Lenovo Flex System Interconnect Fabric

Solution Guide

for Networking OS 8.4

Lenovo™

Note: Before using this information and the product it supports, read the general information in the *Safety information and Environmental Notices and User Guide* documents on the Lenovo *Documentation* CD and the *Warranty Information* document that comes with the product.

First Edition (January 2017)

Contents

Preface

The *Lenovo Flex SI Fabric Solution Guide* describes how to configure and use the Lenovo Networking OS 8.4 software on the Lenovo System Networking RackSwitch G8264CS (referred to as G8264CS throughout this document), the Lenovo Flex System Fabric SI4093 System Interconnect Module (referred to as SI4093) and the Lenovo Flex System Fabric EN4093R 10Gb Scalable Switch (referred to as EN4093R) to achieve the Flex System Interconnect Fabric (referred to as the SI Fabric).

For documentation about the physical installation of the SI4093, EN4093R or G8264CS, see the respective product hardware documentation.

Who Should Use This Guide

This guide is intended for network installers and system administrators engaged in configuring and maintaining a network. The administrator should be familiar with Ethernet concepts, IP addressing and SNMP configuration parameters.

Typographic Conventions

The following table describes the typographic styles used in this document.

Table 1. *Typographic Conventions*

Typeface or Symbol	Meaning	Example
`ABC123`	This type is used for names of commands, files, and directories used within the text.	View the `readme.txt` file.
	It also depicts on-screen computer output and prompts.	`host#`
`ABC123`	This bold type appears in command examples. It shows text that must be typed in exactly as shown.	`host#` **`sys`**
<ABC123>	This italicized type appears in command examples as a parameter placeholder. Replace the indicated text with the appropriate real name or value when using the command. Do not type the brackets.	To establish a Telnet session, enter: `host#` **`telnet`** *<IP address>*
	This also shows book titles, special terms, or words to be emphasized.	Read your *User's Guide* thoroughly.
`[ ]`	Command items shown inside squared brackets are optional and can be used or excluded as the situation demands. Do not type the brackets.	`host#` **`ls`** `[`**`-a`**`]`
`{ | }`	The curled braces and vertical bar are used in command examples to separate choices where multiple options exist. Select only one of the listed options. Do not type the braces or vertical bar.	`host#` **`set`** `{`**`left|right`**`}`
AaBbCc123	This block type depicts menus, buttons, and other controls that appear in Web browsers and other graphical interfaces.	Click the **Save** button.

Additional References

Additional information about installing and configuring the SI Fabric is available in the following guides:

- *Lenovo RackSwitch G8264CS Application Guide for Networking OS 8.4*
- *Lenovo RackSwitch G8264CS ISCLI Command Reference for Networking OS 8.4*
- *Lenovo Flex System Fabric SI4093 System Interconnect Module Application Guide for Networking OS 8.4*
- *Lenovo Flex System Fabric SI4093 System Interconnect Module ISCLI Command Reference for Networking OS 8.4*
- *Lenovo Flex System Fabric EN4093R 10Gb Scalable Switch Application Guide for Networking OS 8.4*
- *Lenovo Flex System Fabric EN4093R 10Gb Scalable Switch ISCLI Command Reference for Networking OS 8.4*

Chapter 1. Introduction

This *Solution Guide* introduces the Lenovo Flex System Interconnect Fabric (referred to as the SI Fabric throughout this document). The SI Fabric provides a single point of network access for data center Ethernet and Fibre Channel network. It supports Flex System compute nodes and internal and external storage nodes for computing and storage resources capabilities in a Flex System chassis.

SI Fabric Architecture

The SI Fabric is managed through a single entity, the user-designated Master switch, and passed on to the internal components. The SI Fabric integrates the following components:

- Two G8264CS switches
- Up to 9 Flex System chassis, each with two Flex modules (SI4093/EN4093R) in paired bays (Bay 1 and Bay 2, or alternately Bay 3 and Bay 4), for a total of up to 18 SI4093/EN4093R modules.

Note: If the servers have an extra net card, the chassis supports up to 4 switches.

- Up to 126 half-width Flex System compute nodes (up to 14 per chassis) with 10Gb Converged Network Adapters (CNAs)
- External Storwize V7000 storage system, as a highly integrated Point Of Delivery (POD) solution for data centers

Figure 1. Flex System Interconnect Fabric Components

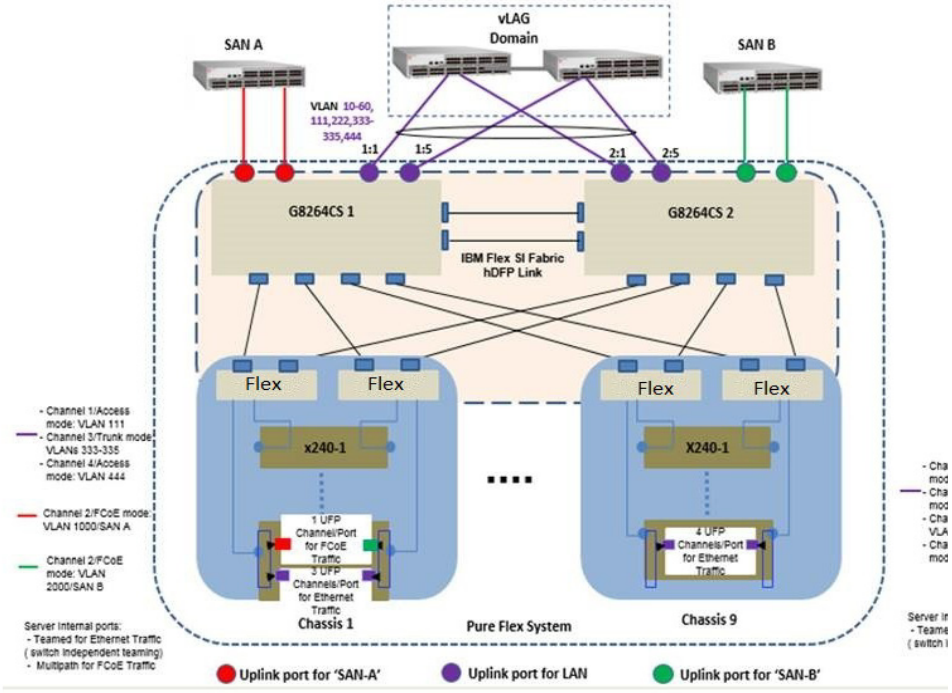
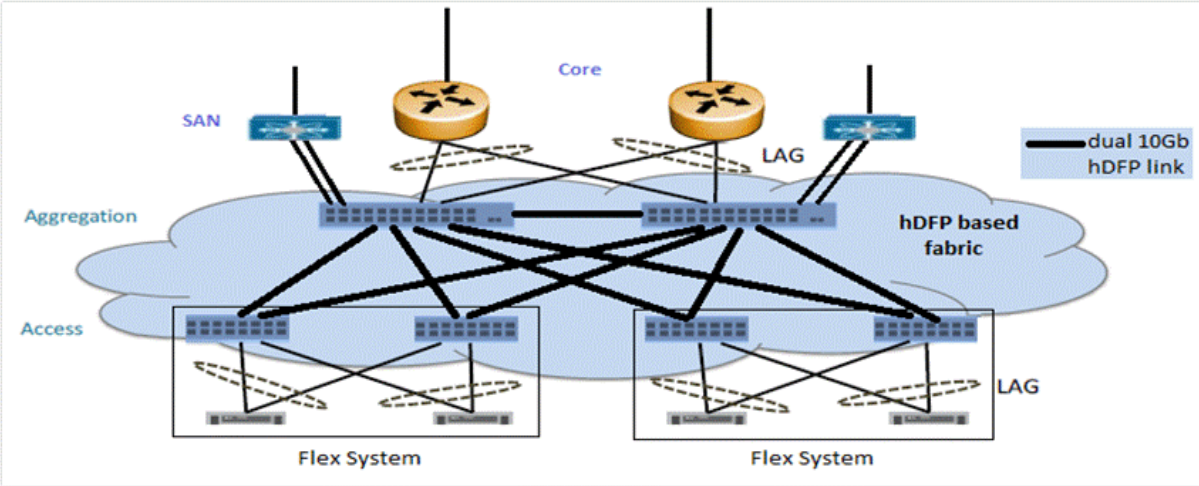


Figure 2 on page 13 illustrates the SI Fabric connections to storage and computing resources.

Figure 2. Flex System Interconnect Fabric Environment



Point of Delivery

A Point Of Delivery (POD) is a module of network, compute, storage, and application components that work together to deliver networking services. In service provider infrastructure, the POD supports cloud computing services to sustain scalability as usage grows.

The SI Fabric integrates the entire POD solution into a seamless network fabric for server and storage under single IP management and attaches to upstream data center network as a loop-free layer-2 stub network fabric with single Ethernet uplink connection or trunk group to each layer-2 network.

The SI Fabric POD solution requires network provisioning only for uplink connections to a data center network, downlink connections to server nodes, and connections to storage nodes.

Hyper Distributed Fabric Protocol

The SI Fabric utilizes the Lenovo proprietary hyper distributed fabric protocol (hDFP) to provide a loop-free network fabric system for data and storage traffic. It integrates compute, network, and storage components as a single IP management switch system. All G8264CS switches and SI4093/EN093R switches are configured to run in SI Fabric mode.

The hDFP aggregates all network switching modules into a single logical switch, the SI Fabric, with G8264CS switches as master and backup nodes at the aggregation layer and SI4093/EN4093R switches as member nodes at the access layer.

Configuration and management of the networking component is done via the management IP interface at master node of the logical switch. If the master node fails, the backup G8264CS switch will take over as the new master node of the logical switch and the old master node will turn into new backup node once recovered.

SI Fabric Components

The SI Fabric unifies SI4093, EN4093R, G8264CS, and storage hardware components.

SI4093/EN4093R Switches

The Lenovo Flex System Fabric SI4093 System Interconnect Module (SI4093) and Lenovo Flex System Fabric EN4093R 10Gb Scalable Switch (EN4093R) provide a transparent network interface between server elements within the chassis and the upstream data and storage networking infrastructure. The standard SI4093 and EN4093R provide 14 internal 10GbE ports as downlinks for server connectivity and 10 external 10GbE Ethernet fabric ports for connection with G8264CS switches.

The SI Fabric can also support expansion of additional 28 internal and 12 externals 10Gbps ports, with optional Feature on Demand (FoD) license keys. Within the SI Fabric, SI4093 and EN4093R provide convergence of traditional Ethernet traffic with Fibre Channel over Ethernet (FCoE) storage session traffic and facilitates low-latency, media-speed server-to-server traffic within the chassis, or server-to-uplink traffic based on the hDFP protocol.

G8264CS Switches

The Lenovo System Networking RackSwitch G8264CS converged switch contains 36 10GbE small form-factor pluggable plus (SFP+) ports and four 40GbE quad small-form-factor pluggable plus (QSFP+) ports, and twelve Omni Ports. Omni Port technology allows the same port to be used as a 10G Ethernet port or 4/8G Fibre Channel port.

SI Fabric Features

Layer-2 Switching Capabilities

The SI Fabric provides the following layer-2 switching capabilities:

- Converged Enhanced Ethernet (CEE)
- 10GbE Ethernet switching
- Fibre Channel over Ethernet (FCoE) and FC/FCoE capabilities
  - N Port Virtualization (NPV) Gateway
  - Full Fabric FC/FCoE switch
- VLANs
- Double Tagging (tagpvid)
- Distributed static/LACP portchannels
- Distributed MAC learning
- Teaming

Network Simplification

The SI Fabric provides the following network simplification features:

- Seamless network fabric for server and storage to connect with data center
- Offers a loop-free network fabric without Spanning Tree Protocol (STP) complexity.
- Minimizes network latency by local L2 switching at every interconnect component, and minimizes the loss of data during network failover within the fabric.
- Converges Ethernet for lossless storage traffic.
- Adds new components to an already running fabric with no traffic loss or disturbance in the existing traffic flow.
- Integrates Fibre Channel Forwarder (FCF) to provide end-to-end Fibre Channel over Ethernet (FCoE) storage functionality within the POD without the need of expensive Fibre Channel switch.
- Supports single-fabric mode topology, dual-fabric mode topology, and full-fabric topology.
- Offers different levels of redundancy inside the fabric: static/LACP distributed portchannels, teaming, dual interconnection redundancy, hot links, master/backup switch.

Management Simplification

The SI Fabric provides the following management simplification features:

- High availability with master and backup nodes
- Staggered upgrade enables upgrading the fabric with no service or connection downtime.
- Minimizes managed network elements with single point of management at the master node of the entire fabric.

- Establishes clear administrative boundaries in data center by pushing traditional networking configuration outside of the POD.
- Integrates physical and virtual infrastructure management for compute, network, and storage elements.

Storage Integration

The SI Fabric offers various connectivity options for storage network and simplifies integration of storage and storage virtualization. For example, integration with IBM Storwize V7000 storage node and access to external SAN storage infrastructure, such as IBM Storwize V7000, V5000 or V3700.

