. Up to 100 meters is supported.
- Only optical cables are supported for lengths greater than 5 meters.

[Table 5-3](#) shows the cable connections for the first spine switch (R1-U1) when cabling three racks together:

Table 5-3 Leaf Switch Connections for the First Rack in a Three-Rack System

Leaf Switch	Connection	Cable Length
R1 IB3 within Rack 1	R1-IB3-P8A to R1-U1-P3A R1-IB3-P8B to R1-U1-P4A R1-IB3-P9A to R1-U1-P5A	3 meters
R1 IB3 to Rack 2	R1-IB3-P9B to R2-U1-P6A R1-IB3-P10A to R2-U1-P7A R1-IB3-P10B to R2-U1-P8A	5 meters
R1 IB3 to Rack 3	R1-IB3-P11A to R3-U1-P9A R1-IB3-P11B to R3-U1-P10A	5 meters
R1 IB2 within Rack 1	R1-IB2-P8A to R1-U1-P3B R1-IB2-P8B to R1-U1-P4B R1-IB2-P9A to R1-U1-P5B	3 meters
R1 IB2 to Rack 2	R1-IB2-P9B to R2-U1-P6B R1-IB2-P10A to R2-U1-P7B R1-IB2-P10B to R2-U1-P8B	5 meters

Table 5-3 (Cont.) Leaf Switch Connections for the First Rack in a Three-Rack System

Leaf Switch	Connection	Cable Length
R1 IB2 to Rack 3	R1-IB2-P11A to R3-U1-P9B R1-IB2-P11B to R3-U1-P10B	5 meters

Table 5-4 shows the cable connections for the second spine switch (R2-U1) when cabling three racks together:

Table 5-4 Leaf Switch Connections for the Second Rack in a Three-Rack System

Leaf Switch	Connection	Cable Length
R2 IB3 within Rack 2	R2-IB3-P8A to R2-U1-P3A R2-IB3-P8B to R2-U1-P4A R2-IB3-P9A to R2-U1-P5A	3 meters
R2 IB3 to Rack 1	R2-IB3-P11A to R1-U1-P9A R2-IB3-P11B to R1-U1-P10A	5 meters
R2 IB3 to Rack 3	R2-IB3-P9B to R3-U1-P6A R2-IB3-P10A to R3-U1-P7A R2-IB3-P10B to R3-U1-P8A	5 meters
R2 IB2 within Rack 2	R2-IB2-P8A to R2-U1-P3B R2-IB2-P8B to R2-U1-P4B R2-IB2-P9A to R2-U1-P5B	3 meters
R2 IB2 to Rack 1	R2-IB2-P11A to R1-U1-P9B R2-IB2-P11B to R1-U1-P10B	5 meters
R2 IB2 to Rack 3	R2-IB2-P9B to R3-U1-P6B R2-IB2-P10A to R3-U1-P7B R2-IB2-P10B to R3-U1-P8B	5 meters

Table 5-5 shows the cable connections for the third spine switch (R3-U1) when cabling three full racks together:

Table 5-5 Leaf Switch Connections for the Third Rack in a Three-Rack System

Leaf Switch	Connection	Cable Length
R3 IB3 within Rack 3	R3-IB3-P8A to R3-U1-P3A R3-IB3-P8B to R3-U1-P4A R3-IB3-P9A to R3-U1-P5A	3 meters
R3 IB3 to Rack 1	R3-IB3-P9B to R1-U1-P6A R3-IB3-P10A to R1-U1-P7A R3-IB3-P10B to R1-U1-P8A	5 meters
R3 IB3 to Rack 2	R3-IB3-P11A to R2-U1-P9A R3-IB3-P11B to R2-U1-P10A	5 meters

Table 5-5 (Cont.) Leaf Switch Connections for the Third Rack in a Three-Rack System

Leaf Switch	Connection	Cable Length
R3 IB2 within Rack 3	R3-IB2-P8A to R3-U1-P3B R3-IB2-P8B to R3-U1-P4B R3-IB2-P9A to R3-U1-P5B	3 meters
R3 IB2 to Rack 1	R3-IB2-P9B to R1-U1-P6B R3-IB2-P10A to R1-U1-P7B R3-IB2-P10B to R1-U1-P8B	5 meters
R3 IB2 to Rack 2	R3-IB2-P11A to R2-U1-P9B R3-IB2-P11B to R2-U1-P10B	5 meters

5.4 Four-Rack Cabling

Note the following when cabling four racks together:

- The spine switch is in U1 (also referred to as IB1) for all racks.
- In the following tables, the leaf switches are referred to as IB2 and IB3. Use the rack unit that is appropriate for your system.
- In Oracle Exadata Database Machine X2-2 racks and Oracle Exadata Storage Expansion Racks with Exadata Storage Server with Sun Fire X4270 M2 Servers, the leaf switches are in U20 and U24, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X2-8 and later, the leaf switches are in U21 and U23, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X4-2 and later racks, or Oracle Exadata Database Machine X3-2 Full Racks or Oracle Exadata Storage Expansion Rack X3-2 racks, the leaf switches are in U20 and U22, also referred to as IB2 and IB3, respectively.
- The cable lengths shown in the tables assume the racks are adjacent to each other. If the racks are not adjacent or use overhead cabling trays, then they may require longer cables lengths. Up to 100 meters is supported.
- Only optical cables are supported for lengths greater than 5 meters.

[Table 5-6](#) shows the cable connections for the first spine switch (R1-U1) when cabling four racks together:

Table 5-6 Leaf Switch Connections for the First Rack in a Four-Rack System

Leaf Switch	Connection	Cable Length
R1 IB3 within Rack 1	R1-IB3-P8A to R1-U1-P3A R1-IB3-P8B to R1-U1-P4A	3 meters
R1 IB3 to Rack 2	R1-IB3-P9A to R2-U1-P5A R1-IB3-P9B to R2-U1-P6A	5 meters
R1 IB3 to Rack 3	R1-IB3-P10A to R3-U1-P7A R1-IB3-P10B to R3-U1-P8A	5 meters

Table 5-6 (Cont.) Leaf Switch Connections for the First Rack in a Four-Rack System

Leaf Switch	Connection	Cable Length
R1 IB3 to Rack 4	R1-IB3-P11A to R4-U1-P9A R1-IB3-P11B to R4-U1-P10A	10 meters
R1 IB2 within Rack 1	R1-IB2-P8A to R1-U1-P3B R1-IB2-P8B to R1-U1-P4B	3 meters
R1 IB2 to Rack 2	R1-IB2-P9A to R2-U1-P5B R1-IB2-P9B to R2-U1-P6B	5 meters
R1 IB2 to Rack 3	R1-IB2-P10A to R3-U1-P7B R1-IB2-P10B to R3-U1-P8B	5 meters
R1 IB2 to Rack 4	R1-IB2-P11A to R4-U1-P9B R1-IB2-P11B to R4-U1-P10B	10 meters

Table 5-7 shows the cable connections for the second spine switch (R2-U1) when cabling four full racks together:

