

Virtual Chassis Technology Best Practices

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Introduction

Juniper Networks Virtual Chassis technology is a feature of select Juniper Networks® EX Series and QFX Series Ethernet Switches, allowing the interconnection and operation of multiple switches as a unified, single, high-bandwidth device. Depending on the model, up to 10 switches may be interconnected through ports that are configured as Virtual Chassis ports.

Virtual Chassis technology is supported on the following platforms. Please refer to Juniper technical documentation for the latest support information.

- EX2200 Ethernet Switch
- EX3300 Ethernet Switch
- EX4200 Ethernet Switch
- EX4300 Ethernet Switch
- EX4550 Ethernet Switch
- EX4600 Ethernet Switch
- QFX3500 Switch
- QFX3600 Switch
- QFX5100 Switch

Solutions that use Virtual Chassis technology combine the scalability and compact form factor of standalone switches with the high availability, high backplane bandwidth characteristics and high port densities of traditional chassis-based switches. Virtual Chassis configurations enable economical deployments of switches that deliver network availability in locations where installation might otherwise be cost prohibitive or physically impossible.

In a Virtual Chassis configuration, all member switches are managed and monitored as a single logical device. This approach simplifies network operations, allows the separation of placement and logical groupings of physical devices, and provides efficient use of resources. The Virtual Chassis solution offers the same Routing Engine (RE) redundancy features as other Juniper Networks chassis-based switches and routers, including graceful Routing Engine switchover (GRES) for hitless failover.

For resiliency and redundancy, Virtual Chassis configurations include a master and a backup switch, both dynamically elected as part of the Virtual Chassis deployment process. Each remaining switch serves as a line card, but is ready to be selected as a backup switch if the master or backup switch fails. Switches may also be selectively prioritized in a Virtual Chassis configuration to assign master and backup roles, and to determine the order in which the remaining switches are elected if the master and backup switches fail.

Virtual Chassis configuration management is performed through the master switch. A Virtual Management Ethernet (VME) interface allows remote management by connecting to the out-of-band management port of any member switch through a single IP address.

In addition, the Virtual Chassis configuration uses a single Juniper Networks Junos® operating system image file and a single configuration file. The Junos OS of all member switches in a Virtual Chassis configuration can be upgraded simultaneously from the master switch with a single command.

Key benefits of Virtual Chassis technology include:

- Simplified overall system maintenance and management through a single management interface
- Pay-as-you-grow scalability, from 24 to 480 10/100/1000 Mbps ports
- Extension of the Virtual Chassis configuration by several kilometers
- Consistent modular Junos OS control plane feature implementation
- Dual REs with GRES

Figure 1 illustrates a typical Virtual Chassis configuration using five EX4300 switches.



Figure 1: Virtual Chassis configuration

Scope

This best practices implementation guide provides information about Juniper's Ethernet switches with Virtual Chassis technology. It describes this technology, explains key concepts, and provides information about designing, operating, maintaining, and managing a Virtual Chassis configuration. This document does not attempt to capture all configuration options and features specific to platforms. Please refer to product-specific documentation for detailed feature support. This document primarily focuses on Virtual Chassis support in EX Series switches. It is intended for system engineers, system administrators, and others who have the technical background required to understand, position, and/or deploy Virtual Chassis technology. For platform-specific information that is the focus of this guide, please refer to the Appendix. For up-to-date support information, refer to Juniper documentation.

Virtual Chassis Technology Concepts

The following sections provide an overview of Virtual Chassis technology concepts.

Virtual Chassis Ports

A Virtual Chassis configuration consists of between 2 and 10 switches connected together through Virtual Chassis ports (VCPs). Configurations can range from a deployment in which each switch is physically colocated, to a deployment in which switches are separated by several kilometers. Each switch within a Virtual Chassis configuration is a member of that Virtual Chassis.

Legacy platforms like EX4200 and EX4550 use dedicated Virtual Chassis ports, which will be used as the primary VCPs. You will need a Juniper Virtual Chassis cable to connect these dedicated VCPs. These platforms also provide the ability to configure one of the small form-factor pluggable transceiver or SFP plus transceiver (SFP/SFP+) ports as extended Virtual Chassis ports, enabling Virtual Chassis deployments to extend across several kilometers where necessary.

Platforms like the EX2200, EX3300, EX4300, EX4600, and QFX5100 do not have dedicated VCPs. Depending on the platform, you can configure the SFP, SFP+, or quad small form-factor pluggable plus transceiver (QSFP+) ports as VCPs.



Figure 2: Virtual Chassis ports on an EX4200 switch rear panel

Extended Virtual Chassis Ports

When Virtual Chassis members are spread across a geographic region, Virtual Chassis members can be interconnected via 1GbE, 10GbE, or 40GbE ports. These ports can be configured to function as VCPs and are often called extended Virtual Chassis ports. The extended Virtual Chassis port concept is only applicable for platforms that have dedicated VCPs like the EX4200 and EX4550.

Virtual Chassis Port LAG

You can combine physical Ethernet ports belonging to different member switches of a Virtual Chassis configuration to form a logical point-to-point link, known as a *link aggregation group (LAG)* or *bundle*. A LAG provides more bandwidth than a single Ethernet link can provide. Additionally, link aggregation provides network redundancy by load-balancing traffic across all available links. If one of the links fails, the system automatically load-balances traffic across all remaining links.

When two switches are interconnected using multiple VCPs, the ports form a LAG bundle automatically. This enables effective bandwidth utilization on the backplane and also provides link-level redundancy for VCPs. On dual-PFE systems, if the VCPs are on different PFEs, they will not form a LAG.

Local Link Bias

When local link bias is disabled, egress traffic exiting a Virtual Chassis on a LAG bundle can be forwarded out of any member link in the LAG bundle. Traffic forwarding decisions are made by an internal algorithm that attempts to load-balance traffic between the member links in the bundle. VCP bandwidth is frequently consumed by egress traffic when local link bias is disabled because the egress traffic traverses the VCPs to reach the destination egress member link in the LAG bundle.

Local link bias conserves bandwidth on VCPs by using local links to forward unicast traffic exiting a Virtual Chassis that has a LAG bundle composed of member links on different member switches in the same Virtual Chassis configuration. A local link is a member link in the LAG bundle that is on the member switch that received the traffic. Because traffic is received and forwarded on the same member switch when local link bias is enabled, no VCP bandwidth is consumed by traffic traversing the VCPs to exit the Virtual Chassis using a different member link in the LAG bundle.

Local link bias only impacts the forwarding of unicast traffic exiting a Virtual Chassis configuration. Ingress traffic handling is not impacted by the local link bias setting. Egress multicast, unknown unicast, and broadcast traffic exiting a Virtual Chassis configuration over a LAG bundle are also not impacted by the local link bias setting and are always load-balanced among the member links. Local link bias is disabled by default.