Scalable Point of Delivery

The SI Fabric provides the following scalability features:

- The SI Fabric enables the size of the POD to grow without the additions of management complexity.
- The SI Fabric adds additional chassis resources up to the maximum configuration under single IP management of the POD.
- Expert Integrated Systems
- The SI Fabric simplifies the I/O connectivity in Foundation offerings and improves the time to value of an integrated system.
- The SI Fabric can be leveraged in Pure Application and Pure Data configurations improving the ability to roll in racks of tested solutions into existing data centers.

Limitations

Following is a list of Flex System Interconnect Fabric limitations for the current release:

- The SI Fabric requires at least Lenovo Networking OS version 8.2 for all G8264CS and SI4093 standalone switches and Lenovo Networking OS version 8.3 for all EN4093R standalone switches.
- Lenovo does not support mixing 10Gb and 40Gb SI Fabric port speeds in SI Fabric logical switches. Lenovo recommends that you reserve additional SI Fabric ports on both G8264CS switches for future expansion.
- All external ports on SI4093/EN4093R devices are automatically configured as Fabric Ports, requiring no additional configuration. Omni Ports on the RackSwitch G8264CS cannot be configured as Fabric Ports.
- To change a port from Ethernet to Fabric mode on the aggregation switches (TORs), the switch needs to be rebooted. If a new chassis is added to the solution and fabric ports need to be reconfigured on both TORs, the user can still operate master/backup failover and reboot the master and backup one by one in order to keep the full access to its servers/storage during the process.

Chapter 2. Initial Configuration

This chapter explains how to set up the software components of the Flex System Interconnect Fabric (SI Fabric).

Hardware Planning

The minimum configuration requires two G8264CS switches, one Flex System chassis populated with two SI4093 or EN4093R switches and two half-width Flex System compute nodes with 10Gb CNAs at each chassis.

The SI Fabric supports two G8264CS switches, up to nine Flex System chassis populated with two SI4093 or EN4093R switches at each chassis, up to 126 half-width Flex System compute nodes and external storage systems.

The SI Fabric acts as a networking provision simplifier. The solution is designed to behave most like an end-host-mode or transparent mode switch, building an active redundant data traffic path between the upper networks and the servers and from one server to another server in the same sets of VLANs.

- The base SI4093 and EN4093R switches provide 14 internal 10GbE ports as downlinks for server connectivity and ten external 10GbE Ethernet fabric ports for connection with G8264CS switches in the SI Fabric.
- An additional 28 internal and 12 externals 10Gbps ports are available for expansion with optional Feature on Demand license keys. This applies to each SI4093 or EN4093R module.
- The SI4093 and EN4093R switches in the SI Fabric provide the convergence of traditional Ethernet traffic with Fibre Channel over Ethernet (FCoE) storage.

Initial System Configuration Overview

To deploy the Flex System Interconnect Fabric from a standalone topology:

1. Upgrade and reboot all standalone G8264CS, SI4093 and EN4093R switches with Lenovo Flex SI Fabric images (see "Upgrading and Converting Standalone Switches to SI Fabric Members Operation" on page 22).
2. Specify SI Fabric ports and SI Fabric-related settings at G8264CS switches and reboot again to take effect (see "Specifying SI Fabric Settings on the G8264CS" on page 23).
3. Connect minimum two 10Gb Ethernet cables as SI Fabric links between the two G8264CS switches. Also connect two 10Gb Ethernet cables from each SI4093 or EN4093R switch to each G8264CS switch (see "Connecting and Attaching the SI Fabric Devices" on page 25).

   Note: Using more links to connect switches will increase the traffic bandwidth inside the fabric.
4. Once the master G8264CS detects all attached SI4093 or EN4093R switches, bind them to the SI Fabric (see "Configuring and Binding the SI4093/EN4093R Switches" on page 27).
5. Configure the management IP address and gateway information at the master and backup G8264CS switches for future data and storage VLAN and port configurations (see "Configuring the SI Fabric Management IP Addresses and Gateway" on page 30).
6. Enable additional management access (see "SNMP, Telnet, and SSH Access" on page 33).
7. If required, install FoD license keys on SI4093 or EN4093R switches (see "SI4093 and EN4093R License Activation Keys" on page 38).

Using the ISCLI

Use the ISCLI via switch serial console to configure the SI Fabric. After the SI Fabric is initialized, you can use ISCLI over Telnet, SSH or SNMP for additional configuration and management tasks.

The ISCLI provides a direct method for collecting switch information and performing switch upgrade and configuration. Using a basic terminal, the ISCLI allows you to view information and statistics about the switch, and to perform any necessary configuration.

Before Configuring the SI Fabric

Before you begin configuring the SI Fabric, you must have this information:

- IP addresses for your routers, servers. and attached network devices
- VLAN information (names and numbers)
- Physical layout, storage, and data connections for the SI Fabric

Upgrading and Converting Standalone Switches to SI Fabric Members Operation

You can add to the SI Fabric any standalone G8264CS, SI4093 and EN4093R switches.

Note: By converting to SI fabric, the switch will automatically lose all its previous configuration.

Use the following commands to load a SI Fabric image to a standalone switch:

```
Router> enable
Router# copy {tftp|ftp|sftp} {image1|image2|boot-image} address <IP address>
filename <SI Fabric filename> {data-port|mgt-port}
```

Note: For EN4093R switches running in stacking mode, make sure to disable the stack mode before uploading the SI Fabric image.

The following list describes the image file names and describes the switch behavior when it recognizes them.

- Upgrading SI Fabric Solution:
  - `G8264-CS-GbFSIM-10G-FSIF-`*version_number*`_Boot.imgs`

    On the master G8264CS switch, the switch replaces the entire SI Fabric solution boot image with the new boot image.
  - `G8264-CS-GbFSIM-10G-FSIF-`*version_number*`_OS.imgs`

    On the master G8264CS switch, the switch replaces the entire SI Fabric solution software image with the new software image.
- Converting standalone switches to SI Fabric Solution:
  - `G8264-CS-STKC-`*version_number*`_Boot.imgs`

    On any G8264CS switch, the switch replaces the current G8264CS boot image with the new G8264CS boot image.
  - `G8264-CS-STKC-`*version_number*`_OS.imgs`

    On any G8264CS switch, the switch replaces the current G8264CS software image with the new G8264CS software image.
  - `GbFSIM-10G-STKC-`*version_number*`_Boot.imgs`

    On any SI4093 or EN4093R switch, the switch replaces the current boot image with the new boot image.
  - `GbFSIM-10G-STKC-`*version_number*`_OS.imgs`

    On any SI4093 or EN4093R switch, the switch replaces the current software image with the new software image.

Note: Changes will take effect after the next reboot of the switch.

Specifying SI Fabric Settings on the G8264CS

After you have rebooted all G8264CS and SI4093 or EN4093R switches with installed SI Fabric software images, they will load factory-default switch settings and default SI Fabric settings.

Perform the following configuration procedure on each G8264CS switch.

Note: Lenovo recommends that you perform side-by-side logical switch setting review and re-configuration at both G8264CS switches.

1. Connect to the G8264CS switch serial console.
2. Assign SI Fabric ports (those that will be connected to the other switches in the SI Fabric):

```
RS G8264CS> enable
RS G8264CS# boot fabric fabric-trunk 1:17-1:38
A Reboot is required for the new settings to take effect.
```

Note: The required reboot may be performed in a later step.

3. Assign a unique domain ID to the SI Fabric:

```
RS G8264CS# boot fabric si-fabric-domain 82
Current fabric domain: 1
New fabric domain: 82
A reboot is required for the new settings to take effect
```

Assign the same SI Fabric domain ID (between 1 and 100) on both G8264CS switches. This will permit them to join the same logical switch, becoming master and backup nodes. The default domain ID is `1`.

See "Boot Options" on page 65 for more information and related commands.

4. Verify that one of the G8264CS switches is set as the master switch:

```
RS G8264CS# show boot fabric
Current fabric settings:
Fabric         : ON
Switch Mode      : Master
Fabric Trunk Ports: 1:17-1:35
Fabric VLAN       : 4090
Fabric domain: 82

Saved fabric settings:
Fabric         : ON
Switch Mode      : Master
Fabric Trunk Ports: 1:17-1:35
Fabric VLAN       : 4090
Fabric domain: 82
```

Note: The default configuration for the G8264CS is the following:

```
RS G8264CS# show boot fabric
Current fabric settings:
Fabric         : ON
Switch Mode      : Member
Fabric Trunk Ports: 1:17-1:35
Fabric VLAN       : 4090
SI Fabric domain: 1
```

Only one of the G8264CS switches should be designated as `Master` in the `Switch Mode` field of the `Saved fabric settings` section. If neither or both of the G8264CS switches are designated as the master switch:

a. Use the following commands on one G8264CS switch to designate it as the master node candidate.

```
RS G8264CS# boot fabric mode master
```

b. Use the following command on the other G8264CS switch to designate it as the member node candidate.

```
RS G8264CS# boot fabric mode member
```

5. Reboot each G8264CS switch.

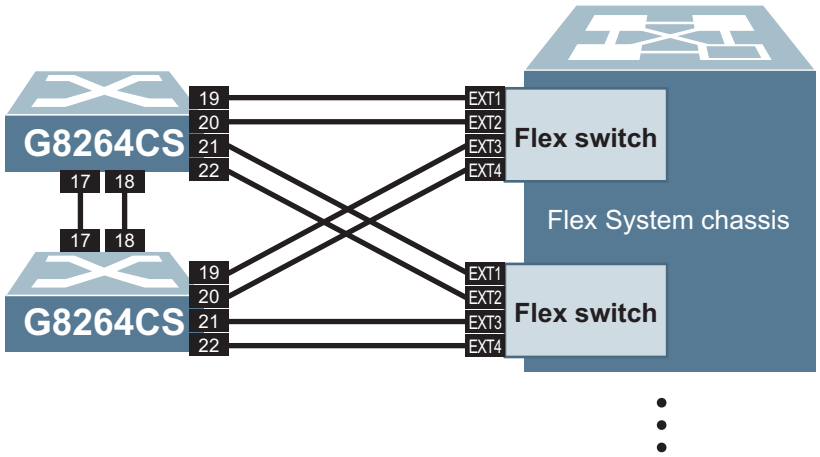
```
RS G8264CS# reload
WARNING: The running-config is different to startup-config.
Confirm operation without saving running-config to startup-config
(y/n) ? y
```

Note: All configuration changes using `boot` commands are automatically saved and are not show in user configuration dumps.

Connecting and Attaching the SI Fabric Devices

Once both G8264CS switches have completely rebooted, the SI Fabric components (G8264CS and SI4093 or EN4093R switches) can be connected together.

Figure 3. Simplified SI Fabric



Consider the example configuration in Figure 3. Two G8264CS switches are used (one as a master node, and one as a backup). Two paired SI4093/EN4093R devices in one Flex System chassis are shown, though up to 18 SI4093/EN4093R switches in up to 9 chassis are supported.

1. Connect the appropriate Ethernet cables between participating devices:
   - Connect the two G8264CS switches together.
   - Connect the master G8264CS switch to each participating SI4093 or EN4093R switch.
   - Connect the backup G8264CS switch to each participating SI4093 or EN4093R switch.

   In this example, two ports are used between each device for robust availability. However, devices can be connected using from 1 to 8 ports each.

   Note: The port numbers are shown as symmetrical: each G8264CS switch uses the same ports numbers to connect to each other, and also to any specific SI4093 or EN4093R. However, this is not a requirement; participating devices can be connected using any available fabric ports.

2. At the master G8264CS, verify that the participating devices are detected:

```
RS G8264CS> enable
RS G8264CS# show fabric attached-switches
Attached Switches in Fabric:
asnum       UUID                   Bay       MAC           csnum   State       Type
--------------------------------------------------------------------------------
A1           N/A                    N/A  74:99:75:20:0e:00   C1   IN_FABRIC G8264CS
A2  669d8dccfb95492bb727d18313c82289 3   08:17:f4:5f:40:00        ATTACH    EN4093R
A3  7fbaa95c6a484e0296c418cae2bbfe5a 2   08:17:f4:84:3b:00        ATTACH     SI4093
A4  c6b9ceff4440486cb65bd1e2e3fe3a94 1   08:17:f4:84:3d:00        ATTACH    EN4093R
A5  c6b9ceff4440486cb65bd1e2e3fe3a94 4   08:17:f4:84:40:00        ATTACH     SI4093
A6  c6b9ceff4440486cb65bd1e2e3fe3a94 3   08:17:f4:a7:55:00        ATTACH     SI4093
A7           N/A                    N/A  08:17:f4:fb:cc:00   C2   IN_FABRIC G8264CS
A8  c6b9ceff4440486cb65bd1e2e3fe3a94 2   34:40:b5:73:92:00        ATTACH    EN4093R
A9  7fbaa95c6a484e0296c418cae2bbfe5a 4   34:40:b5:73:9c:00        ATTACH     SI4093
A10 7fbaa95c6a484e0296c418cae2bbfe5a 3   74:99:75:00:D1:00        ATTACH     SI4093
A11 b88989be60824783af6956a441cd0c61 3   74:99:75:1c:6b:00        ATTACH    EN4093R
A12 7fbaa95c6a484e0296c418cae2bbfe5a 1   74:99:75:1c:7d:00        ATTACH    EN4093R
A13 669d8dccfb95492bb727d18313c82289 2   74:99:75:5d:e1:00        ATTACH     SI4093
A14 669d8dccfb95492bb727d18313c82289 1   74:99:75:7f:7d:00        ATTACH     SI4093
```

Devices listed in the `IN_FABRIC` state are fully participating in the SI Fabric. At this initial stage, only the G8264CS devices will be `IN_FABRIC`. Flex switches will be in the `ATTACH` state, indicating that they have been detected but have not yet been configured to join SI Fabric operation. As no traffic is forwarded, internal ports for Flex switches in the `ATTACH` state are automatically disabled.