Table 5-7 Leaf Switch Connections for the Second Rack in a Four-Rack System

Leaf Switch	Connection	Cable Length
R2 IB3 within Rack 2	R2-IB3-P8A to R2-U1-P3A R2-IB3-P8B to R2-U1-P4A	3 meters
R2 IB3 to Rack 1	R2-IB3-P11A to R1-U1-P9A R2-IB3-P11B to R1-U1-P10A	5 meters
R2 IB3 to Rack 3	R2-IB3-P9A to R3-U1-P5A R2-IB3-P9B to R3-U1-P6A	5 meters
R2 IB3 to Rack 4	R2-IB3-P10A to R4-U1-P7A R2-IB3-P10B to R4-U1-P8A	5 meters
R2 IB2 within Rack 2	R2-IB2-P8A to R2-U1-P3B R2-IB2-P8B to R2-U1-P4B	3 meters
R2 IB2 to Rack 1	R2-IB2-P11A to R1-U1-P9B R2-IB2-P11B to R1-U1-P10B	5 meters
R2 IB2 to Rack 3	R2-IB2-P9A to R3-U1-P5B R2-IB2-P9B to R3-U1-P6B	5 meters
R2 IB2 to Rack 4	R2-IB2-P10A to R4-U1-P7B R2-IB2-P10B to R4-U1-P8B	5 meters

Table 5-8 shows the cable connections for the third spine switch (R3-U1) when cabling four full racks together:

Table 5-8 Leaf Switch Connections for the Third Rack in a Four-Rack System

Leaf Switch	Connection	Cable Length
R3 IB3 within Rack 3	R3-IB3-P8A to R3-U1-P3A R3-IB3-P8B to R3-U1-P4A	3 meters
R3 IB3 to Rack 1	R3-IB3-P10A to R1-U1-P7A R3-IB3-P10B to R1-U1-P8A	5 meters
R3 IB3 to Rack 2	R3-IB3-P11A to R2-U1-P9A R3-IB3-P11B to R2-U1-P10A	5 meters
R3 IB3 to Rack 4	R3-IB3-P9A to R4-U1-P5A R3-IB3-P9B to R4-U1-P6A	5 meters
R3 IB2 within Rack 3	R3-IB2-P8A to R3-U1-P3B R3-IB2-P8B to R3-U1-P4B	3 meters
R3 IB2 to Rack 1	R3-IB2-P10A to R1-U1-P7B R3-IB2-P10B to R1-U1-P8B	5 meters
R3 IB2 to Rack 2	R3-IB2-P11A to R2-U1-P9B R3-IB2-P11B to R2-U1-P10B	5 meters
R3 IB2 to Rack 4	R3-IB2-P9A to R4-U1-P5B R3-IB2-P9B to R4-U1-P6B	5 meters

Table 5-9 shows the cable connections for the fourth spine switch (R4-U1) when cabling four full racks together:

Table 5-9 Leaf Switch Connections for the Fourth Rack in a Four-Rack System

Leaf Switch	Connection	Cable Length
R4 IB3 within Rack 4	R4-IB3-P8A to R4-U1-P3A R4-IB3-P8B to R4-U1-P4A	3 meters
R4 IB3 to Rack 1	R4-IB3-P9A to R1-U1-P5A R4-IB3-P9B to R1-U1-P6A	10 meters
R4 IB3 to Rack 2	R4-IB3-P10A to R2-U1-P7A R4-IB3-P10B to R2-U1-P8A	5 meters
R4 IB3 to Rack 3	R4-IB3-P11A to R3-U1-P9A R4-IB3-P11B to R3-U1-P10A	5 meters
R4 IB2 within Rack 4	R4-IB2-P8A to R4-U1-P3B R4-IB2-P8B to R4-U1-P4B	3 meters
R4 IB2 to Rack 1	R4-IB2-P9A to R1-U1-P5B R4-IB2-P9B to R1-U1-P6B	10 meters
R4 IB2 to Rack 2	R4-IB2-P10A to R2-U1-P7B R4-IB2-P10B to R2-U1-P8B	5 meters
R4 IB2 to Rack 3	R4-IB2-P11A to R3-U1-P9B R4-IB2-P11B to R3-U1-P10B	5 meters

5.5 Five-Rack Cabling

Note the following when cabling five racks together:

- The spine switch is in U1 (also referred to as IB1) for all racks.
- In the following tables, the leaf switches are referred to as IB2 and IB3. Use the rack unit that is appropriate for your system.
- In Oracle Exadata Database Machine X2-2 racks and Oracle Exadata Storage Expansion Racks with Exadata Storage Server with Sun Fire X4270 M2 Servers, the leaf switches are in U20 and U24, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X2-8 and later racks, the leaf switches are in U21 and U23, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X4-2 and later racks, or Oracle Exadata Database Machine X3-2 Full Racks and Oracle Exadata Storage Expansion Rack X3-2 racks, the leaf switches are in U20 and U22, also referred to as IB2 and IB3, respectively.
- The cable lengths shown in the tables assume the racks are adjacent to each other. If the racks are not adjacent or use overhead cabling trays, then they may require longer cables lengths. Up to 100 meters is supported.
- Only optical cables are supported for lengths greater than 5 meters.

Table 5-10 shows the cable connections for the first spine switch (R1-U1) when cabling five racks together:

Table 5-10 Leaf Switch Connections for the First Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R1 IB3 within Rack 1	R1-IB3-P8A to R1-U1-P3A R1-IB3-P8B to R1-U1-P4A	3 meters
R1 IB3 to Rack 2	R1-IB3-P9A to R2-U1-P5A R1-IB3-P9B to R2-U1-P6A	5 meters
R1 IB3 to Rack 3	R1-IB3-P10A to R3-U1-P7A R1-IB3-P10B to R3-U1-P8A	5 meters
R1 IB3 to Rack 4	R1-IB3-P11A to R4-U1-P9A	10 meters
R1 IB3 to Rack 5	R1-IB3-P11B to R5-U1-P10A	10 meters
R1 IB2 within Rack 1	R1-IB2-P8A to R1-U1-P3B R1-IB2-P8B to R1-U1-P4B	3 meters
R1 IB2 to Rack 2	R1-IB2-P9A to R2-U1-P5B R1-IB2-P9B to R2-U1-P6B	5 meters
R1 IB2 to Rack 3	R1-IB2-P10A to R3-U1-P7B R1-IB2-P10B to R3-U1-P8B	5 meters
R1 IB2 to Rack 4	R1-IB2-P11A to R4-U1-P9B	10 meters
R1 IB2 to Rack 5	R1-IB2-P11B to R5-U1-P10B	10 meters

Table 5-11 shows the cable connections for the second spine switch (R2-U1) when cabling five full racks together:

Table 5-11 Leaf Switch Connections for the Second Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R2 IB3 within Rack 2	R2-IB3-P8A to R2-U1-P3A R2-IB3-P8B to R2-U1-P4A	3 meters
R2 IB3 to Rack 1	R2-IB3-P11B to R1-U1-P10A	5 meters
R2 IB3 to Rack 3	R2-IB3-P9A to R3-U1-P5A R2-IB3-P9B to R3-U1-P6A	5 meters
R2 IB3 to Rack 4	R2-IB3-P10A to R4-U1-P7A R2-IB3-P10B to R4-U1-P8A	5 meters
R2 IB3 to Rack 5	R2-IB3-P11A to R5-U1-P9A	10 meters
R2 IB2 within Rack 2	R2-IB2-P8A to R2-U1-P3B R2-IB2-P8B to R2-U1-P4B	3 meters
R2 IB2 to Rack 1	R2-IB2-P11B to R1-U1-P10B	5 meters
R2 IB2 to Rack 3	R2-IB2-P9A to R3-U1-P5B R2-IB2-P9B to R3-U1-P6B	5 meters
R2 IB2 to Rack 4	R2-IB2-P10A to R4-U1-P7B R2-IB2-P10B to R4-U1-P8B	5 meters
R2 IB2 to Rack 5	R2-IB2-P11A to R5-U1-P9B	10 meters