Mixed Virtual Chassis

A mixed Virtual Chassis deployment includes two or more types of EX Series switches, two or more types of QFX Series switches, or a mix of EX Series and QFX Series switches. Table 1 shows the switch models that support Virtual Chassis and the roles they play in a mixed Virtual Chassis configuration—RE or line card (LC).

Table 1: Supported Switches in Mixed Virtual Chassis Configurations

	EX4600 (RE)	EX4300 (RE)	EX4550 (RE)	EX4200 (RE)	EX3300 (RE)	EX2200 (RE)	QFX5100 (RE)	QFX3600 (RE)	QFX3500 (RE)
EX2200 (LC)	No	No	Yes	Yes	No	Yes	No	No	No
EX3300 (LC)	No	No	Yes	Yes	Yes	No	No	No	No
EX4200 (LC)	No	No	Yes	Yes	No	No	No	No	No
EX4300 (LC)	Yes	Yes	No	No	No	No	Yes	No	No
EX4550 (LC)	No	No	Yes	No	No	No	No	No	No
EX4600 (LC)	Yes	No	No	No	No	No	No	No	No
QFX3500 (LC)	No	No	No	No	No	No	Yes	Yes	Yes
QFX3600 (LC)	No	No	No	No	No	No	Yes	Yes	Yes
QFX5100 (LC)	No	No	No	No	No	No	Yes	No	No

Virtual Chassis Member Roles

Each member in a Virtual Chassis configuration is assigned a specific role. A role determines the functions the member performs in the configuration.

One member is assigned the master role and is responsible for managing other members in the Virtual Chassis configuration. One member is assigned the backup role and takes over the master role if the master switch fails. All other members are assigned the line-card role. The system executes a mastership election algorithm to determine member roles. For more detailed information, please see the "Mastership Election Process" section.

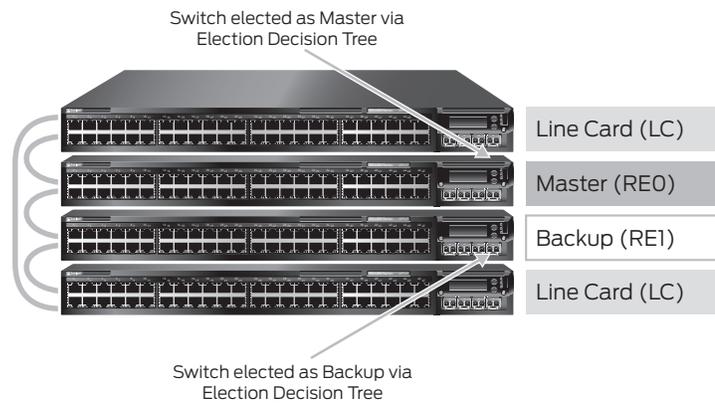


Figure 3: Member roles in a Virtual Chassis configuration

Master Role

The member switch that operates in the master role in a Virtual Chassis configuration has full control over the system. It performs the following functions:

- Serves as the active Routing Engine for the Virtual Chassis configuration
- Manages member switches in the Virtual Chassis configuration
- Runs Junos OS for the Virtual Chassis configuration
- Runs the chassis management processes and network control protocols
- Calculates and maintains the forwarding table and distributes it to the local CPU, and then to Packet Forwarding Engines (PFEs) in all member switches
- Receives and transmits routing information
- Represents all member switches (the hostname and other properties that are assigned to the master switch during setup apply to all members of the Virtual Chassis configuration)
- Holds the active and master copy of the entire Virtual Chassis configuration (copies of the active configuration can also be synchronized to all member switches by using the commit sync command-line interface (CLI) command)

Backup Role

The member switch that functions in the backup role in a Virtual Chassis configuration performs the following functions:

- Serves as the backup RE for the Virtual Chassis configuration
- Maintains synchronization with the master switch so that it can take over the master role if the master fails
- Runs Junos OS for EX Series switches in a backup role
- Synchronizes with the master switch protocol states, forwarding table, and other configurations so that it is prepared to preserve forwarding information and maintain network connectivity with no or minimal disruption if the master switch becomes unavailable

Line Card Role

Each member that functions in a line-card role in a Virtual Chassis configuration performs the following functions:

- Runs Junos OS for EX Series switches in a line-card role
- Detects switch error conditions, such as an unplugged cable, on any interfaces that have been configured on it through the master switch and relays this information to the master switch
- Receives updates about forwarding information from the master switch and programs these updates into the local PFE

A Virtual Chassis member in a line-card role does not run full network control protocols while in that role. However, if a master or backup switch fails, one of the line-card switches takes over the backup role (based on the election process that the “Mastership Election Process” section describes).

A Virtual Chassis configuration must have at least three member switches to have a line-card switch.

Mastership Priority Setting

The role (master, backup, or line card) that a member switch performs within the Virtual Chassis configuration can be determined by configuring its mastership priority from 1 to 255. (For information about a preprovisioned configuration, please see the "[Preprovisioned Method](#)" section.) By default, switches have the default mastership priority value of 128.

The role of the switches in the Virtual Chassis can be determined either using the non-provisioned method or the preprovisioned method.

- Non-provisioned method: The master sequentially assigns a member ID to other member switches. The role is determined by the mastership priority value and other factors in the master election algorithm.
- Preprovisioned method: Deterministically control the member ID and role assigned to a member switch by tying the member switch to its serial number.

Note: Wherever possible, we recommend using the preprovisioned method for adding member switches to the Virtual Chassis configuration.

Non-Provisioned Method

Mastership Election Process

When a Virtual Chassis configuration boots, the Junos OS automatically runs the mastership election process to determine which member switches take the role of master, backup, and line cards. All Virtual Chassis member switches participate in the election process. If a master switch fails, the backup switch automatically and immediately takes on the master role, which minimizes interruption to the operation of the Virtual Chassis configuration. The system subsequently runs the mastership election process to elect one of the line-card switches as the new backup switch. (The system also runs this process if the backup switch fails.)

The election algorithm follows the sequence below to assign member roles and elect a master and a backup switch. The master role is assigned to the switch with the highest ranking. The backup role is assigned to the switch with the second highest ranking. Other switches become line cards.

1. Choose the member with the highest user-configured mastership priority. (One is the lowest and 255 is the highest possible value; please see the "[Mastership Priority Setting](#)" section for more information.)
2. Choose the member that was the master switch the last time the Virtual Chassis configuration booted.
3. In a Virtual Chassis configuration merge scenario, choose the master member that has the highest number of current members in the existing Virtual Chassis configuration. (A merge scenario occurs when two active Virtual Chassis configurations, each with its own master, are combined.)
4. Choose the member that has been included in the Virtual Chassis configuration the longest. (For this factor to be considered, there must be a lapse of at least one minute between the power-on of each interconnected member switch.)
5. Choose the member with the lowest media access control (MAC) address.