Each detected switch is automatically assigned a unique, non-configurable Attached Switch Number (`asnum`), based on the order in which it joins the SI Fabric. In addition, a logical identifier known as the Configured Switch Number (`csnum`) should be configured. During initial setup, the `csnum` values for master and backup G8264CS switches will be automatically assigned as `C1` and `C2` respectively, and `csnum` values for each Flex switch will be unassigned.

Configuring and Binding the SI4093/EN4093R Switches

Newly detected Flex switches are initially isolated from SI Fabric operation. Until they are explicitly configured to operate within the SI Fabric, they will appear in the ATTACH state and their internal ports will remain automatically disabled.

To approve the Flex switches for SI Fabric operation, each member Flex switch listed in the ATTACH state must be configured with a csnum. Once the csnum is assigned, the Flex switch will transition to the IN_FABRIC state and it will receive its configuration from the Master.

All Flex switch configuration is performed at the master G8264CS switch. On the master G8264CS switch, the Flex csnum values may be configured automatically for all switches at once, or manually for each individual switch.

Note: Fabric bind command is non-disruptive. When a new switch is added to the fabric, the command binds it to the next available switch number (csum).

- To automatically assign csnum values for all attached Flex switches, use the following commands:

```
RS G8264CS# configure terminal
RS G8264CS(config)# fabric bind
```

- To manual assign a desired csnum value for any specific Flex switch, use the following configuration mode command:

```
RS G8264CS(config)# fabric switch-number <csnum> bind <asnum>
```

  Repeat the manual command for each participating Flex switch.

  Note: The master G8264CS always has a csnum of C1, and the backup G8264CS always has a csnum of C2. These cannot be manually changed.

When a new csnum is assigned, the member switch will leave and rejoin the SI Fabric and update its configuration accordingly. The following sequence occurs:

- If the desired csnum currently belongs to another member switch, that member switch will placed in the ATTACH state and wait for a new csnum to be assigned before it may rejoin the SI Fabric.
- The csnum and binding assignment will be saved in the SI Fabric configuration as individual csnum entries with the physical switch MAC address (for G8264CS) or csnum and Flex System UUID plus IO bay number (for SI4093 or EN4093R).

In future reboots, each SI Fabric switch will retain the csnum saved in its binding configuration.The asnum values, however, may change, depending on the specific sequence in which switches are returned to service.

You can use the show fabric attached-switches command to verify that the participating devices are properly configured. For example:

```
RS G8264CS(config)# show fabric attached-switches
Attached Switches in Fabric:
asnum       UUID                   Bay       MAC           csnum   State       Type
--------------------------------------------------------------------------------
A1           N/A                   N/A   74:99:75:20:0e:00   C1   IN_FABRIC G8264CS
A2  669d8dccfb95492bb727d18313c82289 3   08:17:f4:5f:40:00   C9   IN_FABRIC EN4093R
A3  7fbaa95c6a484e0296c418cae2bbfe5a 2   08:17:f4:84:3b:00   C12  IN_FABRIC  SI4093
A4  c6b9ceff4440486cb65bd1e2e3fe3a94 1   08:17:f4:84:3d:00   C3   IN_FABRIC EN4093R
A5  c6b9ceff4440486cb65bd1e2e3fe3a94 4   08:17:f4:84:40:00   C6   IN_FABRIC  SI4093
A6  c6b9ceff4440486cb65bd1e2e3fe3a94 3   08:17:f4:a7:55:00   C5   IN_FABRIC  SI4093
A7           N/A                   N/A  08:17:f4:fb:cc:00   C2   IN_FABRIC G8264CS
A8  c6b9ceff4440486cb65bd1e2e3fe3a94 2   34:40:b5:73:92:00   C4   IN_FABRIC EN4093R
A9  7fbaa95c6a484e0296c418cae2bbfe5a 4   34:40:b5:73:9c:00   C14  IN_FABRIC  SI4093
A10 7fbaa95c6a484e0296c418cae2bbfe5a 3   74:99:75:00:D1:00   C13  IN_FABRIC  SI4093
A11 b88989be60824783af6956a441cd0c61 3   74:99:75:1c:6b:00   C15  IN_FABRIC EN4093R
A12 7fbaa95c6a484e0296c418cae2bbfe5a 1   74:99:75:1c:7d:00   C11  IN_FABRIC EN4093R
A13 669d8dccfb95492bb727d18313c82289 2   74:99:75:5d:e1:00   C8   IN_FABRIC  SI4093
A14 669d8dccfb95492bb727d18313c82289 1   74:99:75:7f:7d:00   C7   IN_FABRIC  SI4093
```

The example output shows all detected switches configured with `csnum` values operating in the `IN_FABRIC` state. This indicates that the binding process is complete and all devices in the SI Fabric are acting as a single logical switch.

Reverting SI Fabric Members to Standalone Operation

You can remove any member switch from the SI Fabric and revert it to act as a standalone switch.

At the master G8264CS switch, use the following commands to revert any member switch and re-install a standalone software image:

```
RS G8264CS> enable
RS G8264CS# copy tftp {image1|image2|boot-image} address <IP address>
filename <standalone image filename> {data-port|mgt-port} switch-number <asnum>
```

Configuring the SI Fabric Management IP Addresses and Gateway

To provide out-of-band IP Management and SNMP connection to the SI Fabric, configure the an IP address and IP gateway at the master G8264CS switch.

1. View the attached switches MAC addresses and other information.

```
RS G8264CS> enable
RS G8264CS# show fabric attached-switches
Attached Switches in Fabric:
asnum       UUID                   Bay       MAC           csnum   State       Type
-------------------------------------------------------------------------------
A1           N/A                   N/A   74:99:75:20:0e:00   C1   IN_FABRIC G8264CS
A2  669d8dccfb95492bb727d18313c82289 3   08:17:f4:5f:40:00   C9   IN_FABRIC EN4093R
A3  7fbaa95c6a484e0296c418cae2bbfe5a 2   08:17:f4:84:3b:00   C12  IN_FABRIC  SI4093
A4  c6b9ceff4440486cb65bd1e2e3fe3a94 1   08:17:f4:84:3d:00   C3   IN_FABRIC EN4093R
A5  c6b9ceff4440486cb65bd1e2e3fe3a94 4   08:17:f4:84:40:00   C6   IN_FABRIC  SI4093
A6  c6b9ceff4440486cb65bd1e2e3fe3a94 3   08:17:f4:a7:55:00   C5   IN_FABRIC  SI4093
A7           N/A                   N/A  08:17:f4:fb:cc:00   C2   IN_FABRIC G8264CS
A8  c6b9ceff4440486cb65bd1e2e3fe3a94 2   34:40:b5:73:92:00   C4   IN_FABRIC EN4093R
A9  7fbaa95c6a484e0296c418cae2bbfe5a 4   34:40:b5:73:9c:00   C14  IN_FABRIC  SI4093
A10 7fbaa95c6a484e0296c418cae2bbfe5a 3   74:99:75:00:D1:00   C13  IN_FABRIC  SI4093
A11 b88989be60824783af6956a441cd0c61 3   74:99:75:1c:6b:00   C15  IN_FABRIC EN4093R
A12 7fbaa95c6a484e0296c418cae2bbfe5a 1   74:99:75:1c:7d:00   C11  IN_FABRIC EN4093R
A13 669d8dccfb95492bb727d18313c82289 2   74:99:75:5d:e1:00   C8   IN_FABRIC  SI4093
A14 669d8dccfb95492bb727d18313c82289 1   74:99:75:7f:7d:00   C7   IN_FABRIC  SI4093
```

2. Assign the master G8264CS switch a management IP address, based on its MAC address.

```
RS G8264CS# configure terminal
RS G8264CS(config)# interface ip mgmt ip
RS G8264CS(config-ip-if-mgmt)# mac a8:97:dc:05:70:00 ip address
172.16.50.24 255.255.0.0 enable
```

3. Assign the backup G8264CS switch a management IP address, based on its MAC address.

```
RS G8264CS(config-ip-if-mgmt)# mac a8:97:dc:10:04:00 ip address
172.16.50.23 255.255.0.0 enable
```

4. Assign an IP gateway to the master and backup nodes, based on their MAC addresses:

```
RS G8264CS(config-if-if-mgmt)# exit
RS G8264CS(config)# ip gateway mgmt ip mac a8:97:dc:05:70:00 address
172.16.1.1 enable
RS G8264CS(config)# ip gateway mgmt ip mac a8:97:dc:10:04:00 address
172.16.1.1 enable
```

5. Verify the configuration.

```
RS G8264CS(config)# show running-config
Current configuration:
!
version "8.3"
switch-type "Lenovo Networking Operating System RackSwitch G8264CS,
SI
Fabric"
iscli-new
fabric switch-number 1 mac a8:97:dc:05:70:00
fabric switch-number 2 mac a8:97:dc:10:04:00
!
interface ip mgmt ip
mac a8:97:dc:05:70:00 ip address 172.16.50.24
mac a8:97:dc:05:70:00 ip netmask 255.255.0.0
mac a8:97:dc:05:70:00 enable
!
mac a8:97:dc:10:04:00 ip address 172.16.50.23
mac a8:97:dc:10:04:00 ip netmask 255.255.0.0
mac a8:97:dc:10:04:00 enable
!
ip gateway mgmt ip mac a8:97:dc:05:70:00 address 172.16.1.1
ip gateway mgmt ip mac a8:97:dc:05:70:00 enable
!
ip gateway mgmt ip mac a8:97:dc:10:04:00 address 172.16.1.1
ip gateway mgmt ip mac a8:97:dc:10:04:00 enable
!
end
```

In-band IP Management capability is also available for the SI Fabric logical switch with two Data IP interfaces over data ports. IP address and additional Telnet and SNMP access can be configured via the current Master node of the logical switch.

6. Assign and verify the first In-band management IP address and IP gateway via master node for SI Fabric management.

```
RS G8264CS(config)# interface ip data 1
RS G8264CS(config-ip-if-data)# ip address 172.16.60.24 255.255.0.0
enable
Warning: BOOTP will be disabled
WARNING: IP interface DATA1 and IP interface MGT are on the same
subnet.
WARNING: MGT IP interface (MAC: a8:97:dc:05:70:00) and DATA1 IP
interface have overlapped subnets.
WARNING: MGT IP interface (MAC: a8:97:dc:10:04:00) and DATA1 IP
interface have overlapped subnets.
...
RS G8264CS(config-ip-if-data)# show interface ip
Interface information:
DATA1:  IP4 172.16.60.24     255.255.0.0     172.16.255.255,  vlan 1,
UP
MGT:    IP4 172.16.50.23     255.255.255.128    10.241.33.127,  vlan
4095, UP
No DHCP info available
[floating]: IP4 10.241.33.8     255.255.255.128    10.241.33.127
```

Floating IP Address

Lenovo SI Fabric also supports floating IP which can be used for out-of-band management of fabric by connecting to the current Master (regardless of whether the current Master is the configured Master or the Backup).

1. Disable DHCP on Master and Backup:

```
RS G8264CS(config)# no system dhcp mac <master_mac_addr>
RS G8264CS(config)# no system dhcp mac <backup_mac_addr>
```

2. Configure Management IP address on Master and Backup interfaces:

```
RS G8264CS(config)# interface ip mgmt ip
RS G8264CS(config-ip-if-mgmt)# mac <master_mac_addr> ip address <ip_addr>
<netmask>
RS G8264CS(config-ip-if-mgmt)# mac <backup_mac_addr> ip address <ip_addr>
<netmask>
RS G8264CS(config-ip-if-mgmt)#exit
```

3. Configure gateways on Master and Backup:

```
RS G8264CS(config)# ip gateway mgmt ip mac <master_mac_addr>  address
<gateway> enable
RS G8264CS(config)# ip gateway mgmt ip mac <backup_mac_addr>  address
<gateway> enable
```

4. Configure the floating IP:

```
RS G8264CS(config)# interface ip mgmt ip
RS G8264CS(config-ip-if-mgmt)# floating ip address <ip_addr> <netmask>
RS G8264CS(config-ip-if-mgmt)#exit
```

Note: Master and Backup IP interfaces settings are minimal for configuring floating IP.

SNMP, Telnet, and SSH Access

Many SI Fabric features may be managed remotely using SNMP (and Switch Center), Telnet, or SSH.

Remote management requires prior configuration of the SI Fabric Management IP address and gateway (see "Configuring the SI Fabric Management IP Addresses and Gateway" on page 30).

SNMP and Switch Center Access

The SI Fabric can be managed via Simple Network Management Protocol (SNMP) using an SNMP management tool such as Switch Center. SNMP resource management and switch access are similar to operating a standalone G8264CS switch.