[Table 5-12](#) shows the cable connections for the third spine switch (R3-U1) when cabling five full racks together:

Table 5-12 Leaf Switch Connections for the Third Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R3 IB3 within Rack 3	R3-IB3-P8A to R3-U1-P3A R3-IB3-P8B to R3-U1-P4A	3 meters
R3 IB3 to Rack 1	R3-IB3-P11A to R1-U1-P9A	5 meters
R3 IB3 to Rack 2	R3-IB3-P11B to R2-U1-P10A	5 meters
R3 IB3 to Rack 4	R3-IB3-P9A to R4-U1-P5A R3-IB3-P9B to R4-U1-P6A	5 meters
R3 IB3 to Rack 5	R3-IB3-P10A to R5-U1-P7A R3-IB3-P10B to R5-U1-P8A	5 meters
R3 IB2 within Rack 3	R3-IB2-P8A to R3-U1-P3B R3-IB2-P8B to R3-U1-P4B	3 meters
R3 IB2 to Rack 1	R3-IB2-P11A to R1-U1-P9B	5 meters
R3 IB2 to Rack 2	R3-IB2-P11B to R2-U1-P10B	5 meters
R3 IB2 to Rack 4	R3-IB2-P9A to R4-U1-P5B R3-IB2-P9B to R4-U1-P6B	5 meters
R3 IB2 to Rack 5	R3-IB2-P10A to R5-U1-P7B R3-IB2-P10B to R5-U1-P8B	5 meters

Table 5-13 shows the cable connections for the fourth spine switch (R4-U1) when cabling five full racks together:

Table 5-13 Leaf Switch Connections for the Fourth Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R4 IB3 within Rack 4	R4-IB3-P8A to R4-U1-P3A R4-IB3-P8B to R4-U1-P4A	3 meters
R4 IB3 to Rack 1	R4-IB3-P10A to R1-U1-P7A R4-IB3-P10B to R1-U1-P8A	10 meters
R4 IB3 to Rack 2	R4-IB3-P11A to R2-U1-P9A	5 meters
R4 IB3 to Rack 3	R4-IB3-P11B to R3-U1-P10A	5 meters
R4 IB3 to Rack 5	R4-IB3-P9A to R5-U1-P5A R4-IB3-P9B to R5-U1-P6A	5 meters
R4 IB2 within Rack 4	R4-IB2-P8A to R4-U1-P3B R4-IB2-P8B to R4-U1-P4B	3 meters
R4 IB2 to Rack 1	R4-IB2-P10A to R1-U1-P7B R4-IB2-P10B to R1-U1-P8B	10 meters
R4 IB2 to Rack 2	R4-IB2-P11A to R2-U1-P9B	5 meters
R4 IB2 to Rack 3	R4-IB2-P11B to R3-U1-P10B	5 meters
R4 IB2 to Rack 5	R4-IB2-P9A to R5-U1-P5B R4-IB2-P9B to R5-U1-P6B	5 meters

Table 5-14 shows the cable connections for the fifth spine switch (R5-U1) when cabling five full racks together:

Table 5-14 Leaf Switch Connections for the Fifth Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R5 IB3 within Rack 5	R5-IB3-P8A to R5-U1-P3A R5-IB3-P8B to R5-U1-P4A	3 meters
R5 IB3 to Rack 1	R5-IB3-P9A to R1-U1-P5A R5-IB3-P9B to R1-U1-P6A	10 meters
R5 IB3 to Rack 2	R5-IB3-P10A to R2-U1-P7A R5-IB3-P10B to R2-U1-P8A	10 meters
R5 IB3 to Rack 3	R5-IB3-P11A to R3-U1-P9A	5 meters
R5 IB3 to Rack 4	R5-IB3-P11B to R4-U1-P10A	5 meters
R5 IB2 within Rack 5	R5-IB2-P8A to R5-U1-P3B R5-IB2-P8B to R5-U1-P4B	3 meters
R5 IB2 to Rack 1	R5-IB2-P9A to R1-U1-P5B R5-IB2-P9B to R1-U1-P6B	10 meters
R5 IB2 to Rack 2	R5-IB2-P10A to R2-U1-P7B R5-IB2-P10B to R2-U1-P8B	10 meters
R5 IB2 to Rack 3	R5-IB2-P11A to R3-U1-P9B	5 meters

Table 5-14 (Cont.) Leaf Switch Connections for the Fifth Rack in a Five-Rack System

Leaf Switch	Connection	Cable Length
R5 IB2 to Rack 4	R5-IB2-P11B to R4-U1-P10B	5 meters

5.6 Six-Rack Cabling

Note the following when cabling six racks together:

- The spine switch is in U1 (also referred to as IB1) for all racks.
- In the following tables, the leaf switches are referred to as IB2 and IB3. Use the rack unit that is appropriate for your system.
- In Oracle Exadata Database Machine X2-2 racks and Oracle Exadata Storage Expansion Racks with Exadata Storage Server with Sun Fire X4270 M2 Servers, the leaf switches are in U20 and U24, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X2-8 and later 8-socket racks, the leaf switches are in U21 and U23, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X4-2 and later two-socket racks, or Oracle Exadata Database Machine X3-2 Full Racks and Oracle Exadata Storage Expansion Rack X3-2 racks, the leaf switches are in U20 and U22, also referred to as IB2 and IB3, respectively.
- The cable lengths shown in the tables assume the racks are adjacent to each other. If the racks are not adjacent or use overhead cabling trays, then they may require longer cables lengths. Up to 100 meters is supported.
- Only optical cables are supported for lengths greater than 5 meters.

[Table 5-15](#) shows the cable connections for the first spine switch (R1-U1) when cabling six racks together:

Table 5-15 Leaf Switch Connections for the First Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R1 IB3 within Rack 1	R1-IB3-P8A to R1-U1-P3A R1-IB3-P8B to R1-U1-P4A	3 meters
R1 IB3 to Rack 2	R1-IB3-P9A to R2-U1-P5A R1-IB3-P9B to R2-U1-P6A	5 meters
R1 IB3 to Rack 3	R1-IB3-P10A to R3-U1-P7A	5 meters
R1 IB3 to Rack 4	R1-IB3-P10B to R4-U1-P8A	10 meters
R1 IB3 to Rack 5	R1-IB3-P11A to R5-U1-P9A	10 meters
R1 IB3 to Rack 6	R1-IB3-P11B to R6-U1-P10A	10 meters
R1 IB2 within Rack 1	R1-IB2-P8A to R1-U1-P3B R1-IB2-P8B to R1-U1-P4B	3 meters
R1 IB2 to Rack 2	R1-IB2-P9A to R2-U1-P5B R1-IB2-P9B to R2-U1-P6B	5 meters