If you want to ensure that a specific member is elected as the master switch during initial Virtual Chassis installation, follow these steps:

1. Power on only the switch you want to configure as master of the Virtual Chassis configuration.
2. Configure the mastership priority of that switch to have the highest possible value (255).
3. Without connecting to the master switch, power on all other member switches individually and reset their configurations to factory-default values either through the front LCD menu or by using the following configuration mode CLI command:

```
user@host# load factory-default
```

4. Connect all other members to the master switch while they are powered off.
5. Power on the other member switches.
6. Configure other member switches through the master switch, as desired. These member switches default to a mastership priority of 128 if no previous configuration exists.

Note: We recommend the following guidelines for assigning mastership priority in a non-provisioned Virtual Chassis configuration:

- Specify the same mastership priority value for the master and backup switches in a Virtual Chassis configuration. Doing so helps ensure a smooth transition from master to backup if the master switch becomes unavailable. This configuration also prevents the original master switch from retaking control from the backup switch when the original master switch comes back online, a situation sometimes referred to as flapping or preemption, which reduces the efficiency of system operation.

- Configure the highest possible mastership priority value (255) for the master and backup switches. This configuration ensures that these members continue to function as the master and backup even when new members are added to the Virtual Chassis configuration.

Member ID Numbering

Each switch is a potential member of a Virtual Chassis configuration. When a switch powers on, it receives a member ID (which is displayed on its front-panel LCD). If the switch powers on as a standalone switch, its member ID is 0. When the switch interconnects with other switches in a Virtual Chassis configuration, the master switch assigns a member ID (0 through 9) to the switch. The member ID is based on a variety of factors, including the order in which the switch was added to the Virtual Chassis configuration. As each switch is added and powered on, it receives the next available (unused) member ID.

The member ID distinguishes member switches from one another and is used to:

- Assign a mastership priority value to a member switch.
- Configure interfaces for a member switch (a function that is similar to a slot number on Juniper's chassis-based routers and switches).
- Apply various operational commands to a member switch.
- Display status or characteristics of a member switch.

Note: Members can be physically located in any order in a Virtual Chassis configuration. They do not need to be placed in order of member ID.

Figure 4 illustrates member ID assignments in a Virtual Chassis configuration with five members.

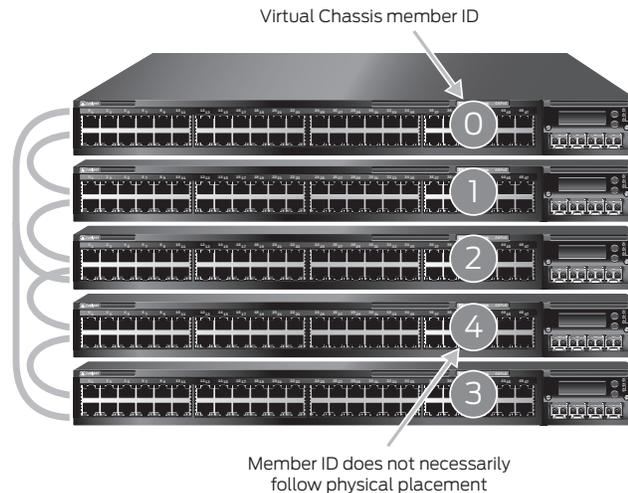


Figure 4: Member ID assignments

Member ID assignments follow these guidelines:

- When a Virtual Chassis member reboots, it retains its member ID.
- The member ID of a switch that is removed from a Virtual Chassis configuration is not released automatically to the available member ID pool.
- If the Virtual Chassis configuration previously included a member switch and that member was physically disconnected or removed from the Virtual Chassis, its member ID is not automatically available for re-assignment by the master switch. For example, consider a Virtual Chassis configuration that is composed of member 0, member 2, and member 3 because member 1 was removed. When you add another member switch and power it on, the master switch assigns it a member ID of 4.
- A replacement switch is treated as a new addition to the Virtual Chassis configuration and receives the next lowest available member ID.
- You can use the following operational mode CLI command to manually configure the member ID of a device. Replace <current-member-id> with the existing member ID of the device, and replace <new-member-id> with the member ID that you want to assign to the device.

```
user@host> request virtual-chassis renumber member-id <current-member-id>
new-member-id <new-member-id>
```

- You can use the following CLI command to return a member ID that was previously used but is no longer assigned to any active member to the member ID pool. Replace <current-member-id> with the desired member ID.

```
user@host> request virtual-chassis recycle member-id <current-member-id>
```

Preprovisioned Method

A preprovisioned configuration allows you to deterministically control the member ID and role assigned to a member switch by associating the switch with its serial number. A preprovisioned configuration file links the serial number of each switch to a designated member ID and role. The serial number must be specified in the configuration file for the member to be recognized as part of the Virtual Chassis configuration.

In this configuration, you must select two members you want to be eligible for election as the master and backup switches. When you list these two members in the preprovisioned configuration, you designate the member role as Routing Engine. One member then functions as the master switch of the Virtual Chassis configuration and the other functions as the backup switch.

Other members not eligible for election as the master or backup switch can be specified as line cards in the preprovisioned configuration.

The preprovisioned configuration offers the option of not explicitly assigning a role to a member switch. This is the same as configuring the switch as a line card, so it will not be eligible for election as the master or backup switch.

In a preprovisioned configuration:

- A switch member can be explicitly configured as a Routing Engine and can then become either master or backup, depending on the results of the master election process.
- You can explicitly configure a member with the role of line card, which makes it ineligible to function as a master or backup switch.
- A member that is not explicitly assigned a role is ineligible to become either the master or the backup switch.
- The mastership priority value is assigned by the switch software based on the specified role:
 - A line-card switch is assigned a mastership priority of 0, making it ineligible to participate in the master election.
 - A switch that is not explicitly assigned a role is assigned a mastership priority of 0, making it ineligible to participate in the master election.

Note: You cannot modify the mastership priority when you are using a preprovisioned configuration. The mastership priority values are generated automatically and controlled by the role assigned to the member switch in the configuration file. The two REs are assigned the same mastership priority value. However, the member that was powered on first has a higher prioritization according to the master election algorithm.

Graceful Routing Engine Switchover

Graceful Routing Engine switchover (GRES) may be configured in a Virtual Chassis configuration. GRES automatically maintains the master switch's kernel states and forwarding state information and copies it to the backup switch to minimize any interruption to network communications should the master go offline. When GRES is configured, the backup switch automatically synchronizes with the master switch to preserve kernel state and forwarding state information. Any kernel updates to the master switch are replicated on the backup switch. If the kernel on the master switch stops operating, if the master switch experiences a hardware failure, or if a manual switchover occurs, the backup switch gracefully assumes the master role.