SI Fabric SNMP settings must be configured prior to use. To configure and verify SNMP settings, use the following configuration commands at the Master G8264CS switch:

```
RS G8264CS(config)# snmp-server version v1v2v3
RS G8264CS(config)# snmp-server read-community "public"
RS G8264CS(config)# snmp-server write-community "private"

RS G8264CS(config)# show snmp-server
Current SNMP params:
  Read community string:  "public"
  Write community string: "private"
  SNMP state machine timeout: 5 minutes
  Trap source address:  mgmt
  Authentication traps disabled.
  All link up/down traps enabled.

Current SNMP trap hosts:

Current v1/v2 access enabled
```

You can view SNMP-server counters as follows.

```
RS G8264CS(config)# show snmp-server counters
------------------------------------------------------------------
SNMP statistics:
snmpInPkts:             317028   snmpInBadVersions:              0
snmpInBadC'tyNames:          2   snmpInBadC'tyUses:              0
snmpInASNParseErrs:          0   snmpEnableAuthTraps:            2
snmpOutPkts:            317022   snmpInBadTypes:                 0
snmpInTooBigs:               0   snmpInNoSuchNames:              0
snmpInBadValues:             0   snmpInReadOnlys:                0
snmpInGenErrs:               0   snmpInTotalReqVars:       1413078
snmpInTotalSetVars:          0   snmpInGetRequests:            463
snmpInGetNexts:         306916   snmpInSetRequests:              0
snmpInGetResponses:          0   snmpInTraps:                    0
snmpOutTooBigs:              0   snmpOutNoSuchNames:             0
snmpOutBadValues:            0   snmpOutReadOnlys:               0
snmpOutGenErrs:              0   snmpOutGetRequests:             0
snmpOutGetNexts:             0   snmpOutSetRequests:             0
snmpOutGetResponses:    307379   snmpOutTraps:                   0
snmpSilentDrops:             0   snmpProxyDrops:                 0
```

Telnet Access

Telnet allows remote access to the SI Fabric CLI. By default, Telnet access to the SI Fabric is disabled.

SI Fabric access and resource management via Telnet are similar to operating a standalone G8264CS switch.

To enable and verify Telnet settings, user the following commands at the Master G8264 switch:

```
RS G8264CS(config)# access telnet enable
RS G8264CS(config)# show access
Current System Access settings:

IP Management currently allowed from *ALL* IP addresses


Usernames:
  user     - enabled    - offline
  oper     - disabled   - offline
  admin    - Always Enabled - online     1 session.
Current User ID table:

Current strong password settings:
  strong password status: disabled

SNMP access currently read-write
Telnet access currently enabled on TCP port 23
TFTP occurs over port 69
```

SSH Access

Secure Shell (SSH) allows for more secure remote access to the SI Fabric CLI than simple Telnet provides. SSH is enabled by default.

SI Fabric access and resource management via SSH are similar to operating a standalone G8264CS switch.

Displaying SI Fabric Configuration

Display the current running configuration to verify SI Fabric settings:

```
RS G8264CS(config)# show running-config
Current configuration:
!
version "8.2.1.0"
switch-type "Lenovo Networking Operating System RackSwitch G8264CS, SI
Fabric"
iscli-new
fabric switch-number 1 mac a8:97:dc:05:70:00
fabric switch-number 2 mac a8:97:dc:10:04:00
fabric switch-number 3 universal-unic-id 63ceda2ec8cc46bf9eb8b3c14b2cefc0
bay 1
fabric switch-number 4 universal-unic-id 63ceda2ec8cc46bf9eb8b3c14b2cefc0
bay 2
!
!
snmp-server version v1v2v3
!
snmp-server read-community "public"
snmp-server write-community "private"
!
no system bootp
!
access telnet enable
!
interface ip mgmt ip
        mac a8:97:dc:05:70:00 ip address 172.16.50.24
        mac a8:97:dc:05:70:00 ip netmask 255.255.0.0
        mac a8:97:dc:05:70:00 enable
!
        mac a8:97:dc:10:04:00 ip address 172.16.50.23
        mac a8:97:dc:10:04:00 ip netmask 255.255.0.0
        mac a8:97:dc:10:04:00 enable
!
ip gateway mgmt ip mac a8:97:dc:05:70:00 address 172.16.1.1
ip gateway mgmt ip mac a8:97:dc:05:70:00 enable
!
ip gateway mgmt ip mac a8:97:dc:10:04:00 address 172.16.1.1
ip gateway mgmt ip mac a8:97:dc:10:04:00 enable
!
end
```

Chapter 3. Managing the Flex SI Fabric Solution

After you have performed the Flex SI Fabric Solution (SI Fabric) initial configuration steps (see Chapter 2, "Initial Configuration), complete the relevant management actions:

SI4093 and EN4093R License Activation Keys

License keys determine the number of available ports on the Flex switches:

- Basic License

  The basic license is active by default on the Flex switch. It provides the use of 24 ports as follows:

  - Internal ports INTA1 through INTA14
  - External ports EXT1 through EXT10

- Optional Upgrade License 1

  In addition to all ports provided by the basic license, the following are available:

  - Internal ports INTB1 through INTB14
  - Two External QSFP+ ports. By default, each is configured for operation as four 10 Gbps Ethernet uplinks (EXT15 through EXT22) using the appropriate system divider cables. However, if high-bandwidth connections are preferred, each QSFP+ port can independently configured to operate in undivided 40 Gbps Ethernet mode.

- Optional Upgrade License 2

  Upgrade license 2 requires that upgrade license 1 be installed first. In addition to all ports provided by the basic license and upgrade license 1, the following are available:

  - Internal ports INTC1 through INTC14
  - External SFP+ ports EXT11 through Port EXT14

Additionally, the user has the option to select any ports as long as the total bandwidth for all the enabled ports does not exceed the current installed license. For further details, see "Flexible Port Mapping" on page 41.

Obtaining Activation Keys

The upgrade licenses can be acquired using the *Lenovo System x Features on Demand* (FoD) website:

`http://fod.lenovo.com/lkms/`

You can also use the website to review and manage licenses, and to obtain additional help. if required.

Note: A Lenovo ID and password are required to log into the FoD website. If you do not yet have a Lenovo ID, you can register at the website.

Activation keys are provided as files that must be uploaded to the Flex switch. To acquire an activation key, use the FoD website to purchase an Authorization Code. You will need to provide the unique ID (UID) of the specific Flex switch where the key will be installed. The UID is the last 12 characters of the Flex switch serial number. This serial number is located on the Part Number (PN) label and is also displayed during successful login to the device.

Download the activation key file from the FoD site when available in your account.

Installing Activation Keys

Once FoD activation key files have been acquired, they must be installed on the Flex switch. The example below depicts use of the Master Command Line Interface (CLI), but other device interfaces (such as SNMP) may also be used.

When installing licenses, please note the following requirements:

- The Flex switch must be reset to activate any newly installed licenses.
- The 64 Port License (Upgrade 2) will not function unless the 46 Port License (Upgrade 1) is also present. If installing both upgrades at the same time, upload both keys prior to resetting the Flex switch.

To install activation keys, complete the following steps:

1. Log in to the master G8264CS.
2. At the CLI prompt, enter the following commands:

```
RS G8264CS> enable
RS G8264CS# configure terminal
RS G8264CS(config)# software-key
RS G8264CS(Software-Key)# enakey address <server IP address> keyfile <key
filename> protocol <tftp or sftp> switch <3-20> mgt-port|data-port
```

3. Follow the prompts to enter the appropriate parameters, including the file transfer protocol and server parameters.

Note: Repeat the `enakey` command for any additional keys being installed.

Transferring Activation Keys

Licenses keys are based on the unique Flex switch device serial number and are non-transferable.

In the event that the Flex switch must be replaced, a new activation key must be acquired and installed. When the replacement is handled through Lenovo Service and Support, your original license will be transferred to the serial number of the replacement unit and you will be provided a new license key.

Managing Systems through Master and Backup G8264CS Switches

The SI Fabric is designed to enable master node and backup node between the G8264CS switches pair to provide continuous availability. All SI Fabric management is done using the master G8264CS switch. If the current master node fails, the current backup G8264CS switch will detect the absence of the master node and become the new master node of the SI Fabric. See "Configuring the SI Fabric Management IP Addresses and Gateway" on page 30 for details.

The Management IP address of the new master node is used to continue the resource management of the SI Fabric. If the data IP interface is used, the new master node will automatically assume the responsibility of resource management.

Note: If both the master and backup G8264CS switches fail, all Member Flex switch will also reset with all Internal server ports in disabled state and wait to rejoin the SI Fabric logical switch once the master G8264CS node recovers.

Deploying Staggered Image Upgrades for Master G8264CS Switch

The SI Fabric has a staggered mode for image upgrades. This staggered image upgrade provides network redundancy for the compute node, with redundant connection to its local Flex switches. All servers are still reachable during the image upgrade.

As with the traditional image upgrade process, the staggered upgrade downloads the SI Fabric boot image and OS software image to master node, and lets the master node push the new images to all member switches.

The staggered approach differs from the traditional image upgrade process in that instead of requiring a simultaneous reboot of the entire logical switch, the staggered update permits the master to reboot switches on a sequential basis.

Following is the staggered image upgrade sequence:

- After the new boot image and OS image are downloaded and installed on all switches, the master node will reboot the backup node. The master node waits for the backup node to rejoin before it reboots itself to preserve failover capabilities to the current backup node.
- After both new master and new backup nodes are booted with new image, the new master node will reboot all Flex switches in I/O module bay 1 of all Flex System chassis.
- After all rebooted Flex switches rejoin, the new master node will reboot all Flex switches in IO Module bay 2 of all Flex System chassis. This rolling reboot will take place at all Flex switches in I/O module bay 3 then at all Flex switches in I/O Module bay 4.

Note: Boot image should be downloaded and installed, prior to downloading OS image via staggered upgrade.

During the staggered upgrade process, the compute node with redundant connection will ensure that at least one server link is available and prevents any server connectivity interruption.

Deploying Staggered Image Reboot for Master G8264CS Switch

The SI Fabric allows the user to reboot the switch (without performing an image upgrade) and still have server access.

Staggered reload can be executed only if the new boot image is identical with the current one. All switches in the SI Fabric need to run the same software version.

Flexible Port Mapping

The SI Fabric allows administrators to manually enable or disable specific switch ports within the limitations of the installed licenses' bandwidth. Each switch in the SI Fabric that supports licensing has bandwidth restrictions determined by its license level.

Commands associated with flexible port mapping can only be run from the master switch and can have an additional parameter.

To add or remove ports of a SI Fabric switch to/from the port map by specifying the switch's configured number and port number, use the following command:

```
RS G8264CS(config)# [no] boot port-map <ports alias or member>
```

To reset the port map configuration to the default settings, use the following command:

```
RS G8264CS(config)# default boot port-map [<csnum>]
```

If a configured switch number is specified, the command will reset the port map configuration only for the selected switch.

Microburst Detection

Microbursts are short peaks in data traffic that manifest as a sudden increase in the number of data packets transmitted over a specific millisecond-level time frame, potentially overwhelming network buffers. Microburst detection allows users to analyze and mitigate microburst-related incidents, thus preventing network congestion.

To enable or disable microburst detection, use the following command:

```
RS G8264CS(config)# [no] microburst enable
```

By default, microburst detection is `disabled`.

Connecting Uplink to the Data Center Network

The SI Fabric provides uplink connection from both G8264CS switches to the data center network. The uplink port group feature provides layer-2 loop-free connectivity without the complexity of STP operation. The uplink connection can be a single physical interface, a static portchannel trunk group, a static LACP trunk group, or a hotlink pair.

When the SI Fabric is initially configured, all Ethernet ports that are not configured as SI Fabric ports at either G8264CS switches can be used as uplink connection. Initially, these Ethernet ports for uplink connection are placed in the Black-hole VLAN, which prevents any network loop. While an uplink port is in Black-hole VLAN, the port will not receive/forward traffic.

When an uplink connection is assigned to a target data VLAN or to a set of target data VLANs from black-hole VLAN (VLAN 4091 in this example), an uplink group is formed.

The uplink group prevents any ingress traffic from looping back to data center network and allows the SI Fabric to operate without use of Spanning Tree Protocol (STP).

When an uplink connection is removed from its last data VLAN, the SI Fabric moves this uplink connection back to the Black-hole VLAN and ensures no network loop.

The example below shows the commands and commented text for the uplink connection creation and assignments at the SI Fabric switches in IO Module bay 1 and bay 2 of the same Flex System chassis.

1. An uplink group is formed when the administrator configures an uplink connection to a target data VLAN or a set of target data VLANs from the Black-hole VLAN. The uplink group in the SI Fabric prevents other uplink connection from adding to this target data VLAN(s).