Table 5-15 (Cont.) Leaf Switch Connections for the First Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R1 IB2 to Rack 3	R1-IB2-P10A to R3-U1-P7B	5 meters
R1 IB2 to Rack 4	R1-IB2-P10B to R4-U1-P8B	10 meters
R1 IB2 to Rack 5	R1-IB2-P11A to R5-U1-P9B	10 meters
R1 IB2 to Rack 6	R1-IB2-P11B to R6-U1-P10B	10 meters

Table 5-16 shows the cable connections for the second spine switch (R2-U1) when cabling six full racks together:

Table 5-16 Leaf Switch Connections for the Second Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R2 IB3 within Rack 2	R2-IB3-P8A to R2-U1-P3A R2-IB3-P8B to R2-U1-P4A	3 meters
R2 IB3 to Rack 1	R2-IB3-P11B to R1-U1-P10A	5 meters
R2 IB3 to Rack 3	R2-IB3-P9A to R3-U1-P5A R2-IB3-P9B to R3-U1-P6A	5 meters
R2 IB3 to Rack 4	R2-IB3-P10A to R4-U1-P7A	5 meters
R2 IB3 to Rack 5	R2-IB3-P10B to R5-U1-P8A	10 meters
R2 IB3 to Rack 6	R2-IB3-P11A to R6-U1-P9A	10 meters
R2 IB2 within Rack 2	R2-IB2-P8A to R2-U1-P3B R2-IB2-P8B to R2-U1-P4B	3 meters
R2 IB2 to Rack 1	R2-IB2-P11B to R1-U1-P10B	5 meters
R2 IB2 to Rack 3	R2-IB2-P9A to R3-U1-P5B R2-IB2-P9B to R3-U1-P6B	5 meters
R2 IB2 to Rack 4	R2-IB2-P10A to R4-U1-P7B	5 meters
R2 IB2 to Rack 5	R2-IB2-P10B to R5-U1-P8B	10 meters
R2 IB2 to Rack 6	R2-IB2-P11A to R6-U1-P9B	10 meters

Table 5-17 shows the cable connections for the third spine switch (R3-U1) when cabling six full racks together:

Table 5-17 Leaf Switch Connections for the Third Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R3 IB3 within Rack 3	R3-IB3-P8A to R3-U1-P3A R3-IB3-P8B to R3-U1-P4A	3 meters
R3 IB3 to Rack 1	R3-IB3-P11A to R1-U1-P9A	5 meters
R3 IB3 to Rack 2	R3-IB3-P11B to R2-U1-P10A	5 meters

Table 5-17 (Cont.) Leaf Switch Connections for the Third Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R3 IB3 to Rack 4	R3-IB3-P9A to R4-U1-P5A R3-IB3-P9B to R4-U1-P6A	5 meters
R3 IB3 to Rack 5	R3-IB3-P10A to R5-U1-P7A	5 meters
R3 IB3 to Rack 6	R3-IB3-P10B to R6-U1-P8A	10 meters
R3 IB2 within Rack 3	R3-IB2-P8A to R3-U1-P3B R3-IB2-P8B to R3-U1-P4B	3 meters
R3 IB2 to Rack 1	R3-IB2-P11A to R1-U1-P9B	5 meters
R3 IB2 to Rack 2	R3-IB2-P11B to R2-U1-P10B	5 meters
R3 IB2 to Rack 4	R3-IB2-P9A to R4-U1-P5B R3-IB2-P9B to R4-U1-P6B	5 meters
R3 IB2 to Rack 5	R3-IB2-P10A to R5-U1-P7B	5 meters
R3 IB2 to Rack 6	R3-IB2-P10B to R6-U1-P8B	10 meters

[Table 5-18](#) shows the cable connections for the fourth spine switch (R4-U1) when cabling six full racks together:

Table 5-18 Leaf Switch Connections for the Fourth Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R4 IB3 within Rack 4	R4-IB3-P8A to R4-U1-P3A R4-IB3-P8B to R4-U1-P4A	3 meters
R4 IB3 to Rack 1	R4-IB3-P10B to R1-U1-P8A	10 meters
R4 IB3 to Rack 2	R4-IB3-P11A to R2-U1-P9A	5 meters
R4 IB3 to Rack 3	R4-IB3-P11B to R3-U1-P10A	5 meters
R4 IB3 to Rack 5	R4-IB3-P9A to R5-U1-P5A R4-IB3-P9B to R5-U1-P6A	5 meters
R4 IB3 to Rack 6	R4-IB3-P10A to R6-U1-P7A	5 meters
R4 IB2 within Rack 4	R4-IB2-P8A to R4-U1-P3B R4-IB2-P8B to R4-U1-P4B	3 meters
R4 IB2 to Rack 1	R4-IB2-P10B to R1-U1-P8B	10 meters
R4 IB2 to Rack 2	R4-IB2-P11A to R2-U1-P9B	5 meters
R4 IB2 to Rack 3	R4-IB2-P11B to R3-U1-P10B	5 meters
R4 IB2 to Rack 5	R4-IB2-P9A to R5-U1-P5B R4-IB2-P9B to R5-U1-P6B	5 meters
R4 IB2 to Rack 6	R4-IB2-P10A to R6-U1-P7B	5 meters

[Table 5-19](#) shows the cable connections for the fifth spine switch (R5-U1) when cabling six full racks together:

Table 5-19 Leaf Switch Connections for the Fifth Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R5 IB3 within Rack 5	R5-IB3-P8A to R5-U1-P3A R5-IB3-P8B to R5-U1-P4A	3 meters
R5 IB3 to Rack 1	R5-IB3-P10A to R1-U1-P7A	10 meters
R5 IB3 to Rack 2	R5-IB3-P10B to R2-U1-P8A	10 meters
R5 IB3 to Rack 3	R5-IB3-P11A to R3-U1-P9A	5 meters
R5 IB3 to Rack 4	R5-IB3-P11B to R4-U1-P10A	5 meters
R5 IB3 to Rack 6	R5-IB3-P9A to R6-U1-P5A R5-IB3-P9B to R6-U1-P6A	5 meters
R5 IB2 within Rack 5	R5-IB2-P8A to R5-U1-P3B R5-IB2-P8B to R5-U1-P4B	3 meters
R5 IB2 to Rack 1	R5-IB2-P10A to R1-U1-P7B	10 meters
R5 IB2 to Rack 2	R5-IB2-P10B to R2-U1-P8B	10 meters
R5 IB2 to Rack 3	R5-IB2-P11A to R3-U1-P9B	5 meters
R5 IB2 to Rack 4	R5-IB2-P11B to R4-U1-P10B	5 meters
R5 IB2 to Rack 6	R5-IB2-P9A to R6-U1-P5B R5-IB2-P9B to R6-U1-P6B	5 meters

Table 5-20 shows the cable connections for the sixth spine switch (R6-U1) when cabling six full racks together:

Table 5-20 Leaf Switch Connections for the Sixth Rack in a Six-Rack System

Leaf Switch	Connection	Cable Length
R6 IB3 within Rack 6	R6-IB3-P8A to R6-U1-P3A R6-IB3-P8B to R6-U1-P4A	3 meters
R6 IB3 to Rack 1	R6-IB3-P9A to R1-U1-P5A R6-IB3-P9B to R1-U1-P6A	10 meters
R6 IB3 to Rack 2	R6-IB3-P10A to R2-U1-P7A	10 meters
R6 IB3 to Rack 3	R6-IB3-P10B to R3-U1-P8A	10 meters
R6 IB3 to Rack 4	R6-IB3-P11A to R4-U1-P9A	5 meters
R6 IB3 to Rack 5	R6-IB3-P11B to R5-U1-P10A	5 meters
R6 IB2 within Rack 6	R6-IB2-P8A to R6-U1-P3B R6-IB2-P8B to R6-U1-P4B	3 meters
R6 IB2 to Rack 1	R6-IB2-P9A to R1-U1-P5B R6-IB2-P9B to R1-U1-P6B	10 meters
R6 IB2 to Rack 2	R6-IB2-P10A to R2-U1-P7B	10 meters
R6 IB2 to Rack 3	R6-IB2-P10B to R3-U1-P8B	10 meters
R6 IB2 to Rack 4	R6-IB2-P11A to R4-U1-P9B	5 meters
R6 IB2 to Rack 5	R6-IB2-P11B to R5-U1-P10B	5 meters

5.7 Seven-Rack Cabling

Note the following when cabling five racks together:

- The spine switch is in U1 (also referred to as IB1) for all racks.
- In the following tables, the leaf switches are referred to as IB2 and IB3. Use the rack unit that is appropriate for your system.
- In Oracle Exadata Database Machine X2-2 racks and Oracle Exadata Storage Expansion Racks with Exadata Storage Server with Sun Fire X4270 M2 Servers, the leaf switches are in U20 and U24, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X2-8 and later racks, the leaf switches are in U21 and U23, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X4-2 and later racks, or Oracle Exadata Database Machine X3-2 Full Racks and Oracle Exadata Storage Expansion Rack X3-2 racks, the leaf switches are in U20 and U22, also referred to as IB2 and IB3, respectively.
- The cable lengths shown in the tables assume the racks are adjacent to each other. If the racks are not adjacent or use overhead cabling trays, then they may require longer cables lengths. Up to 100 meters is supported.
- Only optical cables are supported for lengths greater than 5 meters.

[Table 5-21](#) shows the cable connections for the first spine switch (R1-U1) when cabling seven racks together:

Table 5-21 Leaf Switch Connections for the First Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R1 IB3 within Rack 1	R1-IB3-P8A to R1-U1-P3A R1-IB3-P8B to R1-U1-P4A	3 meters
R1 IB3 to Rack 2	R1-IB3-P9A to R2-U1-P5A	5 meters
R1 IB3 to Rack 3	R1-IB3-P9B to R3-U1-P6A	5 meters
R1 IB3 to Rack 4	R1-IB3-P10A to R4-U1-P7A	10 meters
R1 IB3 to Rack 5	R1-IB3-P10B to R5-U1-P8A	10 meters
R1 IB3 to Rack 6	R1-IB3-P11A to R6-U1-P9A	10 meters
R1 IB3 to Rack 7	R1-IB3-P11B to R7-U1-P10A	10 meters
R1 IB2 within Rack 1	R1-IB2-P8A to R1-U1-P3B R1-IB2-P8B to R1-U1-P4B	3 meters
R1 IB2 to Rack 2	R1-IB2-P9A to R2-U1-P5B	5 meters
R1 IB2 to Rack 3	R1-IB2-P9B to R3-U1-P6B	5 meters
R1 IB2 to Rack 4	R1-IB2-P10A to R4-U1-P7B	10 meters
R1 IB2 to Rack 5	R1-IB2-P10B to R5-U1-P8B	10 meters
R1 IB2 to Rack 6	R1-IB2-P11A to R6-U1-P9B	10 meters
R1 IB2 to Rack 7	R1-IB2-P11B to R7-U1-P10B	10 meters

Table 5-22 shows the cable connections for the second spine switch (R2-U1) when cabling seven full racks together:

Table 5-22 Leaf Switch Connections for the Second Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R2 IB3 within Rack 2	R2-IB3-P8A to R2-U1-P3A R2-IB3-P8B to R2-U1-P4A	3 meters
R2 IB3 to Rack 1	R2-IB3-P11B to R1-U1-P10A	5 meters
R2 IB3 to Rack 3	R2-IB3-P9A to R3-U1-P5A	5 meters
R2 IB3 to Rack 4	R2-IB3-P9B to R4-U1-P6A	5 meters
R2 IB3 to Rack 5	R2-IB3-P10A to R5-U1-P7A	10 meters
R2 IB3 to Rack 6	R2-IB3-P10B to R6-U1-P8A	10 meters
R2 IB3 to Rack 7	R2-IB3-P11A to R7-U1-P9A	10 meters
R2 IB2 within Rack 2	R2-IB2-P8A to R2-U1-P3B R2-IB2-P8B to R2-U1-P4B	3 meters
R2 IB2 to Rack 1	R2-IB2-P11B to R1-U1-P10B	5 meters
R2 IB2 to Rack 3	R2-IB2-P9A to R3-U1-P5B	5 meters
R2 IB2 to Rack 4	R2-IB2-P9B to R4-U1-P6B	5 meters
R2 IB2 to Rack 5	R2-IB2-P10A to R5-U1-P7B	10 meters
R2 IB2 to Rack 6	R2-IB2-P10B to R6-U1-P8B	10 meters
R2 IB2 to Rack 7	R2-IB2-P11A to R7-U1-P9B	10 meters

Table 5-23 shows the cable connections for the third spine switch (R3-U1) when cabling seven full racks together:

Table 5-23 Leaf Switch Connections for the Third Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R3 IB3 within Rack 3	R3-IB3-P8A to R3-U1-P3A R3-IB3-P8B to R3-U1-P4A	3 meters
R3 IB3 to Rack 1	R3-IB3-P11A to R1-U1-P9A	5 meters
R3 IB3 to Rack 2	R3-IB3-P11B to R2-U1-P10A	5 meters
R3 IB3 to Rack 4	R3-IB3-P9A to R4-U1-P5A	5 meters
R3 IB3 to Rack 5	R3-IB3-P9B to R5-U1-P6A	5 meters
R3 IB3 to Rack 6	R3-IB3-P10A to R6-U1-P7A	10 meters
R3 IB3 to Rack 7	R3-IB3-P10B to R7-U1-P8A	10 meters
R3 IB2 within Rack 3	R3-IB2-P8A to R3-U1-P3B R3-IB2-P8B to R3-U1-P4B	3 meters
R3 IB2 to Rack 1	R3-IB2-P11A to R1-U1-P9B	5 meters
R3 IB2 to Rack 2	R3-IB2-P11B to R2-U1-P10B	5 meters
R3 IB2 to Rack 4	R3-IB2-P9A to R4-U1-P5B	5 meters

Table 5-23 (Cont.) Leaf Switch Connections for the Third Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R3 IB2 to Rack 5	R3-IB2-P9B to R5-U1-P6B	5 meters
R3 IB2 to Rack 6	R3-IB2-P10A to R6-U1-P7B	10 meters
R3 IB2 to Rack 7	R3-IB2-P10B to R7-U1-P8B	10 meters

Table 5-24 shows the cable connections for the fourth spine switch (R4-U1) when cabling seven full racks together:

Table 5-24 Leaf Switch Connections for the Fourth Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R4 IB3 within Rack 4	R4-IB3-P8A to R4-U1-P3A R4-IB3-P8B to R4-U1-P4A	3 meters
R4 IB3 to Rack 1	R4-IB3-P10B to R1-U1-P8A	10 meters
R4 IB3 to Rack 2	R4-IB3-P11A to R2-U1-P9A	5 meters
R4 IB3 to Rack 3	R4-IB3-P11B to R3-U1-P10A	5 meters
R4 IB3 to Rack 5	R4-IB3-P9A to R5-U1-P5A	5 meters
R4 IB3 to Rack 6	R4-IB3-P9B to R6-U1-P6A	5 meters
R4 IB3 to Rack 7	R4-IB3-P10A to R7-U1-P7A	10 meters
R4 IB2 within Rack 4	R4-IB2-P8A to R4-U1-P3B R4-IB2-P8B to R4-U1-P4B	3 meters
R4 IB2 to Rack 1	R4-IB2-P10B to R1-U1-P8B	10 meters
R4 IB2 to Rack 2	R4-IB2-P11A to R2-U1-P9B	5 meters
R4 IB2 to Rack 3	R4-IB2-P11B to R3-U1-P10B	5 meters
R4 IB2 to Rack 5	R4-IB2-P9A to R5-U1-P5B	5 meters
R4 IB2 to Rack 6	R4-IB2-P9B to R6-U1-P6B	5 meters
R4 IB2 to Rack 7	R4-IB2-P10A to R7-U1-P7B	10 meters

Table 5-25 shows the cable connections for the fifth spine switch (R5-U1) when cabling seven full racks together:

Table 5-25 Leaf Switch Connections for the Fifth Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R5 IB3 within Rack 5	R5-IB3-P8A to R5-U1-P3A R5-IB3-P8B to R5-U1-P4A	3 meters
R5 IB3 to Rack 1	R5-IB3-P10A to R1-U1-P7A	10 meters
R5 IB3 to Rack 2	R5-IB3-P10B to R2-U1-P8A	10 meters
R5 IB3 to Rack 3	R5-IB3-P11A to R3-U1-P9A	5 meters

Table 5-25 (Cont.) Leaf Switch Connections for the Fifth Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R5 IB3 to Rack 4	R5-IB3-P11B to R4-U1-P10A	5 meters
R5 IB3 to Rack 6	R5-IB3-P9A to R6-U1-P5A	5 meters
R5 IB3 to Rack 7	R5-IB3-P9B to R7-U1-P6A	5 meters
R5 IB2 within Rack 5	R5-IB2-P8A to R5-U1-P3B R5-IB2-P8B to R5-U1-P4B	3 meters
R5 IB2 to Rack 1	R5-IB2-P10A to R1-U1-P7B	10 meters
R5 IB2 to Rack 2	R5-IB2-P10B to R2-U1-P8B	10 meters
R5 IB2 to Rack 3	R5-IB2-P11A to R3-U1-P9B	5 meters
R5 IB2 to Rack 4	R5-IB2-P11B to R4-U1-P10B	5 meters
R5 IB2 to Rack 6	R5-IB2-P9A to R6-U1-P5B	5 meters
R5 IB2 to Rack 7	R5-IB2-P9B to R7-U1-P6B	5 meters

Table 5-26 shows the cable connections for the sixth spine switch (R6-U1) when cabling seven full racks together:

Table 5-26 Leaf Switch Connections for the Sixth Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R6 IB3 within Rack 6	R6-IB3-P8A to R6-U1-P3A R6-IB3-P8B to R6-U1-P4A	3 meters
R6 IB3 to Rack 1	R6-IB3-P9B to R1-U1-P6A	10 meters
R6 IB3 to Rack 2	R6-IB3-P10A to R2-U1-P7A	10 meters
R6 IB3 to Rack 3	R6-IB3-P10B to R3-U1-P8A	10 meters
R6 IB3 to Rack 4	R6-IB3-P11A to R4-U1-P9A	5 meters
R6 IB3 to Rack 5	R6-IB3-P11B to R5-U1-P10A	5 meters
R6 IB3 to Rack 7	R6-IB3-P9A to R7-U1-P5A	5 meters
R6 IB2 within Rack 6	R6-IB2-P8A to R6-U1-P3B R6-IB2-P8B to R6-U1-P4B	3 meters
R6 IB2 to Rack 1	R6-IB2-P9B to R1-U1-P6B	10 meters
R6 IB2 to Rack 2	R6-IB2-P10A to R2-U1-P7B	10 meters
R6 IB2 to Rack 3	R6-IB2-P10B to R3-U1-P8B	10 meters
R6 IB2 to Rack 4	R6-IB2-P11A to R4-U1-P9B	5 meters
R6 IB2 to Rack 5	R6-IB2-P11B to R5-U1-P10B	5 meters
R6 IB2 to Rack 7	R6-IB2-P9A to R7-U1-P5B	5 meters

Table 5-27 shows the cable connections for the seventh spine switch (R7-U1) when cabling seven full racks together:

Table 5-27 Leaf Switch Connections for the Seventh Rack in a Seven-Rack System

Leaf Switch	Connection	Cable Length
R7 IB3 within Rack 7	R7-IB3-P8A to R7-U1-P3A R7-IB3-P8B to R7-U1-P4A	3 meters
R7 IB3 to Rack 1	R7-IB3-P9A to R1-U1-P5A	10 meters
R7 IB3 to Rack 2	R7-IB3-P9B to R2-U1-P6A	10 meters
R7 IB3 to Rack 3	R7-IB3-P10A to R3-U1-P7A	10 meters
R7 IB3 to Rack 4	R7-IB3-P10B to R4-U1-P8A	10 meters
R7 IB3 to Rack 5	R7-IB3-P11A to R5-U1-P9A	5 meters
R7 IB3 to Rack 6	R7-IB3-P11B to R6-U1-P10A	5 meters
R7 IB2 within Rack 7	R7-IB2-P8A to R7-U1-P3B R7-IB2-P8B to R7-U1-P4B	3 meters
R7 IB2 to Rack 1	R7-IB2-P9A to R1-U1-P5B	10 meters
R7 IB2 to Rack 2	R7-IB2-P9B to R2-U1-P6B	10 meters
R7 IB2 to Rack 3	R7-IB2-P10A to R3-U1-P7B	10 meters
R7 IB2 to Rack 4	R7-IB2-P10B to R4-U1-P8B	10 meters
R7 IB2 to Rack 5	R7-IB2-P11A to R5-U1-P9B	5 meters
R7 IB2 to Rack 6	R7-IB2-P11B to R6-U1-P10B	5 meters

5.8 Eight-Rack Cabling

Note the following when cabling five racks together:

- The spine switch is in U1 (also referred to as IB1) for all racks.
- In the following tables, the leaf switches are referred to as IB2 and IB3. Use the rack unit that is appropriate for your system.
- In Oracle Exadata Database Machine X2-2 racks and Oracle Exadata Storage Expansion Racks with Exadata Storage Server with Sun Fire X4270 M2 Servers, the leaf switches are in U20 and U24, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X2-8 and later racks, the leaf switches are in U21 and U23, also referred to as IB2 and IB3, respectively.
- In Oracle Exadata Database Machine X4-2 and later racks, or Oracle Exadata Database Machine X3-2 Full Racks and Oracle Exadata Storage Expansion Rack X3-2 racks, the leaf switches are in U20 and U22, also referred to as IB2 and IB3, respectively.
- The cable lengths shown in the tables assume the racks are adjacent to each other. If the racks are not adjacent or use overhead cabling trays, then they may require longer cables lengths. Up to 100 meters is supported.
- Only optical cables are supported for lengths greater than 5 meters.