When GRES is disabled and the backup switch assumes the master role in a redundant failover configuration, the PFEs reinitialize to boot-up state before they connect to the new master switch. In a graceful switchover configuration, the PFEs do not reinitialize their state. Instead, they resynchronize their states with the new master switch to minimize data traffic interruption.

Nonstop Active Routing

Nonstop active routing (NSR) provides a mechanism for transparently switching over the REs without necessitating restart of supported routing protocols. Both Routing Engines are fully active in processing protocol sessions, so each can take over for the other. The switchover is transparent to neighbors.

Nonstop Bridging

Nonstop bridging (NSB) provides resilience for Layer 2 protocol sessions on a Virtual Chassis configuration with redundant Routing Engines. NSB operates by synchronizing all protocol information for NSB-supported Layer 2 protocols between the master and backup REs. If the switch has a Routing Engine switchover, the NSB-supported Layer 2 protocol sessions remain active because all session information is already synchronized to the backup RE. Traffic disruption for the NSB-supported Layer 2 protocol is minimal or nonexistent as a result of the switchover. The RE switchover is transparent to neighbor devices, which do not detect any changes related to the NSB-supported Layer 2 protocol sessions on the switch.

Forwarding Path

A Virtual Chassis configuration uses an internal shortest path forwarding algorithm to determine the path for routing packets internally through the member switches. When a Virtual Chassis is deployed, its Virtual Chassis Control Protocol (VCCP) builds a forwarding table that includes information about each switch component and its location. From this table, the system determines the shortest forwarding path for data between the ingress port and the egress port in a Virtual Chassis configuration.

Note: When you have multiple paths between two switches that are not part of a single LAG bundle (different port speeds), the traffic will not be load-balanced across the two paths. Only one of the paths is used at any given time.

Virtual Chassis Control Protocol

VCCP automatically discovers and maintains Virtual Chassis neighbors, and it floods Virtual Chassis topology information that permits shortest-path switching between member switches using either internal or external (Virtual Chassis trunk) switch paths. VCCP detects and reacts to changes in the Virtual Chassis topology because of switch or Virtual Chassis backbone failures. VCCP uses a link metric that's scaled to interface speed when calculating its shortest-path-first (SPF) tree. Load balancing is not supported; a single best path is installed for each known destination, even though multiple equal-cost paths may exist. VCCP detects and reacts to changes in the Virtual Chassis topology related to switch or Virtual Chassis backbone failures. VCCP uses hello interval (default 1 second) and detects when a neighbor is down if it loses 10 consecutive hellos. It is important to note that hello timeouts are the last means of Virtual Chassis link failure detection; usually link failures and hardware failures are detected by hardware interrupt in PFE or other daemons.

Fast Failover

The Virtual Chassis [fast failover feature](#) is a hardware-assisted failover mechanism that automatically reroutes traffic and reduces traffic loss in the event of a link or switch failure in a Virtual Chassis. If a link between two members fails, traffic flow between those members must be rerouted quickly so that there is minimal traffic loss.

When fast failover is activated, each VCP is automatically configured with a backup port of the same type. If a VCP fails, its backup port is used to send traffic. These backup ports act as standby ports and are not meant for load-balancing traffic or any other purposes.

For fast failover to be effective, Virtual Chassis members must be configured in a ring topology. The ring topology can be formed by using either dedicated VCPs or user-configured uplink VCPs. Fast failover is also supported in a Virtual Chassis configuration that consists of multiple rings. Fast failover is supported only in a ring topology that uses identical port types—for example, either a topology that uses all dedicated VCPs or one that uses all uplink VCPs. Fast failover is not supported in a ring topology that includes both dedicated VCPs and uplink VCPs.

Software Compatibility

A Virtual Chassis configuration can include a mix of switch models provided they all run the same software version as the master switch. Please refer to the Appendix for switch model combinations that are supported in mixed Virtual Chassis configurations.

When a member switch is added to a Virtual Chassis configuration, the master switch checks the compatibility of the Junos OS version running on the new switch. If the switch is running a different software version, it obtains a member ID from the master switch but does not become a functional member of the Virtual Chassis configuration and does not forward data packets.

The required software package should be downloaded to the master switch in the Virtual Chassis configuration. Then the new member switch can be upgraded to the stored software version using the following CLI command. This command downloads the image from the master switch through the Virtual Chassis ports to the specified member and then reboots the member. The member does not need to be directly connected to the master switch.

```
request system software add <package location> member <member-id> reboot
```

Automatic Software Update

For a standalone switch to join an existing Virtual Chassis configuration, it must be running the same version of Junos OS that is running on the master. When the master detects that a new switch has been added to the configuration, it checks the software version on the new switch; if the software is not the same as the version running on the master, the new switch is kept in an inactive state. An automatic software update feature, if enabled, allows you to automatically update the software version on new member switches as they are added, so they can join the Virtual Chassis.

```
set virtual-chassis auto-sw-update <platform> package-name <package-name>
```

There are some cases (related to the Junos OS version) where the automatic software update feature might not work. Please check Junos OS documentation for more details.

Nonstop Software Upgrade

Nonstop software upgrade (NSSU) lets you upgrade the software running on an EX Series-based Virtual Chassis configuration with a single command and minimal disruption to network traffic.

Performing an NSSU provides these benefits:

- No disruption to the control plane: NSSU takes advantage of GRES and NSR to ensure no disruption to the control plane. During the upgrade process, interface, kernel, and routing protocol information are preserved.
- Minimal disruption to data traffic: NSSU upgrades member switches one at a time, permitting traffic to continue flowing through members that are not being upgraded.

To achieve minimal traffic disruption, you must configure LAGs such that the member links of each reside on different line cards or Virtual Chassis members. When the link on one member is down, the remaining links are up, and traffic continues to flow through the LAG.

When you request NSSU on a Virtual Chassis:

- The Virtual Chassis master verifies that:
 - The backup is online and running the same software version.
 - GRES and NSR are enabled.
 - The Virtual Chassis has a preprovisioned configuration.
- The master installs the new software image on the backup and reboots it.
- The master resynchronizes the backup.
- The master installs the new software image on member switches that are in the line-card role and reboots them, one at a time. The master waits for each member to come online and be activated before starting the software upgrade on the next member.
- Once all members in the line-card role have been upgraded, the master performs a GRES and the upgraded backup becomes the master.
- The software on the original master is upgraded and the original master is automatically rebooted. After the original master has rejoined the Virtual Chassis, you can optionally return control to it by requesting a GRES.

Please refer to the documentation on NSSU support for different releases.

Feature Licenses in Virtual Chassis

When deployed in a Virtual Chassis configuration, Enhanced, Advanced, or Media Access Control Security (MACsec) feature licenses are required only for the Routing Engines. If there are 10 switches in a Virtual Chassis configuration with two REs, only two feature licenses are required.