2. Configure interfaces and assign their data VLANs.

   You can use a mix of one or more single physical interfaces, static portchannel trunk groups, LACP trunk groups, and hotlink pairs as uplink connections. For example:

   - A single physical interface:

```
RS G8264CS(config)# interface port 1:2
RS G8264CS(config-if)# switchport access vlan 100
RS G8264CS(config-if)# exit
```

   - Static portchannel:

```
RS G8264CS(config)# portchannel 288 port 1:3,2:3 enable
RS G8264CS(config)# interface port 1:3,2:3
RS G8264CS(config-if)# switchport access vlan 101
RS G8264CS(config-if)# exit
```

- LACP:

```
RS G8264CS(config)# portchannel 289 lacp key 2890
RS G8264CS(config)# interface port 1:4,2:4
RS G8264CS(config-if)# lacp key 2890
RS G8264CS(config-if)# lacp mode active
RS G8264CS(config-if)# switchport access vlan 102
RS G8264CS(config-if)# exit
```

3. Configure hotlinks for uplink redundancy:

   a. Configure hotlink triggers:

```
RS G8264CS(config)# hotlinks trigger 1 enable
RS G8264CS(config)# hotlinks trigger 1 master port 1:5
RS G8264CS(config)# hotlinks trigger 1 backup port 2:5
```

   b. Globally enable the hotlinks feature:

```
RS G8264CS(config)# hotlinks ena
```

   c. Add the trigger interfaces to their uplink VLANs.

      If the trigger interface is composed of access ports:

```
RS G8264CS(config)# interface port 1:5,2:5
RS G8264CS(config-if)# switchport access vlan 104
RS G8264CS(config-if)# exit
```

      Otherwise, if the trigger interface is composed of ports in trunk mode:

```
RS G8264CS(config)# interface port 1:5,2:5
RS G8264CS(config-if)# switchport mode trunk
RS G8264CS(config-if)# switchport trunk allowed vlan 104
RS G8264CS(config-if)# exit
```

4. Verify port configuration:

```
RS G8264CS(config)# show interface info 1:2-1:5,2:1-2:5
```

Defining Server Ports

In full-fabric mode, multiple uplink groups can be connected to servers via uplink ports. Once defined as server port, the port can become member of any VLANs.

Uplink groups server port loop detector is based on BPDU Guard Feature. If a port configured as server port receives a BPDU, the port is automatically error disabled.

To define a port as a server port use the following command:

```
RS G8264CS(config)# system server-ports port <ports alias or member>
```

Connecting Downlink Compute Nodes

The SI Fabric provides downlink connections from the Flex switches' internal ports-only compute nodes. Factory default settings configure all Internal ports on Flex switches for downlink connection in a default VLAN.

Note: If you assign downlink connections, the SI Fabric does not impose the uplink connection requirement mentioned previously.

The SI Fabric also supports the Unified Fabric Port (UFP) protocol between internal ports as downlink connections and server NICs. The downlink connection provisioning at the SI Fabric is similar to the common network provisioning at a standalone Flex switch.

In order to maintain system redundancy, two Flex switches are used, installed in neighboring bays in the Flex System chassis: either Bay 1 and Bay 2, or alternately in Bay 3 and Bay 4. When you configure the Flex downlink connection to a compute node that has redundant NICs or NIC teaming, be sure that the switches and NICs are in the same chassis, and that the same internal port number is used in both paired Flex switches.

The example below shows the downlink connection creation and assignments at the SI Fabric logical switch made up by two G8264CS switches and two Flex switches in IO Module bay 1 and bay 2 of the same Flex System chassis.

1. Confirm that the paired Flex switches are in the same Flex System chassis and in neighboring IO module bays.

```
RS G8264CS(config)# show fabric attached-switches
Attached Switches in Fabric:
asnum       UUID                    Bay       MAC           csnum   State       Type
-------------------------------------------------------------------------------
A1           N/A                    N/A   74:99:75:20:0e:00   C1   IN_FABRIC G8264CS
A2  669d8dccfb95492bb727d18313c82289 3   08:17:f4:5f:40:00   C9   IN_FABRIC EN4093R
A3  7fbaa95c6a484e0296c418cae2bbfe5a 2   08:17:f4:84:3b:00   C12  IN_FABRIC  SI4093
A4  c6b9ceff4440486cb65bd1e2e3fe3a94 1   08:17:f4:84:3d:00   C3   IN_FABRIC EN4093R
A5  c6b9ceff4440486cb65bd1e2e3fe3a94 4   08:17:f4:84:40:00   C6   IN_FABRIC  SI4093
A6  c6b9ceff4440486cb65bd1e2e3fe3a94 3   08:17:f4:a7:55:00   C5   IN_FABRIC  SI4093
A7           N/A                    N/A   08:17:f4:fb:cc:00   C2   IN_FABRIC G8264CS
A8  c6b9ceff4440486cb65bd1e2e3fe3a94 2   34:40:b5:73:92:00   C4   IN_FABRIC EN4093R
A9  7fbaa95c6a484e0296c418cae2bbfe5a 4   34:40:b5:73:9c:00   C14  IN_FABRIC  SI4093
A10 7fbaa95c6a484e0296c418cae2bbfe5a 3   74:99:75:00:D1:00   C13  IN_FABRIC  SI4093
A11 b88989be60824783af6956a441cd0c61 3   74:99:75:1c:6b:00   C15  IN_FABRIC EN4093R
A12 7fbaa95c6a484e0296c418cae2bbfe5a 1   74:99:75:1c:7d:00   C11  IN_FABRIC EN4093R
A13 669d8dccfb95492bb727d18313c82289 2   74:99:75:5d:e1:00   C8   IN_FABRIC  SI4093
A14 669d8dccfb95492bb727d18313c82289 1   74:99:75:7f:7d:00   C7   IN_FABRIC  SI4093
```

The example information shows that the Flex switches with `csnum` C3 and C4 are in the same Flex System (their UUID is the same) in neighboring IO Module bays: Bay 1 and Bay 2 respectively.

2. View default VLAN information.

```
RS G8264CS(config)# show vlan 1
VLAN                Name                Status            Ports
----  --------------------------------  ------
------------------------
1     Default VLAN                      ena     1:17-1:35 2:17-2:35
                                                3:INTA1-3:EXT22
                                                4:INTA1-4:EXT22
...
```

   In this example, the default VLAN 1 information includes all possible downlink ports from all Flex member switches.

3. Configure the downlink connection in pairs.

```
RS G8264CS(config)# interface port 3:INTA1,4:INTA1
RS G8264CS(config-if)# switchport mode trunk
RS G8264CS(config-if)# switchport trunk allowed vlan 1060
```

   In this example, the pair of Internal ports 3:INTA1 and 4:INTA1 represent physical internal ports on two members Flex switch and are connected to the compute node in Bay 1 of the Flex System chassis.

4. Verify the interface configuration.

```
RS G8264CS(config-if)# show interface info 3:INTA1,4:INTA1
Alias   Port Tag    Type    RMON Lrn PVID     DESCRIPTION
VLAN(s)
           Trk                   NVLAN

------- ---- --- ---------- ---- --- ------ ------------
--------------------
3:INTA1 257   y  Internal    d    e     1   3:INTA1        1 1060
4:INTA1 385   y  Internal    d    e     1   4:INTA1        1 1060

RS G8264CS(config-if)# exit
```

   This example shows the available downlink ports on the C3 and C4 Flex switches and their assigned VLANs.

Connecting to Storage Resources

The SI Fabric facilitates integrated end-to-end FC/FCoE storage connectivity. In this configuration, G8264CS switches act as FCoE gateways for bridging FCoE and Fibre Channel networks, and embedded Flex switches as FCoE aggregators. It connects FCoE enabled compute nodes and storage nodes with Converged Enhanced Ethernet (CEE) support.

SI Fabric serves storage connectivity requirements in three different ways - FIP Snooping Bridge, NPV Gateway mode, and Full fabric mode. The SI Fabric in FIP Snooping configuration connects to an external FCoE Forwarder(FCF) to provide secure FCoE device connectivity. In NPV Gateway mode, the SI Fabric can provide connectivity to existing SAN fabric via Omni ports (1:53-1:64 and 2:53-2:64) on G8264CS as uplinks. In Full fabric mode, the SI Fabric serves as FC-BB-5 compliant FC/FCoE SAN which provides connectivity to FC/FCoE server/storage.

FIP Snooping Bridge

Follow these steps to enable FCoE function at the SI Fabric, comprised of two G8264CS switches and two Flex switches.

1. Enable FCoE function by turning on CEE and global FIP Snooping.

```
RS G8264CS(config)# cee enable
RS G8264CS(config)# fcoe fips enable
```

2. Create a typical FCoE VLAN 1002 for internal FCoE nodes and external FCF. if required.

```
RS G8264CS(config)# vlan 1002
VLAN 1002 is created.
```

3. Place the internal FCoE port and external FCF port into the FCoE VLAN with VLAN trunking enabled.

```
RS G8264CS(config)# interface port 1:20,3:INTA5
RS G8264CS(config-if)# switchport mode trunk
RS G8264CS(config-if)# switchport trunk allowed vlan 1,1002
RS G8264CS(config-if)# exit
```

4. Keep default FCoE settings (FIP Snooping/FCF mode) on FCoE/FCF ports.

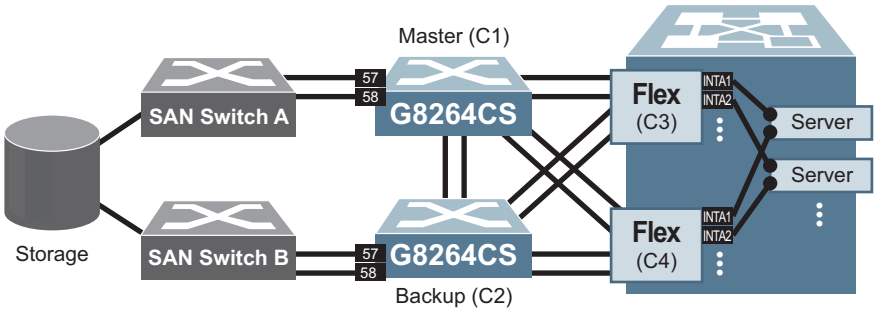
```
RS G8264CS(config)# show fcoe fips port 1:20,3:INTA5

Port 1:20 FIP Snooping Configuration:
FIP snooping: enabled, FCF mode: auto

Port 3:INTA5 FIP Snooping Configuration:
FIP snooping: enabled, FCF mode: auto
...
```

NPV Gateway Mode

Figure 4. NPV Gateway example



1. Enable NPV Gateway function starting with enabling each pair of Omni ports with Fibre Channel mode at both G8264CS switches (which automatically enables VLAN trunking).

```
RS G8264CS(config)# system port 1:53-1:64,2:53-2:64 type fc
```

2. Create an FC VLAN for NPV Gateway functionality on first G8264CS and add at least one FC port from it as an uplink to SAN fabric. It is recommended to have more than one uplink to SAN fabric. Each G8264CS switch can accommodate up to 12 NPV VLANs. To have traffic redundancy, configure different NPV VLAN from the other G8264CS. Also specify the FC port(s), which has the external connection to upstream full-fabric SAN switch under each NPV enabled VLAN.

```
RS G8264CS(config)# vlan 1060
VLAN 1060 is created.

RS G8264CS(config-vlan)# interface fc 1:57,1:58
RS G8264CS(config-fc)# switchport trunk allowed vlan 1,1060

RS G8264CS(config-fc)# interface port 3:INTA1,3:INTA2
RS G8264CS(config-if)# switchport mode trunk
RS G8264CS(config-if)# switchport trunk allowed vlan add 1060
RS G8264CS(config-if)# exit

RS G8264CS(config)# vlan 1060
RS G8264CS(config-vlan)# npv enable
RS G8264CS(config-vlan)# npv traffic-map external-interface 1:57,1:58
RS G8264CS(config-vlan)# exit
```

3. Configure another NPV enabled VLAN for second G8264CS switch.

```
RS G8264CS(config)# vlan 2060
VLAN 1060 is created.

RS G8264CS(config-vlan)# interface fc 2:57,2:58
RS G8264CS(config-fc)# switchport trunk allowed vlan 1,2060

RS G8264CS(config-fc)# interface port 4LINTA1,4:INTA2
RS G8264CS(config-if)# switchport mode trunk
RS G8264CS(config-if)# switchport trunk allowed vlan add 2060
RS G8264CS(config-if)# exit

RS G8264CS(config)# vlan 2060
RS G8264CS(config-vlan)# npv enable
RS G8264CS(config-vlan)# npv traffic-map external-interface 2:57,2:58
RS G8264CS(config-vlan)# exit
```

4. Verify NPV status.

```
RS G8264CS(config)# show npv status
Unit:1 VLAN:  1060       NPV enabled
Unit:2 VLAN:  2060       NPV enabled

RS G8264CS(config)# show npv traffic-map
-------------------------------------------------------------------
        VLAN     Source Ports            NP-Uplink Dest Ports
-------------------------------------------------------------------
        1060       empty             1:57,1:58
        2060       empty             2:57,2:58
```

Full-Fabric Mode

In full-fabric mode, the SI Fabric supports E_Port feature for up to four FC ISL links between G8264CS switches to expand fabric connectivity.