Table 5-28 shows the cable connections for the first spine switch (R1-U1) when cabling eight racks together:

Table 5-28 Leaf Switch Connections for the First Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R1 IB3 within Rack 1	R1-IB3-P8A to R1-U1-P3A	3 meters
R1 IB3 to Rack 2	R1-IB3-P8B to R2-U1-P4A	5 meters
R1 IB3 to Rack 3	R1-IB3-P9A to R3-U1-P5A	5 meters
R1 IB3 to Rack 4	R1-IB3-P9B to R4-U1-P6A	10 meters
R1 IB3 to Rack 5	R1-IB3-P10A to R5-U1-P7A	10 meters
R1 IB3 to Rack 6	R1-IB3-P10B to R6-U1-P8A	10 meters
R1 IB3 to Rack 7	R1-IB3-P11A to R7-U1-P9A	10 meters
R1 IB3 to Rack 8	R1-IB3-P11B to R8-U1-P10A	10 meters
R1 IB2 within Rack 1	R1-IB2-P8A to R1-U1-P3B	3 meters
R1 IB2 to Rack 2	R1-IB2-P8B to R2-U1-P4B	5 meters
R1 IB2 to Rack 3	R1-IB2-P9A to R3-U1-P5B	5 meters
R1 IB2 to Rack 4	R1-IB2-P9B to R4-U1-P6B	10 meters
R1 IB2 to Rack 5	R1-IB2-P10A to R5-U1-P7B	10 meters
R1 IB2 to Rack 6	R1-IB2-P10B to R6-U1-P8B	10 meters
R1 IB2 to Rack 7	R1-IB2-P11A to R7-U1-P9B	10 meters
R1 IB2 to Rack 8	R1-IB2-P11B to R8-U1-P10B	10 meters

Table 5-29 shows the cable connections for the second spine switch (R2-U1) when cabling eight full racks together:

Table 5-29 Leaf Switch Connections for the Second Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R2 IB3 within Rack 2	R2-IB3-P8A to R2-U1-P3A	3 meters
R2 IB3 to Rack 1	R2-IB3-P11B to R1-U1-P10A	5 meters
R2 IB3 to Rack 3	R2-IB3-P8B to R3-U1-P4A	5 meters
R2 IB3 to Rack 4	R2-IB3-P9A to R4-U1-P5A	5 meters
R2 IB3 to Rack 5	R2-IB3-P9B to R5-U1-P6A	10 meters
R2 IB3 to Rack 6	R2-IB3-P10A to R6-U1-P7A	10 meters
R2 IB3 to Rack 7	R2-IB3-P10B to R7-U1-P8A	10 meters
R2 IB3 to Rack 8	R2-IB3-P11A to R8-U1-P9A	10 meters
R2 IB2 within Rack 2	R2-IB2-P8A to R2-U1-P3B	3 meters
R2 IB2 to Rack 1	R2-IB2-P11B to R1-U1-P10B	5 meters
R2 IB2 to Rack 3	R2-IB2-P8B to R3-U1-P4B	5 meters
R2 IB2 to Rack 4	R2-IB2-P9A to R4-U1-P5B	5 meters
R2 IB2 to Rack 5	R2-IB2-P9B to R5-U1-P6B	10 meters
R2 IB2 to Rack 6	R2-IB2-P10A to R6-U1-P7B	10 meters

Table 5-29 (Cont.) Leaf Switch Connections for the Second Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R2 IB2 to Rack 7	R2-IB2-P10B to R7-U1-P8B	10 meters
R2 IB2 to Rack 8	R2-IB2-P11A to R8-U1-P9B	10 meters

[Table 5-30](#) shows the cable connections for the third spine switch (R3-U1) when cabling eight full racks together:

Table 5-30 Leaf Switch Connections for the Third Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R3 IB3 within Rack 3	R3-IB3-P8A to R3-U1-P3A	3 meters
R3 IB3 to Rack 1	R3-IB3-P11A to R1-U1-P9A	5 meters
R3 IB3 to Rack 2	R3-IB3-P11B to R2-U1-P10A	5 meters
R3 IB3 to Rack 4	R3-IB3-P8B to R4-U1-P4A	5 meters
R3 IB3 to Rack 5	R3-IB3-P9A to R5-U1-P5A	5 meters
R3 IB3 to Rack 6	R3-IB3-P9B to R6-U1-P6A	10 meters
R3 IB3 to Rack 7	R3-IB3-P10A to R7-U1-P7A	10 meters
R3 IB3 to Rack 8	R3-IB3-P10B to R8-U1-P8A	10 meters
R3 IB2 within Rack 3	R3-IB2-P8A to R3-U1-P3B	3 meters
R3 IB2 to Rack 1	R3-IB2-P11A to R1-U1-P9B	5 meters
R3 IB2 to Rack 2	R3-IB2-P11B to R2-U1-P10B	5 meters
R3 IB2 to Rack 4	R3-IB2-P8B to R4-U1-P4B	5 meters
R3 IB2 to Rack 5	R3-IB2-P9A to R5-U1-P5B	5 meters
R3 IB2 to Rack 6	R3-IB2-P9B to R6-U1-P6B	10 meters
R3 IB2 to Rack 7	R3-IB2-P10A to R7-U1-P7B	10 meters
R3 IB2 to Rack 8	R3-IB2-P10B to R8-U1-P8B	10 meters

[Table 5-31](#) shows the cable connections for the fourth spine switch (R4-U1) when cabling eight full racks together:

Table 5-31 Leaf Switch Connections for the Fourth Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R4 IB3 within Rack 4	R4-IB3-P8A to R4-U1-P3A	3 meters
R4 IB3 to Rack 1	R4-IB3-P10B to R1-U1-P8A	10 meters
R4 IB3 to Rack 2	R4-IB3-P11A to R2-U1-P9A	5 meters
R4 IB3 to Rack 3	R4-IB3-P11B to R3-U1-P10A	5 meters
R4 IB3 to Rack 5	R4-IB3-P8B to R5-U1-P4A	5 meters
R4 IB3 to Rack 6	R4-IB3-P9A to R6-U1-P5A	5 meters

Table 5-31 (Cont.) Leaf Switch Connections for the Fourth Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R4 IB3 to Rack 7	R4-IB3-P9B to R7-U1-P6A	10 meters
R4 IB3 to Rack 8	R4-IB3-P10A to R8-U1-P7A	10 meters
R4 IB2 within Rack 4	R4-IB2-P8A to R4-U1-P3B	3 meters
R4 IB2 to Rack 1	R4-IB2-P10B to R1-U1-P8B	10 meters
R4 IB2 to Rack 2	R4-IB2-P11A to R2-U1-P9B	5 meters
R4 IB2 to Rack 3	R4-IB2-P11B to R3-U1-P10B	5 meters
R4 IB2 to Rack 5	R4-IB2-P8B to R5-U1-P4B	5 meters
R4 IB2 to Rack 6	R4-IB2-P9A to R6-U1-P5B	5 meters
R4 IB2 to Rack 7	R4-IB2-P9B to R7-U1-P6B	10 meters
R4 IB2 to Rack 8	R4-IB2-P10A to R8-U1-P7B	10 meters