Design Considerations

The following sections describe design considerations of a Virtual Chassis configuration. These sections include information about cabling Virtual Chassis members together, appropriate number of members, and link aggregation across Virtual Chassis members.

How Many Members Should a Virtual Chassis Configuration Have?

A Virtual Chassis configuration may include between 2 and 10 switches. When selecting the appropriate number of switches for a deployment, there are a number of factors to consider, including port density, resiliency requirements, and system cost.

In general, a Virtual Chassis configuration in which ports are distributed across multiple switches provides higher availability. However, increasing the number of switches also increases cost and space requirements. For example, assume that you want to deploy a system that includes 96 ports. Options for this system include the following:

Option 1:

- Two EX4300-48P switches—one switch serving in the master role and one switch serving in the backup role.
 - Advantage: Compact footprint; cost-effective
 - Disadvantage: Loss of one switch affecting 50 percent of users

Option 2:

- Four EX4300-24P switches—one switch serving in the master role, one switch serving in the backup role, and two switches serving as line cards.
 - Advantage: Higher availability as the loss of one switch only affects 25 percent of users; does not affect uplinks if the failed switch did not include any uplinks
 - Disadvantage: Increased space, power, and cost

Location of Master and Backup Switches

When selecting the physical placement of members in a Virtual Chassis configuration, consider the following guidelines. These guidelines are intended to ensure the lowest probability of a severe fault bringing down both the master and backup switches. The guidelines also ensure a high probability that, if a Virtual Chassis configuration splits, the master and backup switches fall into different parts, and each part has at least half the original Virtual Chassis members. (A Virtual Chassis split is a situation that may occur as the result of a double failure in a Virtual Chassis configuration ring topology.)

Master and backup switches should be evenly spaced by member hop in a Virtual Chassis configuration. Place the master and backup switches in separate locations, if the switches are distributed across locations. (Please see Figure 7 for an example, and note the multiple uplink ports configured as Virtual Chassis ports for added bandwidth and link redundancy.)

Figure 5 illustrates the recommended location of the master and backup switches in a daisy-chained ring cabling configuration.

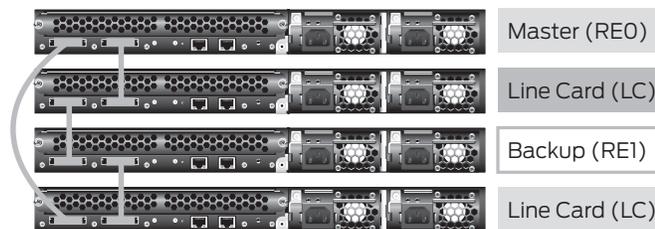


Figure 5: Recommended member location in a daisy-chained ring deployment

Figure 6 illustrates the recommended location of the master and backup switches in a braided-ring cabling configuration.



Figure 6: Recommended member location in a braided-ring deployment

Figure 7 illustrates the recommended location of the master and backup switches in an extended Virtual Chassis configuration. The top switch is connected to the bottom switch in each stack for added bandwidth and redundancy.

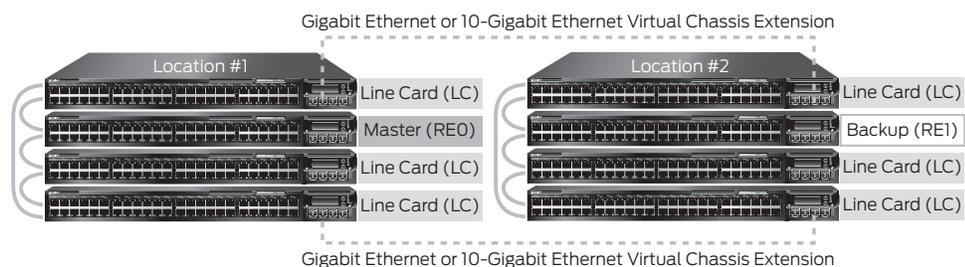


Figure 7: Recommended member location in a physically distributed deployment

Virtual Chassis Topologies

The following figures show the Virtual Chassis topologies that can be deployed based on specific user requirements. A single ring topology is the most commonly deployed topology, but Virtual Chassis configurations can also be deployed in full mesh or multiple ring topologies. When deploying Virtual Chassis in mixed mode, single ring is the recommended topology.