Follow these steps to enable full-fabric function on the same SI Fabric:

1. Enable full-fabric FC/FCoE switch function by using these FC ports at either G8264CS switches for direct connectivity to FC/FCoE storage nodes.

```
RS G8264CS(config)# cee enable
RS G8264CS(config)# fcoe fips enable
RS G8264CS(config)# system port 1:53-1:64,2:53-2:64 type fc
```

2. Create one FC VLAN for full FC/FCoE network for the first G8264CS switch and add at least one FC port from it and the other FCoE internal ports.
   Each G8264CS switch can have only 1 full fabric VLAN. The full fabric VLAN should be a different VLAN from the other G8264CS switch for storage traffic redundancy.

```
RS G8264CS(config)# vlan 1024
VLAN 1024 is created.

RS G8264CS(config-vlan)# interface fc 1:55,1:56
RS G8264CS(config-fc)# switchport trunk allowed vlan 1,1024

RS G8264CS(config-fc)# interface port 3:INTA3,3:INTA4
RS G8264CS(config-if)# switchport mode trunk
RS G8264CS(config-if)# switchport trunk allowed vlan add 1024
RS G8264CS(config-if)# exit

RS G8264CS(config)# vlan 1024
RS G8264CS(config-vlan)# fcf enable
RS G8264CS(config-vlan)# exit
```

3. Configure another full FC VLAN for the second G8264CS switch.

```
RS G8264CS(config)# vlan 2024
VLAN 1024 is created.

RS G8264CS(config-vlan)# interface fc 2:55,2:56
RS G8264CS(config-fc)# switchport trunk allowed vlan 1,2024

RS G8264CS(config-fc)# interface port 4:INTA3,4:INTA4
RS G8264CS(config-if)# switchport mode trunk
RS G8264CS(config-if)# switchport trunk allowed vlan add 2024
RS G8264CS(config-if)# exit

RS G8264CS(config)# vlan 2024
RS G8264CS(config-vlan)# fcf enable
```

4. Configure E_Ports.

   E_ports (expansion ports) connect two full-fabric switches to form an inter-switch link (ISL). This is an optional configuration which is useful only when user wanted to expand the SAN fabric to more than one switch. Maximum of four full-fabric switches can be interconnected. Only Fibre Channel port types can be configured as E-ports. These ports must be members of a Fibre Channel VLAN. Use the following commands to configure E_ports:

```
RS G8264CS(config-fc)# interface fc 1:54
RS G8264CS(config-fc)# switchport trunk allowed vlan add 2024
RS G8264CS(config-fc)# type e

RS G8264CS(config-fc)# exit
```

5. Configure FC zoning.

   Each FC port can only be assigned to one FC VLAN and each FC VLAN can only include FC ports from the same G8264CS switch

```
RS G8264CS(config)# zone name master vlan 1024
RS G8264CS(config-zone)# member pwwn 10:00:5c:f3:fc:6e:4a:a1
RS G8264CS(config-zone)# member pwwn 50:05:07:68:05:04:09:2c
RS G8264CS(config-zone)# zoneset name SC vlan 1024
RS G8264CS(config-zoneset)# member master
RS G8264CS(config-zoneset)# zoneset activate name SC vlan 1024
RS G8264CS(config-zoneset)# exit

RS G8264CS(config)# zone name backup vlan 2024
RS G8264CS(config-zone)# member pwwn 50:05:07:68:05:08:09:2c
RS G8264CS(config-zone)# member pwwn 10:00:5c:f3:fc:6e:4a:a5
RS G8264CS(config-zone)# zoneset name SC2 vlan 2024
RS G8264CS(config-zoneset)# member backup
RS G8264CS(config-zoneset)# zoneset activate name SC2 vlan 2024
RS G8264CS(config-zoneset)# exit
```

Secure Input/Output Module on Master and Backup G8264CS Switches

The SI Fabric supports Secure Input/Output Module (SIOM) feature which enables you to determine which protocols can be enabled. The SIOM only allows secured traffic and secured authentication management.

Settting an SIOM Security Policy

The SIOM feature introduces the following levels of security policy:

- **Legacy Mode**

  Legacy Mode maintains the existing security behavior of the IOM or switch. All communication protocols currently supported by the IOM software continue to be allowed and supported in this mode. All behaviors of the IOM remain the same; the only difference is you can set the mode which will take effect after the next reboot of the switch.

- **Secure Mode**

  In *Security Mode* or SIOM, only secure communication protocols are allowed to be enabled. Communication protocols that are deemed to be not secure are disabled and not allowed to run on the switch.

Note: Once a switch has entered Secure Mode, it cannot return to Legacy Mode without a reboot.

Enabling and Disabling the SIOM

To enable Secure Mode on the SI Fabric, enter:

```
SIM(config)# boot security-policy secure-mode
```

Note: The switch will remain in Legacy Mode until you reboot.

To disable Secure Mode on the SI Fabric, enter:

```
SIM(config)# boot security-policy legacy-mode
```

Note: The switch will remain in Secure Mode until you reboot.

To display the running security policy, enter:

```
SIM(config)# show boot security-policy
```

Note: In stacking mode, the Master and the Backup switches control the security policy.

Using Protocols With SIOM

Some protocols can be used with SIOM. This section explains which protocols can and cannot operate with SIOM on the Flex SI Fabric Solution.

Insecure Protocols

When you are in Secure Mode, the following protocols are deemed “insecure” and are disabled:

- HTTP
- LDAP Client
- SNMPv1
- SNMPv2
- Telnet (server and client)
- FTP (server and client)
- Radius (client
- TACACS+ (client)
- TFTP Server

Except for the TFTP server, these protocols cannot be enabled when the switch is operating in Secure Mode because the commands to enable or disable them disappear with SIOM enabled.

The following protocols, although deemed “insecure” by SIOM, are enabled by default and can be disabled.

- DHCP client
- SysLog

Note: Service Location Protocol (SLP) Discovery is also deemed “insecure” but is unaffected by Secure Mode. SLP has the same default settings as in Legacy Mode. If you can enable or disable SLP in Legacy Mode, you can enable or disable it the same way in Secure Mode.

The following supported protocols are not enabled by default but can always be enabled in Secure Mode.

- DNS Resolution
- TFTP client (for signed items only, such as switch images)

The following protocols, although deemed “insecure” and allowed by SIOM, are not supported by the SI Fabric:

- RCP
- SMTP
- MIME
- TCP command in secure mode (Port 6090)
- DHCPv6 client

Secure Protocols

The following protocols are deemed “secure” and are enabled by default in Secure Mode:

- SCP Server

- SNMPv3 Client
- SFTP Client
- SSHv2 Server
- SSHv2 Client
- HTTPS Server

You can disable these protocols.

The following protocols are deemed “secure” and cannot be disabled in any mode:

- NTP Client v4
- LDAPS Client

The following protocols are also deemed “secure” on the SI Fabric and can be enabled.

- IKE
- IPSec

The default state for these protocols in Secure Mode, whether enabled or disabled, is the same as in Legacy Mode.

The following protocols are deemed “secure” but are not currently supported by the SI Fabric:

- EAPoL
- SCP
- S/MIME
- SNMPv3 Manager
- TCP command secure mode (Port 6091)

Insecure Protocols Unaffected by SIOM

The following protocols are deemed “insecure” but can be enabled in all Security Policy Modes:

- Ping
- Ping IPv6
- Traceroute
- Traceroute IPv6
- TFTP IPv6
- SNMPv3 IPv6
- bootp

Notes:

- Telnet IPv6 and TFTP IPv6 are disabled in Secure Mode.
- TFTP IPv6 is allowed in Secure Mode for signed image transfers only.

Implementing Secure LDAP (LDAPS)

Lightweight Directory Access Protocol (LDAP) is a protocol for accessing distributed directory information services over a network. Lenovo Networking OS uses LDAP for authentication and authorization. With an LDAP client enabled, the switch will authenticate a user and determine the user's privilege level by checking with one or more directory servers instead of a local database of users. This prevents customers from having to configure local user accounts on multiple switches; they can maintain a centralized directory instead.

As part of the SIOM, you can implement Secure Lightweight Directory Access Protocol (LDAPS) in addition to standard LDAP.

Enabling LDAPS

LDAPS is disabled by default. To enable LDAPS:

1. Turn LDAP authentication on

```
SIM(config)# ldap-server enable
```

2. Enable LDAP Enhanced Mode:

```
SIM(config)# ldap-server mode enhanced
```

This changes the `ldap-server` subcommands to support LDAPS.

3. Configure the IPv4 addresses of each LDAP server.

```
SIM(config)# ldap-server host {1-4} <IP address or hostname>
```

4. You may change the default TCP port number used to listen to LDAPS (optional).

The well-known port for LDAP is 636.

```
SIM(config)# ldap-server port <1-65000>
```

5. Configure the Security Mode:

```
SIM(config)# ldap-server security {clear|ldaps|mutual|starttls}
```

where:

Parameter	Description
clear	Cleartext Mode (no security)
ldaps	LDAPS Mode
mutual	Mutual authentication in Transport Layer Security (TLS)
starttls	Secure LDAP via StartTLS without cleartext fallback

6. Configure the distinguished name (DN) and password (optional).

```
SIM(config)# ldap-server binddn dn "<distinguished name> "
SIM(config)# ldap-server binddn key "<password> "
```

   If this is not configured, the switch will use user-provided login credentials to bind. A DN will then be constructed from the user's login credentials and then used in the initial BIND attempt.

7. Configure the root DN:

```
SIM(config)# ldap-server basedn <root DN name>
```

8. Configure the user search attribute (optional):

```
SIM(config)# ldap-server attribute username <search attribute>
```

   If no user search attribute is specified, the default is `uid`.

9. Configure the group search attribute (optional):

```
SIM(config)# ldap-server attribute group <search attribute>
```

   If no group search attribute is specified, the default is `memberOf`.

10. Configure the login permissions attribute:

```
SIM(config)# ldap-server attribute login-permission <attribute>
```

   Note: If no login permissions attribute is configured, LDAP client will not function.

11. Configure the group filter attribute (optional):

```
SIM(config)# ldap-server group-filter <filter attributes separated by comma>
```

   Note: The group filter string must contain no whitespace.

   If no group filter attribute is configured, no groups will be filtered and all groups will be considered in any search.

12. Enable DNS server verification:

```
SIM(config)# ldap-server srv
```

Disabling LDAPS

To disable LDAPS, enter:

```
SIM(config)# ldap-server security clear
SIM(config)# ldap-server mode legacy
```

For information about using LDAP in Legacy Mode, see "LDAP Authentication and Authorization" on page 111.

Syslogs and LDAPS

Syslogs are required for the following error conditions:

- `Password change required on first login`
- `Password expired`
- `Username or password invalid`
- `Account temporarily locked`
- `Unknown/no reason given`

Using Cryptographic Mode

The Flex SI Fabric Solution is able to change between Cryptographic Compatibility Mode and NIST SP 800-131a *Cryptographic Mode*. In Cryptographic Mode, encryption key lengths must comply with NIST SP 800-131a minimum requirements; only compliant encryption algorithms are allowed.

To enable Cryptographic Mode:

Note: You may want to save your configuration before enabling Cryptographic Mode, as this process will wipe out your configuration.

1. Set the boot mode:

```
SIM(config)# boot strict enable
```

2. Reboot the switch.

3. Verify that the switch is operating in Cryptographic Mode:

```
SIM# show boot strict
Current strict settings:
Strict Mode                          : enabled
Old default Snmpv3 accounts support : no

Strict settings saved:
Strict Mode                          : enabled
Old default Snmpv3 accounts support : no
```

Certificate Signing Request on Master and Backup G8264CS Switches

Before a digital certificate can be signed by a Certificate Authority (CA), it needs to be created. The generation of a certificate involves creating a Certificate Signing Request (CSR). The CSR includes various information related to the device and a public key. The public key is included in the CSR file itself and the private key associated with the public key is generated separately and kept private. The CSR can then be exported to a remote device to be signed by a CA.