Table 5-32 shows the cable connections for the fifth spine switch (R5-U1) when cabling eight full racks together:

Table 5-32 Leaf Switch Connections for the Fifth Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R5 IB3 within Rack 5	R5-IB3-P8A to R5-U1-P3A	3 meters
R5 IB3 to Rack 1	R5-IB3-P10A to R1-U1-P7A	10 meters
R5 IB3 to Rack 2	R5-IB3-P10B to R2-U1-P8A	10 meters
R5 IB3 to Rack 3	R5-IB3-P11A to R3-U1-P9A	5 meters
R5 IB3 to Rack 4	R5-IB3-P11B to R4-U1-P10A	5 meters
R5 IB3 to Rack 6	R5-IB3-P8B to R6-U1-P4A	5 meters
R5 IB3 to Rack 7	R5-IB3-P9A to R7-U1-P5A	5 meters
R5 IB3 to Rack 8	R5-IB3-P9B to R8-U1-P6A	10 meters
R5 IB2 within Rack 5	R5-IB2-P8A to R5-U1-P3B	3 meters
R5 IB2 to Rack 1	R5-IB2-P10A to R1-U1-P7B	10 meters
R5 IB2 to Rack 2	R5-IB2-P10B to R2-U1-P8B	10 meters
R5 IB2 to Rack 3	R5-IB2-P11A to R3-U1-P9B	5 meters
R5 IB2 to Rack 4	R5-IB2-P11B to R4-U1-P10B	5 meters
R5 IB2 to Rack 6	R5-IB2-P8B to R6-U1-P4B	5 meters
R5 IB2 to Rack 7	R5-IB2-P9A to R7-U1-P5B	5 meters
R5 IB2 to Rack 8	R5-IB2-P9B to R8-U1-P6B	10 meters

Table 5-33 shows the cable connections for the sixth spine switch (R6-U1) when cabling eight full racks together:

Table 5-33 Leaf Switch Connections for the Sixth Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R6 IB3 within Rack 6	R6-IB3-P8A to R6-U1-P3A	3 meters
R6 IB3 to Rack 1	R6-IB3-P9B to R1-U1-P6A	10 meters
R6 IB3 to Rack 2	R6-IB3-P10A to R2-U1-P7A	10 meters
R6 IB3 to Rack 3	R6-IB3-P10B to R3-U1-P8A	10 meters
R6 IB3 to Rack 4	R6-IB3-P11A to R4-U1-P9A	5 meters
R6 IB3 to Rack 5	R6-IB3-P11B to R5-U1-P10A	5 meters
R6 IB3 to Rack 7	R6-IB3-P8B to R7-U1-P4A	5 meters
R6 IB3 to Rack 8	R6-IB3-P9A to R8-U1-P5A	5 meters
R6 IB2 within Rack 6	R6-IB2-P8A to R6-U1-P3B	3 meters
R6 IB2 to Rack 1	R6-IB2-P9B to R1-U1-P6B	10 meters
R6 IB2 to Rack 2	R6-IB3-P10A to R2-U1-P7B	10 meters
R6 IB2 to Rack 3	R6-IB2-P10B to R3-U1-P8B	10 meters
R6 IB2 to Rack 4	R6-IB2-P11A to R4-U1-P9B	5 meters
R6 IB2 to Rack 5	R6-IB2-P11B to R5-U1-P10B	5 meters
R6 IB2 to Rack 7	R6-IB2-P8B to R7-U1-P4B	5 meters
R6 IB2 to Rack 8	R6-IB2-P9A to R8-U1-P5B	5 meters

Table 5-34 shows the cable connections for the seventh spine switch (R7-U1) when cabling eight full racks together:

Table 5-34 Leaf Switch Connections for the Seventh Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R7 IB3 within Rack 7	R7-IB3-P8A to R7-U1-P3A	3 meters
R7 IB3 to Rack 1	R7-IB3-P9A to R1-U1-P5A	10 meters
R7 IB3 to Rack 2	R7-IB3-P9B to R2-U1-P6A	10 meters
R7 IB3 to Rack 3	R7-IB3-P10A to R3-U1-P7A	10 meters
R7 IB3 to Rack 4	R7-IB3-P10B to R4-U1-P8A	10 meters
R7 IB3 to Rack 5	R7-IB3-P11A to R5-U1-P9A	5 meters
R7 IB3 to Rack 6	R7-IB3-P11B to R6-U1-P10A	5 meters
R7 IB3 to Rack 8	R7-IB3-P8B to R8-U1-P4A	5 meters
R7 IB2 within Rack 7	R7-IB2-P8A to R7-U1-P3B	3 meters
R7 IB2 to Rack 1	R7-IB2-P9A to R1-U1-P5B	10 meters
R7 IB2 to Rack 2	R7-IB2-P9B to R2-U1-P6B	10 meters
R7 IB2 to Rack 3	R7-IB2-P10A to R3-U1-P7B	10 meters
R7 IB2 to Rack 4	R7-IB2-P10B to R4-U1-P8B	10 meters
R7 IB2 to Rack 5	R7-IB2-P11A to R5-U1-P9B	5 meters

Table 5-34 (Cont.) Leaf Switch Connections for the Seventh Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R7 IB2 to Rack 6	R7-IB2-P11B to R6-U1-P10B	5 meters
R7 IB2 to Rack 8	R7-IB2-P8B to R8-U1-P4B	5 meters

Table 5-35 shows the cable connections for the eighth spine switch (R8-U1) when cabling eight full racks together:

Table 5-35 Leaf Switch Connections for the Eighth Rack in a Eight-Rack System

Leaf Switch	Connection	Cable Length
R8 IB3 within Rack 8	R8-IB3-P8A to R8-U1-P3A	3 meters
R8 IB3 to Rack 1	R8-IB3-P8B to R1-U1-P4A	10 meters
R8 IB3 to Rack 2	R8-IB3-P9A to R2-U1-P5A	10 meters
R8 IB3 to Rack 3	R8-IB3-P9B to R3-U1-P6A	10 meters
R8 IB3 to Rack 4	R8-IB3-P10A to R4-U1-P7A	10 meters
R8 IB3 to Rack 5	R8-IB3-P10B to R5-U1-P8A	10 meters
R8 IB3 to Rack 6	R8-IB3-P11A to R6-U1-P9A	5 meters
R8 IB3 to Rack 7	R8-IB3-P11B to R7-U1-P10A	5 meters
R8 IB2 within Rack 8	R8-IB2-P8A to R8-U1-P3B	3 meters
R8 IB2 to Rack 1	R8-IB2-P8B to R1-U1-P4B	10 meters
R8 IB2 to Rack 2	R8-IB2-P9A to R2-U1-P5B	10 meters
R8 IB2 to Rack 3	R8-IB2-P9B to R3-U1-P6B	10 meters
R8 IB2 to Rack 4	R8-IB2-P10A to R4-U1-P7B	10 meters
R8 IB2 to Rack 5	R8-IB2-P10B to R5-U1-P8B	10 meters
R8 IB2 to Rack 6	R8-IB2-P11A to R6-U1-P9B	5 meters
R8 IB2 to Rack 7	R8-IB2-P11B to R7-U1-P10B	5 meters

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