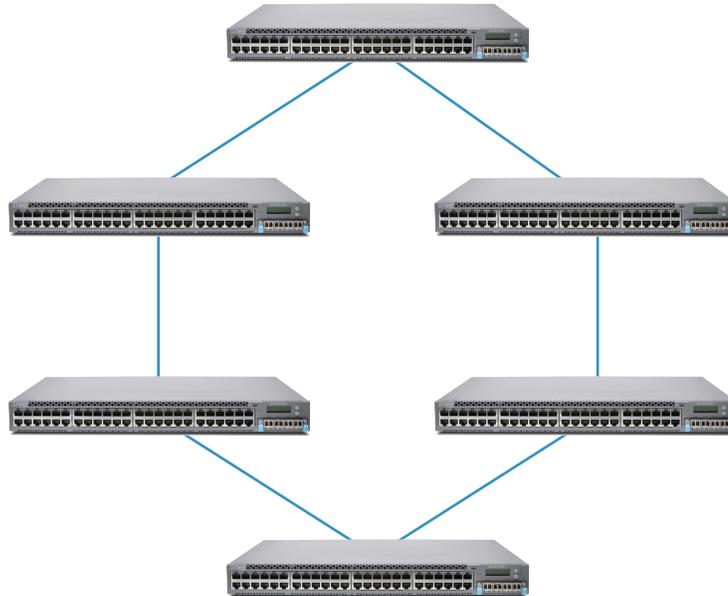


Figure 8: Single ring topology

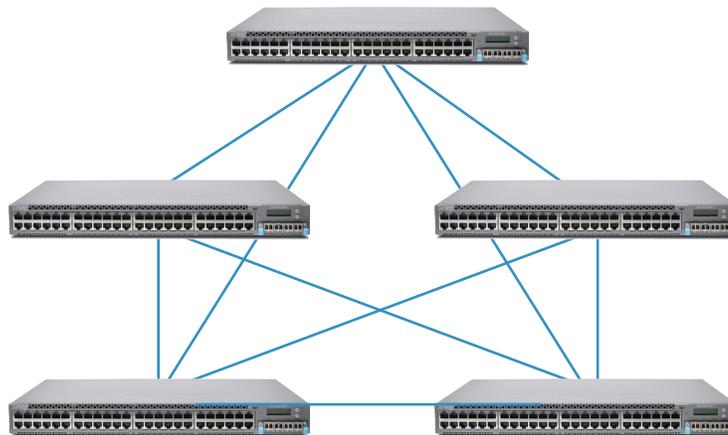


Figure 9: Full mesh topology

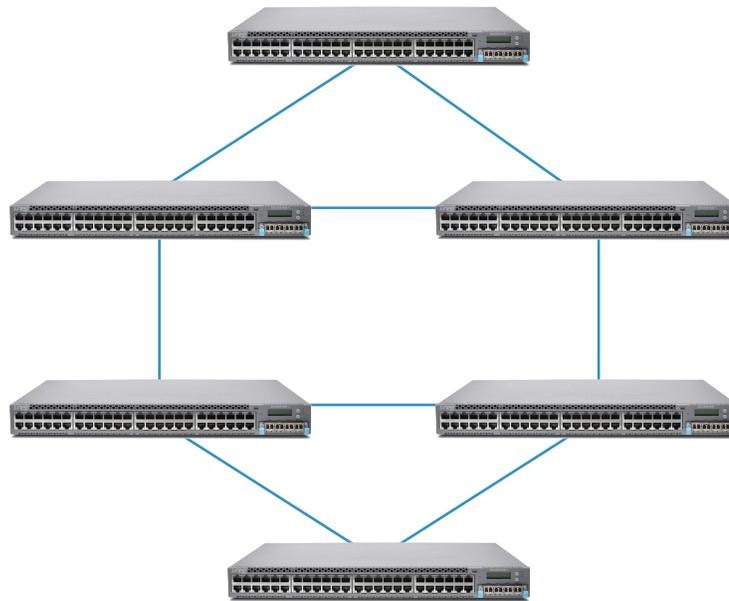


Figure 10: Multiple rings topology

Cabling Options

The physical placement of switches as part of a Virtual Chassis configuration is flexible. Possible deployments include members in a single rack, across several racks, in the same wiring closet, and spanning wiring closets across floors, buildings, and facilities. You can use the following for interconnecting Virtual Chassis ports based on platforms:

- Virtual Chassis Port Cable (EX4200/EX4550)
- Direct attach copper (DAC) cable
- SFP+ or QSFP+ ports with regular fiber-optic cables

Daisy-chained ring, braided ring, or extended configurations are some of the commonly deployed Virtual Chassis interconnected designs. The following sections describe each method.

Daisy-Chained Ring

In the daisy-chained ring configuration, each device in the Virtual Chassis configuration is connected to the device immediately adjacent to it. In addition, members at the end of the Virtual Chassis configuration are connected to each other to complete the ring topology.

The daisy-chained ring configuration provides a simple and intuitive method for interconnecting devices. The maximum height or breadth of the Virtual Chassis is 5 meters if you are using dedicated VCPs on EX4200 and EX4550; this limitation does not apply to platforms that do not have a dedicated VCP.

Figure 11 illustrates the daisy-chained ring cabling method.

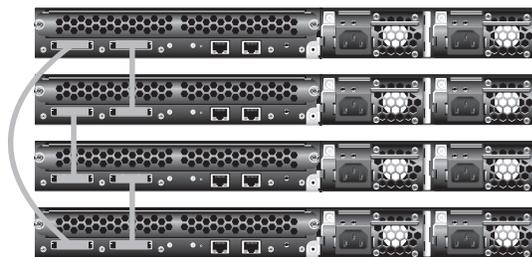


Figure 11: Dedicated Virtual Chassis daisy-chained ring

Braided-Ring Cabling

In a braided-ring cabling configuration, alternating devices are connected to each other. In addition, the two device pairs at each end of the Virtual Chassis configuration are directly connected to each other to complete the ring topology. Connections between devices can use either VCP on the back of a device.

DAC cables come in fixed lengths and are only a few meters long. In this case, braided-ring cabling methods increase space across which Virtual Chassis members can be distributed.

Figure 12 illustrates the braided-ring cabling method.

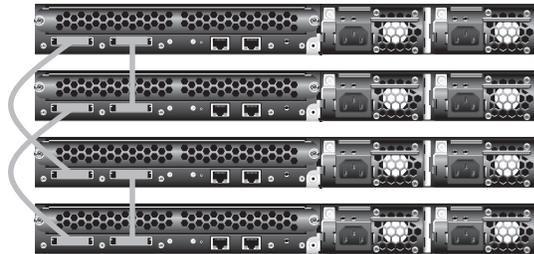


Figure 12: Dedicated Virtual Chassis braided-ring cabling

Extended Virtual Chassis Configuration

Extended Virtual Chassis configuration allows the interconnection of individual Virtual Chassis members or dedicated Virtual Chassis configurations across distances of up to 50 km with redundant fiber links. This configuration is used when deploying a Virtual Chassis configuration across wiring closets, data center racks, data center rows, or facilities.

To implement this configuration, use the following CLI command:

```
user@host> request virtual-chassis vc-port set pic-slot <pic-slot> port
<port> member <member-id>
```

Figure 13 illustrates the extended Virtual Chassis configuration.

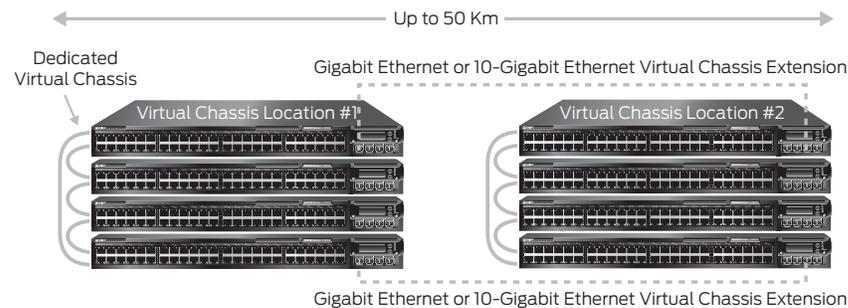


Figure 13: Extended Virtual Chassis configuration

Note: For platforms that do not have dedicated VCPs, there is no difference between a regular Virtual Chassis and an extended Virtual Chassis configuration.

Virtual Chassis Cabling using SFP+ or QSFP+ Ports

Any 10GbE or 40GbE port on an EX4300 or EX4600 switch can be configured as a Virtual Chassis port. Virtual Chassis configurations allow the interconnection of individual Virtual Chassis members or dedicated Virtual Chassis configurations across long distances (depending on the type of transceiver) with redundant fiber links. This enables Virtual Chassis deployments across wiring closets, data center racks, data center rows, or facilities.

To configure a port as a VCP, use the following CLI command:

```
user@host> request virtual-chassis vc-port set pic-slot <pic-slot> port
<port> member <member-id>
```

Using Uplinks

When using uplink modules, we recommend that:

- They be placed in Virtual Chassis line-card switches; this approach prevents the loss of a master or backup member and an uplink port, if a single device fails.
- They be placed in devices separated at equal distances by member hop; this approach ensures the best Virtual Chassis configuration uplink-to-backplane traffic distribution and the lowest probability of oversubscribing the backplane. It also provides the highest uplink coverage if a member switch or VCP fails or a Virtual Chassis configuration split occurs.