1. Create an HTTPS CSR defining the information you want to be used in the various fields:

```
SIM(config)# access https generate-csr
Country Name (2 letter code) []:  <country code>
State or Province Name (full name) []:  <state>
Locality Name (eg, city) []:  <city>
Organization Name (eg, company) []:  <company>
Organizational Unit Name (eg, section) []:  <org. unit>
Common Name (eg, YOUR name) []:  <name>
Email (eg, email address) []:  <email address>
Confirm Generate CSR? [y/n]: y
.........................................+++
.............+++
Cert Req generated successfully
```

2. To verify the CSR you can use the following command:

show https host-csr [pem-format|txt-format]

```
SIM> show https host-csr txt-format

Certificate Request:
    Data:
        Version: 0 (0x0)
        Subject: C=US, ST=Cali, L=Santa Barbara, O=Lenovo, OU=Sales, CN=www.zagat.com
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
            RSA Public Key: (2048 bit)
                Modulus (2048 bit):
                    00:b5:05:f6:d5:ad:ab:f2:1d:a9:57:c4:bc:84:1b:
                    c6:bc:cd:04:95:ea:ad:ec:4a:44:3a:6e:42:9f:39:
                    96:14:11:a7:8e:3e:6f:da:9a:42:c6:c4:62:a1:33:
                    0e:a8:d3:6a:21:ce:f3:3c:4f:c1:8d:d1:e7:9e:c7:
                    29:04:ea:c6:7d:54:9a:4e:10:24:10:38:45:c6:4b:
                    13:19:f2:dd:8a:83:3f:5c:cf:8b:85:a7:2a:b0:eb:
                    7a:26:1f:4c:94:47:01:81:6a:59:d5:f5:d6:7e:3b:
                    b5:bc:e4:3f:6d:dd:84:15:07:61:93:e0:d1:40:f8:
                    9d:15:d0:a6:e1:9b:a4:ab:85:b5:2b:f0:56:e9:ef:
                    36:43:2b:aa:be:1b:63:3c:fd:74:ab:78:76:53:12:
                    e6:65:4c:0d:07:91:df:b3:91:96:f4:55:f7:37:73:
                    8c:f6:77:d7:9d:2b:a5:bd:17:3f:11:f2:85:4b:d6:
                    b4:1d:3f:70:1f:13:bb:5e:2e:4c:a8:ad:6a:7f:11:
                    36:97:a6:25:0a:87:66:31:c9:92:59:03:31:5d:ff:
                    df:c6:aa:93:7c:51:9f:8e:1b:6f:2a:be:c4:4c:66:
                    d6:2c:4b:6d:e6:ae:4e:02:82:fc:fa:a1:de:3b:c9:
                    24:25:d5:6e:15:15:18:ce:9b:a6:98:ad:0c:32:1f:
                    94:01
                Exponent: 65537 (0x10001)
        Attributes:
            a0:00
    Signature Algorithm: sha256WithRSAEncryption
        24:26:dd:96:49:47:9d:78:74:48:9b:63:4c:32:f0:78:da:7d:
        82:c9:17:6d:7e:93:38:60:94:d5:02:c1:31:dc:42:69:f5:57:
        46:a8:44:5a:99:ea:55:d3:99:bf:f0:48:3b:ef:60:fd:50:e6:
        33:cd:89:86:d3:51:97:f2:d1:68:6f:88:8c:e7:0f:3e:19:2a:
        f4:ea:6b:dc:05:24:d7:98:cd:a3:d3:c3:ef:03:93:8b:3f:fe:
        75:5e:67:f1:48:b6:20:a6:ff:ae:5a:25:41:7f:e4:c8:48:d4:
        63:37:16:98:9e:2d:1b:b6:65:7a:0d:90:87:07:19:f0:02:17:
        3a:3e:fd:f0:40:3e:a4:0f:53:97:9b:d5:18:22:78:f3:07:94:
        63:be:f9:f2:5c:23:6d:0f:22:d1:17:db:38:24:5c:6b:7b:e0:
        41:a6:51:28:30:2c:f4:1d:62:6c:06:f2:4c:0c:5b:79:51:13:
        73:f8:88:ba:2e:05:98:5d:41:5e:9d:58:b1:0c:8f:fc:f2:79:
        d5:30:7c:95:e9:ff:9a:cc:dd:d9:4c:2e:98:32:5a:ab:cd:59:
        a4:37:a5:38:03:4e:e7:27:dc:14:c8:75:9d:ca:e0:62:37:02:
        19:17:16:e3:92:c0:c3:16:13:26:c9:40:d7:ec:f2:8c:8e:fc:
        1a:dc:27:4c
```

```
SIM> show https host-csr pem-format

-----BEGIN CERTIFICATE REQUEST-----
MIICtDCCAZwCAQAwbzELMAkGA1UEBhMCVVMxEzARBgNVBAgMCkNhbGlmb3JuaWEx
ETAPBgNVBAcMCFNhbiBKb3NlMQwwCgYDVQQKDANBQkMxFDASBgNVBAsMC0VuZ2lu
ZWVyaW5nMRQwEgYDVQQDDAt3d3cuYWJjLmNvbTCCASIwDQYJKoZIhvcNAQEBBQAD
ggEPADCCAQoCggEBAMEnVJBSnIY9OGiCcH+xmYKpWga7E5j9JSK9JU57Md7NofJ2
FvQ8hfPO8b4bzLQzKbNBxGc59BJjZJ5w8eGKRDCjlIf1uIAgg3Gs8ZK1FozOUJZN
xbtYBx6QrTBYmXdHStQ7CQ9sfWhnEnusnvc8bxNlukyuEcFsAUdz93r1sEfN3cDe
/bO43l7GmvhTEdmfFvAfgi9b9RDqUjliATpgS3+a2kwhjvHCTeveQN1/MYQZvbJo
V4qq+pgQOt9ZJOMDrGQ0YmO1p84+GdxXVwGePCOvCRLESsq5rQb3zPSVvWnTsq0G
gURvbV+VQN9dI9lANZGZJi6BRNIRdBen/dH0KRcCAwEAAaAAMA0GCSqGSIb3DQEB
BQUAA4IBAQCSLDOrOnl7kaZri2OjDpzgiiG+9Skde3MehaklddfZnCkT1ALL3ZXY
xWwYnvF5jAgnHhxRJbPOzwHNDWMtZiiNOTHyzHVptsyRBv70Kb8odJmuyKWDqunJ
Ho1hHe63a7MRLFkQ+6io3kGrmq1bdM5U6xvvS+0ZXXUaiK1p/lNLOrsYk45D01Az
YHhcdRQtFUbQxqbirpi0jLsi82X7JCNQ2XCP6dhphkWKI6wsCvmlJdazW+V/gH/X
wqMkNF8mkodzlhC+1COd2yzSXxqpG/Xf0TRF9SAyN5vK4NDDzZu+iPvh6RkXXeNV
neyr2J5JENyGORPynuVoHWuzEy+5GUHa
-----END CERTIFICATE REQUEST-----
```

3. Export the CSR file to an external server:

```
SIM(config)# copy cert-request tftp

Port type ["DATA"/"MGT"/"EXTM"]: <port type>
Address or name of remote host: <hostname or IPv4 address>
Destination file name: <path and filename on the remote server>

Certificate request successfully tftp'd to...
```

4. Import the signed certificate from an external server:

```
SIM(config)# copy sftp host-cert-only mgt-port
Address or name of remote host: 10.241.3.32
Enter SFTP server port [22]:
Source file name: mars.crt
User name: admin
Password:
Confirm download operation (y/n) ? y
Connecting to 10.241.3.32...via port 22
SFTP: User platformlinux logged in.

Download in progress

SFTP: Read 985 bytes

Certificate file download complete (985 bytes)

Restart the HTTPS server manually to make the switch use the certificate
```

5. Reset HTTPS server.

```
SIM(config)# no access https enable
access https enable
Generating certificate. Please wait (approx 30 seconds)
```

Chapter 4. Flex SI Fabric -Specific ISCLI Commands

The Flex System Interconnect Fabric (SI Fabric) requires a new group of ISCLI commands to manage the new set of capabilities. These commands come in addition to the existing SI4093, EN4093R and G8264CS commands.

For the existing SI4093, EN4093R and G8264CS commands, see the respective product ISCLI guides.

Information Commands

Command Syntax and Usage

`show fabric`

Displays the current SI Fabric information.

Command mode: All

`show interface fabric-trunk` *<trunk ID>* **`interface-counters`**

Displays the current SI Fabric trunk statistics.

Command mode: All

`show system black-hole`

Displays the current configured SI Fabric Black-hole VLAN.

Command mode: All

`show system internal-VLAN`

Displays the current SI Fabric internal-VLAN space.

Command mode: All

`show system chassis swn` *<switch number>*

Displays the current chassis related information at the specified switch.

Command mode: All

Configuration Commands

Command Syntax and Usage

system black-hole vlan <*VLAN number*>

Configures the SI Fabric black-hole VLAN

Command mode: Global configuration

system internal-VLAN <*VLAN number or range*> [**black-hole vlan** <*VLAN number*>]

Configures the SI Fabric internal VLAN or VLANs.

Command mode: Global configuration

copy tftp {**image1**|**image2**} **address** <*IP address*> **filename** <*filename*> {**data-port**|**mgt-port**} **staggered-upgrade** [**delay** <*minutes (1–30)*>]

Copies image from TFTP server and upgrade SI Fabric members in staggered mode.

Command mode: Global configuration

copy ftp {**image1**|**image2**} {**data-port**|**mgt-port**} **staggered-upgrade** [**delay** <*minutes (1–30)*>]

Copies image from FTP server and upgrade SI Fabric members in staggered mode.

Command mode: Global configuration

copy sftp {**image1**|**image2**} {**data-port**|**mgt-port**} **staggered-upgrade** [**delay** <*minutes (1–30)*>]

Copies image from SFTP server and upgrade SI Fabric members in staggered mode.

Command mode: Global configuration

reload staggered [delay <*delay*>**]**

Starts a rolling reload based on the time delay in minutes between switch reboots. The default value is one minute between switch reboots.

Command mode: Global configuration

fabric bind

Configure all attached switch units.

Command mode: Global configuration

[no] logging log {all|<*feature*>**}**

Displays a list of features for which syslog messages can be generated. You can choose to enable/disable specific features (such as `vlans`, `stg`, or `ssh`), or enable/disable syslog on all available features.

Command mode: Global configuration

copy log [swn <*switch number*>**] {stfp|tftp [address** <*address*>**] [filename** <*filename*>**]}**

Copies syslog content to an external host using SFTP or TFTP.

Command mode: Global configuration

IP Interface Configuration Commands

You can use the Command Line Interface (CLI) for making, viewing, and saving IP interface configuration changes.

Command Syntax and Usage

`interface ip data {1|2}`

Enter Data IP interface mode.

Command mode: Global configuration

`interface ip mgmt {ip|ipv6}`

Enter Management IP interface mode.

Command mode: Global configuration

`mac` *<MAC address>* **`ip address`** *<IP address>* *<IP netmask>* **`enable`**

Configure the IP address using dotted decimal notation.

Command mode: Interface IP (Management)

`mac` *<MAC address>* **`ipv6 address`** *<IPv6 address>* *<IPv6 prefix>* **`enable`**

Configure the IPv6 address using hexadecimal format with colons.

Command mode: Interface IP (Management)

`show interface ip [data|mgmt]`

Displays the current IP interface settings.

Command mode: All

`ip gateway data {ip|ipv6} address` {*<IPv4 address>*|*<IPv6 address>*} **`enable`**

Configures the IP address of the default IP gateway over Data IP interface.

Command mode: Global configuration

`ip gateway mgmt {ip|ipv6} mac` *<MAC address>* **`address`** {*<IPv4 address>*|*<IPv6 address>*} **`enable`**

Configures the IP address of the default IP gateway over Management IP interface.

Command mode: Global configuration

`show ip gateway {data|mgmt}`

Displays the current IP interface settings.

Command mode: All

Software Key Commands

You can use the Command Line Interface (CLI) for updating and reviewing switch FoD software license.

Command Syntax and Usage

`software-key`

Enter software key command menu.

Command mode: Global configuration

`enakey address` *<IP address>* **`keyfile`** *<filename>* **`[protocol {tftp|sftp} switch`** *<switch number>* **`{data-port|mgt-port}]`**

Enable software key.

Command mode: Software Key Menu

`invkeys address` *<IP address>* **`[invfile`** *<filename>* **`protocol {tftp|sftp} switch`** *<switch number>* **`{data-port|mgt-port}]`**

Upload inventory installed activation keys.

Command mode: Software Key Menu

`ptkeys address` *<IP address>* **`key {Upgrade1|Upgrade2} [protocol {tftp|sftp} file`** *<filename>* **`switch`** *<switch number>* **`{data-port|mgt-port}]`**

Upload Software Key.

Command mode: Software Key Menu

`rmkey key {Upgrade1|Upgrade2} switch` *<switch number>*

Remove Software Key.

Command mode: Global configuration

`show software-key [switch` *<switch number>*`]`

Show software licensing keys.

Command mode: All

Boot Options

To use following new Boot Options commands, you must be logged in to the switch as the administrator. The new Boot Options commands provide options for the SI Fabric.

Command Syntax and Usage

`boot fabric si-fabric-domain` *<domain number>*

Configures the SI Fabric domain number on switches. The same domain number needs to be applied on both switches to form the SI Fabric.

Command mode: Global configuration

`boot fabric fabric-trunk` *<list of ports>*

Configures the ports used to connect the switch to the SI Fabric. Enter only 10Gb external ports.

Command mode: Global configuration

`si-fabric sif-errup`

Turns on the ports that were disabled (`errdis`) during SI Fabric merger.

Command mode: Global configuration

`show boot staggered-upgrade`

Show status of staggered upgrade of the member switches in the SI Fabric.

Command mode: All

Appendix A. Getting help and technical assistance

If you need help, service, or technical assistance or just want more information about Lenovo products, you will find a wide variety of sources available from Lenovo to assist you.

Use this information to obtain additional information about Lenovo and Lenovo products, and determine what to do if you experience a problem with your Lenovo system or optional device.

Note: This section includes references to IBM web sites and information about obtaining service. IBM is Lenovo's preferred service provider for the System x, Flex System, and NeXtScale System products.

Before you call, make sure that you have taken these steps to try to solve the problem yourself.

If you believe that you require warranty service for your Lenovo product, the service technicians will be able to assist you more efficiently if you prepare before you call.