Figure 14 illustrates the use of uplinks in a Virtual Chassis configuration.

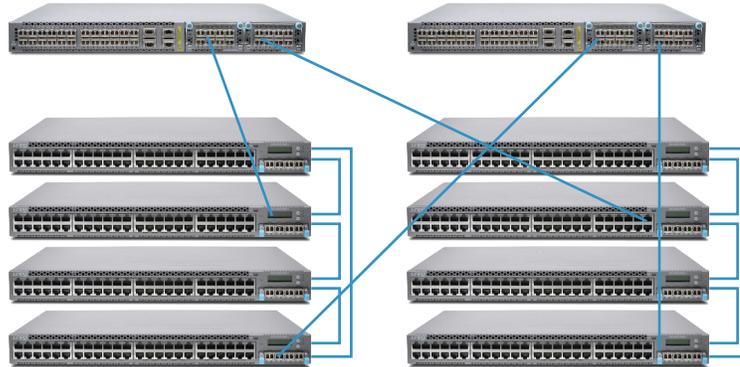


Figure 14: Uplinks in a Virtual Chassis configuration

Class of Service (CoS) on VCP

You can apply a scheduler map to a VCP as shown in the code below.

```
[edit class-of-service interfaces]
user@switch# set vcp-* scheduler-map ef-map
```

VCP interfaces support full hierarchical scheduling enhanced transmission selection (ETS) on platforms that support ETS, like the EX4600 and QFX5100.

You cannot attach classifiers, congestion notification profiles, or rewrite rules to VCP interfaces. Also, you cannot configure buffer settings on VCP interfaces.

Virtual Chassis Split

In rare cases, Virtual Chassis configurations can be “split” when a single switch, cable, or VCP in a chained topology fails, or when two or more adjacent switch members lose connectivity in a ring topology.

Without the “split-detection” feature enabled, a split will initiate a new master re-election process in each of the new segments, resulting in two or more identical Virtual Chassis configurations unaware of each other’s presence. This can create problems at the network level when, for example, each of the new Virtual Chassis segments contains the same routing information, resulting in two or more “routers” in the network with identical IDs, networks, advertisements, etc.

With the “split-detection” feature enabled, no more than one segment will remain active and operational under the original configuration following a Virtual Chassis split. All other segments created by the split will be forced into an “inactive” Virtual Chassis state, with all switch members assuming a line-card role with no master or backup. Users must either manually reload the factory default configuration on the inactive switch members or resolve the faults that caused the split (e.g., repair or replace the broken Virtual Chassis cables or member switches) before the switches can rejoin the active Virtual Chassis configuration. Virtual Chassis split detection is enabled by default.

When a Virtual Chassis configuration splits into two separate Virtual Chassis configurations, the individual member switches detect this topology change and run the master election algorithm to select a new master for each of the two Virtual Chassis configurations. The new masters then determine whether their respective Virtual Chassis configuration remains active. One of the configurations remains active based on the following:

- It contains both the stable master and the stable backup (that is, the original master and backup from the pre-split Virtual Chassis configuration).

- It contains the stable master and the configuration is greater than half the original Virtual Chassis size.
- It contains the stable backup and is at least half the original Virtual Chassis size.

In accordance with the rules given in the second and third list items, if the Virtual Chassis configuration splits into two equal parts and the stable master and stable backup are in different parts, then the part that contains the stable backup becomes active.

While the Virtual Chassis split detection implementation is desirable in most cases, there are rare situations that could lead to all parts of a Virtual Chassis split being rendered inactive. For example, the two halves of a split Virtual Chassis will have no “active” members if the resulting segments have an equal number of Virtual Chassis members, the original master and backup switches do not fall into the same split segment, and the original backup switch is part of the failure that triggers the split. A real-world example of such a situation would be a two-member Virtual Chassis configuration.

With split detection enabled, when a Virtual Chassis only has two member switches, the following scenarios can occur:

- The master switch “dies.” To the remaining switch (the backup), this could be seen as a “split,” since there were only two members in the Virtual Chassis and now it’s just itself in this “half.” Per Virtual Chassis split rule, this “old backup” remains “active” and everything is fine.
- The backup switch “dies.” To the remaining switch (the master), this could be seen as a “split,” since there were only two members in the Virtual Chassis and now it’s just itself in this “half.” Per Virtual Chassis split rule, this “old master” becomes “inactive.” This is not necessarily desirable, as now both members of the original Virtual Chassis are “inactive”—one has died and one has deactivated itself, possibly under a “single” failure such as a power supply.

To mitigate the second issue, EX Series switches have a “set virtual-chassis no-split-detection” CLI that will leave all split parts active. This has some drawbacks (duplicate IPs/router-IDs, etc.), but it will work fine for the two-member Virtual Chassis scenario, since the remaining switch is the only member of the Virtual Chassis configuration.

Virtual Chassis Merge

There are two scenarios in which separate Virtual Chassis might merge:

- A Virtual Chassis that had split into two is now merging back into its original configuration because the problem causing the split has been resolved.
- You want to merge two previously separate Virtual Chassis configurations.

Every Virtual Chassis configuration has a unique ID (VCID) that is automatically assigned when the Virtual Chassis configuration is formed. You can explicitly assign a VCID using the set virtual-chassis id command. A VCID that you assign takes precedence over automatically assigned VCIDs.

When you reconnect a split Virtual Chassis configuration or connect two separate Virtual Chassis for the first time, the members determine whether the separate configurations can merge. The members use the following rules to determine whether a merge is possible:

- If the Virtual Chassis configurations have the same VCID, then the configurations can merge. This occurs when two Virtual Chassis were formed as the result of a split.
- If the VCIDs are different, then the two configurations can merge only if both are active (inactive configurations cannot merge, ensuring that members removed from one Virtual Chassis configuration do not become members of another Virtual Chassis configuration). If the configurations are both active and one of them has a user-configured VCID, this ID becomes the ID of the merged Virtual Chassis. If neither Virtual Chassis has a user-configured VCID, then the VCID of the configuration with the highest mastership priority becomes the ID of the merged Virtual Chassis. The resulting merged configuration is now active.

When you connect two Virtual Chassis configurations, the following occurs:

1. The shortest-path-first (SPF) algorithm is triggered. The SPF algorithm computes the network topology and then triggers the master election algorithm. The master election algorithm waits for the members to synchronize the topology information before running.
2. The master election algorithm merges the VCIDs of all members.
3. Each member runs the master election algorithm to select a master and a backup from all members with the same VCIDs.
4. The master determines whether the Virtual Chassis configuration is active or inactive.
5. If the Virtual Chassis configuration is active, the master assigns roles to all members. If the Virtual Chassis configuration is inactive, the master assigns all members the role of line card.