- Check all cables to make sure that they are connected.
- Check the power switches to make sure that the system and any optional devices are turned on.
- Check for updated software, firmware, and operating-system device drivers for your Lenovo product. The Lenovo Warranty terms and conditions state that you, the owner of the Lenovo product, are responsible for maintaining and updating all software and firmware for the product (unless it is covered by an additional maintenance contract). Your service technician will request that you upgrade your software and firmware if the problem has a documented solution within a software upgrade.
- If you have installed new hardware or software in your environment, check the IBM ServerProven website to make sure that the hardware and software is supported by your product.
- Go to the IBM Support portal to check for information to help you solve the problem.
- Gather the following information to provide to the service technician. This data will help the service technician quickly provide a solution to your problem and ensure that you receive the level of service for which you might have contracted.
  - Hardware and Software Maintenance agreement contract numbers, if applicable
  - Machine type number (if applicable–Lenovo 4-digit machine identifier)
  - Model number
  - Serial number
  - Current system UEFI and firmware levels
  - Other pertinent information such as error messages and logs

- Start the process of determining a solution to your problem by making the pertinent information available to the service technicians. The IBM service technicians can start working on your solution as soon as you have completed and submitted an Electronic Service Request.

You can solve many problems without outside assistance by following the troubleshooting procedures that Lenovo provides in the online help or in the Lenovo product documentation. The Lenovo product documentation also describes the diagnostic tests that you can perform. The documentation for most systems, operating systems, and programs contains troubleshooting procedures and explanations of error messages and error codes. If you suspect a software problem, see the documentation for the operating system or program.

Appendix B. Notices

Lenovo may not offer the products, services, or features discussed in this document in all countries. Consult your local Lenovo representative for information on the products and services currently available in your area.

Any reference to a Lenovo product, program, or service is not intended to state or imply that only that Lenovo product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any Lenovo intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any other product, program, or service.

Lenovo may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

Lenovo (United States), Inc.
1009 Think Place - Building One
Morrisville, NC 27560
U.S.A.

Attention: Lenovo Director of Licensing

LENOVO PROVIDES THIS PUBLICATION “AS IS” WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some jurisdictions do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. Lenovo may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

The products described in this document are not intended for use in implantation or other life support applications where malfunction may result in injury or death to persons. The information contained in this document does not affect or change Lenovo product specifications or warranties.

Nothing in this document shall operate as an express or implied license or indemnity under the intellectual property rights of Lenovo or third parties. All information contained in this document was obtained in specific environments and is presented as an illustration. The result obtained in other operating environments may vary.

Lenovo may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Any references in this publication to non-Lenovo Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this Lenovo product, and use of those Web sites is at your own risk.

Any performance data contained herein was determined in a controlled environment. Therefore, the result obtained in other operating environments may vary significantly. Some measurements may have been made on development-level systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurements may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

Trademarks

Lenovo, the Lenovo logo, Flex System, System x, NeXtScale System, and X-Architecture are trademarks of Lenovo in the United States, other countries, or both.

Intel and Intel Xeon are trademarks of Intel Corporation in the United States, other countries, or both.

Internet Explorer, Microsoft, and Windows are trademarks of the Microsoft group of companies.

Linux is a registered trademark of Linus Torvalds.

Other company, product, or service names may be trademarks or service marks of others.

Important Notes

Processor speed indicates the internal clock speed of the microprocessor; other factors also affect application performance.

CD or DVD drive speed is the variable read rate. Actual speeds vary and are often less than the possible maximum.

When referring to processor storage, real and virtual storage, or channel volume, KB stands for 1 024 bytes, MB stands for 1 048 576 bytes, and GB stands for 1 073 741 824 bytes.

When referring to hard disk drive capacity or communications volume, MB stands for 1 000 000 bytes, and GB stands for 1 000 000 000 bytes. Total user-accessible capacity can vary depending on operating environments.

Maximum internal hard disk drive capacities assume the replacement of any standard hard disk drives and population of all hard-disk-drive bays with the largest currently supported drives that are available from Lenovo.

Maximum memory might require replacement of the standard memory with an optional memory module.

Each solid-state memory cell has an intrinsic, finite number of write cycles that the cell can incur. Therefore, a solid-state device has a maximum number of write cycles that it can be subjected to, expressed as total bytes written (TBW). A device that has exceeded this limit might fail to respond to system-generated commands or might be incapable of being written to. Lenovo is not responsible for replacement of a device that has exceeded its maximum guaranteed number of program/erase cycles, as documented in the Official Published Specifications for the device.

Lenovo makes no representations or warranties with respect to non-Lenovo products. Support (if any) for the non-Lenovo products is provided by the third party, not Lenovo.

Some software might differ from its retail version (if available) and might not include user manuals or all program functionality.

Recycling Information

Lenovo encourages owners of information technology (IT) equipment to responsibly recycle their equipment when it is no longer needed. Lenovo offers a variety of programs and services to assist equipment owners in recycling their IT products. For information on recycling Lenovo products, go to:

http://www.lenovo.com/recycling

Particulate Contamination

Attention: Airborne particulates (including metal flakes or particles) and reactive gases acting alone or in combination with other environmental factors such as humidity or temperature might pose a risk to the device that is described in this document.

Risks that are posed by the presence of excessive particulate levels or concentrations of harmful gases include damage that might cause the device to malfunction or cease functioning altogether. This specification sets forth limits for particulates and gases that are intended to avoid such damage. The limits must not be viewed or used as definitive limits, because numerous other factors, such as temperature or moisture content of the air, can influence the impact of particulates or environmental corrosives and gaseous contaminant transfer. In the absence of specific limits that are set forth in this document, you must implement practices that maintain particulate and gas levels that are consistent with the protection of human health and safety. If Lenovo determines that the levels of particulates or gases in your environment have caused damage to the device, Lenovo may condition provision of repair or replacement of devices or parts on implementation of appropriate remedial measures to mitigate such environmental contamination. Implementation of such remedial measures is a customer responsibility..

Contaminant	Limits
Particulate	• The room air must be continuously filtered with 40% atmospheric dust spot efficiency (MERV 9) according to ASHRAE Standard 52.2[1]. • Air that enters a data center must be filtered to 99.97% efficiency or greater, using high-efficiency particulate air (HEPA) filters that meet MIL-STD-282. • The deliquescent relative humidity of the particulate contamination must be more than 60%[2]. • The room must be free of conductive contamination such as zinc whiskers.
Gaseous	• Copper: Class G1 as per ANSI/ISA 71.04-1985[3] • Silver: Corrosion rate of less than 300 Å in 30 days

[1] ASHRAE 52.2-2008 - *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

[2] The deliquescent relative humidity of particulate contamination is the relative humidity at which the dust absorbs enough water to become wet and promote ionic conduction.

[3] ANSI/ISA-71.04-1985. *Environmental conditions for process measurement and control systems: Airborne contaminants*. Instrument Society of America, Research Triangle Park, North Carolina, U.S.A.

Telecommunication Regulatory Statement

This product may not be certified in your country for connection by any means whatsoever to interfaces of public telecommunications networks. Further certification may be required by law prior to making any such connection. Contact a Lenovo representative or reseller for any questions.

Electronic Emission Notices

When you attach a monitor to the equipment, you must use the designated monitor cable and any interference suppression devices that are supplied with the monitor.

Federal Communications Commission (FCC) Statement

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Properly shielded and grounded cables and connectors must be used to meet FCC emission limits. Lenovo is not responsible for any radio or television interference caused by using other than recommended cables and connectors or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that might cause undesired operation.

Industry Canada Class A Emission Compliance Statement

This Class A digital apparatus complies with Canadian ICES-003.

Avis de Conformité à la Réglementation d'Industrie Canada

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

Australia and New Zealand Class A Statement

Attention: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

European Union - Compliance to the Electromagnetic Compatibility Directive

This product is in conformity with the protection requirements of EU Council Directive 2004/108/EC (until April 19, 2016) and EU Council Directive 2014/30/EU (from April 20, 2016) on the approximation of the laws of the Member States relating to electromagnetic compatibility. Lenovo cannot accept responsibility for

any failure to satisfy the protection requirements resulting from a non-recommended modification of the product, including the installation of option cards from other manufacturers.

This product has been tested and found to comply with the limits for Class A equipment according to European Standards harmonized in the Directives in compliance. The limits for Class A equipment were derived for commercial and industrial environments to provide reasonable protection against interference with licensed communication equipment.

Lenovo, Einsteinova 21, 851 01 Bratislava, Slovakia

CE

Warning: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Germany Class A Compliance Statement

Deutschsprachiger EU Hinweis:

Hinweis für Geräte der Klasse A EU-Richtlinie zur Elektromagnetischen Verträglichkeit

Dieses Produkt entspricht den Schutzanforderungen der EU-Richtlinie 2014/30/EU (früher 2004/108/EC) zur Angleichung der Rechtsvorschriften über die elektromagnetische Verträglichkeit in den EU-Mitgliedsstaaten und hält die Grenzwerte der Klasse A der Norm gemäß Richtlinie.

Um dieses sicherzustellen, sind die Geräte wie in den Handbüchern beschrieben zu installieren und zu betreiben. Des Weiteren dürfen auch nur von der Lenovo empfohlene Kabel angeschlossen werden. Lenovo übernimmt keine Verantwortung für die Einhaltung der Schutzanforderungen, wenn das Produkt ohne Zustimmung der Lenovo verändert bzw. wenn Erweiterungskomponenten von Fremdherstellern ohne Empfehlung der Lenovo gesteckt/eingebaut werden.

Deutschland:

Einhaltung des Gesetzes über die elektromagnetische Verträglichkeit von Betriebsmittein

Dieses Produkt entspricht dem "Gesetz über die elektromagnetische Verträglichkeit von Betriebsmitteln" EMVG (früher "Gesetz über die elektromagnetische Verträglichkeit von Geräten"). Dies ist die Umsetzung der EU-Richtlinie 2014/30/EU (früher 2004/108/EC) in der Bundesrepublik Deutschland.

Zulassungsbescheinigung laut dem Deutschen Gesetz über die elektromagnetische Verträglichkeit von Betriebsmitteln, EMVG vom 20. Juli 2007 (früher Gesetz über die elektromagnetische Verträglichkeit von Geräten), bzw. der EMV EU Richtlinie 2014/30/EU (früher 2004/108/EC), für Geräte der Klasse A.

Dieses Gerät ist berechtigt, in Übereinstimmung mit dem Deutschen EMVG das EG-Konformitätszeichen - CE - zu führen. Verantwortlich für die Konformitätserklärung nach Paragraf 5 des EMVG ist die Lenovo (Deutschland) GmbH, Meitnerstr. 9, D-70563 Stuttgart.

Informationen in Hinsicht EMVG Paragraf 4 Abs. (1) 4:

Das Gerät erfüllt die Schutzanforderungen nach EN 55024 und EN 55022 Klasse A.

Nach der EN 55022: "Dies ist eine Einrichtung der Klasse A. Diese Einrichtung kann im Wohnbereich Funkstörungen verursachen; in diesem Fall kann vom Betreiber verlangt werden, angemessene Maßnahmen durchzuführen und dafür aufzukommen."

Nach dem EMVG: "Geräte dürfen an Orten, für die sie nicht ausreichend entstört sind, nur mit besonderer Genehmigung des Bundesministers für Post und Telekommunikation oder des Bundesamtes für Post und Telekommunikation betrieben werden. Die Genehmigung wird erteilt, wenn keine elektromagnetischen Störungen zu erwarten sind." (Auszug aus dem EMVG, Paragraph 3, Abs. 4). Dieses Genehmigungsverfahrenist nach Paragraph 9 EMVG in Verbindung mit der entsprechenden Kostenverordnung (Amtsblatt 14/93) kostenpflichtig.

Anmerkung: Um die Einhaltung des EMVG sicherzustellen sind die Geräte, wie in den Handbüchern angegeben, zu installieren und zu betreiben.

Japan VCCI Class A Statement

この装置は、クラス A 情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。 VCCI–A

This is a Class A product based on the standard of the Voluntary Control Council for Interference (VCCI). If this equipment is used in a domestic environment, radio interference may occur, in which case the user may be required to take corrective actions.

Japan Electronics and Information Technology Industries Association (JEITA) Statement

高調波ガイドライン適合品

Japan Electronics and Information Technology Industries Association (JEITA) Confirmed Harmonics Guidelines (products less than or equal to 20 A per phase)

高調波ガイドライン準用品

Japan Electronics and Information Technology Industries Association (JEITA) Confirmed Harmonics Guidelines with Modifications (products greater than 20 A per phase).

Korea Communications Commission (KCC) Statement

이 기기는 업무용(A급)으로 전자파적합기기로
서 판매자 또는 사용자는 이 점을 주의하시기
바라며, 가정외의 지역에서 사용하는 것을 목
적으로 합니다.

This is electromagnetic wave compatibility equipment for business (Type A).
Sellers and users need to pay attention to it. This is for any areas other than home.

Russia Electromagnetic Interference (EMI) Class A statement

ВНИМАНИЕ! Настоящее изделие относится к классу А.
В жилых помещениях оно может создавать радиопомехи, для снижения которых необходимы дополнительные меры

People’s Republic of China Class A electronic emission statement

中华人民共和国“A类”警告声明

声 明

此为A级产品，在生活环境中，该产品可能会造成无线电干扰。在这种情况下，可能需要用户对其干扰采取切实可行的措施。

Taiwan Class A compliance statement

警告使用者:
這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。

Lenovo

Printed in USA