- When the other members receive their role from the master, they change their role to backup or line card. They also use the active or inactive state information sent by the master to set their own state and to construct the Virtual Chassis member list from the information sent by the master.
- If the Virtual Chassis state is active, the master waits for messages from the members indicating that they have changed to their assigned roles. The master then changes its own role to "master."

Implementation

The following sections describe options for installing a Virtual Chassis configuration. There are two methods for installing and configuring Virtual Chassis technology: non-provisioned and preprovisioned.

Non-Provisioned Mode Installation

Use the non-provisioned installation method to build a Virtual Chassis configuration or to add a new member to an existing Virtual Chassis configuration without prior user configuration. Although it is not required, we recommend that the master and backup switches be designated by configuring the mastership priority of these switches to be the highest value of all members.

We also recommend that factory defaults be loaded on all members before adding these switches to the Virtual Chassis configuration, as this prevents unexpected behavior when adding new members. Factory defaults can be loaded by using either of the following configuration mode CLI commands:

```
user@host# load factory-default
user@host# set system root-authentication plain-password
```

(Follow the prompts to configure a root password to apply the change.)

```
user@ host#commit
```

Using the LCD Menus on a Switch

To perform a non-provisioned installation, follow these general steps.

- Begin by installing the switch you want to be the master by taking these actions:
 - Install required power supplies.
 - Place the switch in the desired location.
 - Power up the switch and load the factory default configuration.
 - Assign the highest mastership priority to the switch.

This switch becomes the master and obtains a member ID of 0.

- For each switch you want to be a line-card switch, take these actions:
 - Install required power supplies.
 - Power up the switch and load the factory default configuration.
 - If you do not want to use the default VCPs, you can manually configure some of the 10GbE or 40GbE ports as VCPs.
 - Power off the switch.
 - Place the switch in the desired location.
 - Connect the switch to existing members of the Virtual Chassis using VCPs.
 - Power up the switch.
 - Repeat these steps as needed to install additional line-card switches.

The mastership election process assigns the switch the next lowest available member ID based on the order in which the switch is added to the Virtual Chassis configuration. The switch may be temporarily configured as the backup switch (because the proposed backup switch has not yet been added to the Virtual Chassis configuration). The switch becomes a line card when the actual backup switch is installed.

3. For the switch you want to be the backup switch in the Virtual Chassis configuration, take these actions:
 - a. Install required power supplies.
 - b. Power up the switch and load the factory default configuration.
 - c. Power off the switch.
 - d. Place the switch in the desired location.
 - e. Connect the switch to existing members of the Virtual Chassis configuration with a VCP cable.
 - f. Power up the switch.

The mastership election process assigns the switch the next lowest available member ID based on the order that the switch is added to the Virtual Chassis configuration.

- g. Assign this switch the same mastership priority as the master switch. Doing so prevents mastership preemption if the master fails and then recovers.

Preprovisioned Mode Installation

A preprovisioned Virtual Chassis configuration links the serial number of each switch in the Virtual Chassis configuration to a specified member ID and role. The serial number must be specified in the configuration file for the member to be recognized as part of the Virtual Chassis configuration.

We recommend that factory defaults be loaded on all members before adding these switches to the Virtual Chassis configuration. Factory defaults can be loaded in either of these ways:

- Using the following configuration mode CLI commands:

```
user@host# load factory-default
user@host# set system root-authentication plain-password
```

(Follow the prompts to configure a root password to apply the change.)

```
user@host#commit
```

- Using the LCD menus on a switch
1. Begin by installing the switch that you want to be the master by taking these actions:
 - a. Install required power supplies.
 - b. Place the switch in the desired location.
 - c. Power up the switch and load the factory default configuration.
 - d. Set the Virtual Chassis configuration mode as "preprovisioned" mode:

```
[edit virtual-chassis]
user@host# set preprovisioned
```

- e. Specify all members to be included in the Virtual Chassis configuration, listing each switch's serial number with the desired member ID and the desired role:

```
[edit virtual-chassis]
user@host# set member 0 serial-number 123456 role routing-engine
user@host# set member 1 serial-number 567890 role line-card
user@host# set member 2 serial-number 910112 role line-card
user@host# set member 3 serial-number 121314 role line-card
user@host# set member 4 serial-number 151617 role routing-engine
```

2. Add the remaining switches to the Virtual Chassis:
 - a. Install required power supplies on the remaining switches.

- b. Power up the switches and load the factory default configuration.
- c. Power off the switches.
- d. Place the switches in the desired locations.
- e. Connect the VCPs.
- f. Power up the switches.
- g. These switches should now be part of the Virtual Chassis and should be assigned roles based on their serial number.

Managing and Maintaining a Virtual Chassis Configuration

The following sections provide information about adding or replacing member switches, as well as guidance for a variety of other maintenance operations.

Note: Some maintenance operations require connecting to the Virtual Chassis configuration through a console so that you can issue CLI commands. If you connect through a console to a Virtual Chassis member other than the master switch, the connection redirects to the master switch automatically.

Adding a New Switch to an Existing Virtual Chassis Configuration in the Same Wiring Closet

This section describes how to add a new switch to a Virtual Chassis configuration when the new switch is installed in the same wiring closet as the other Virtual Chassis switch members. Before beginning:

- Install required power supplies and uplink modules in the new switch.
- Place the new switch in the desired location.
- Confirm that the new switch is powered off.

If expanding a preprovisioned configuration, make a note of the serial number on the back of the switch. Then edit the existing Virtual Chassis preprovisioning configuration to include the serial number and the role of the new switch.

To add the new switch, follow these steps:

1. If the new member switch was previously configured, power it on, reset the configuration to the factory default values, and then power it off.
2. Interconnect the unpowered new switch to at least one member of the existing Virtual Chassis configuration by using the VCPs.
3. Power on the new switch.
4. Confirm that the new switch is now included in the Virtual Chassis configuration by checking the front-panel LCD for the member ID. It should display a member ID that is higher than 0 because there are already at least two members of the Virtual Chassis configuration.

Note: If you are using a preprovisioned configuration, the member ID is assigned to the serial number of the member in the configuration file.

Replacing a Member Switch

A member switch may be replaced in a Virtual Chassis configuration with little loss of traffic. When a switch is replaced, the configuration of the replaced switch is retained and may be applied to the new switch, if desired.

The following sections describe how to replace a member switch in a variety of situations.

Note: A replacement switch does not inherit the configuration of the previous switch if its member ID changes.

Removing, Repairing, and Reinstalling the Same Switch

If a member switch needs to be replaced, it can be removed from the Virtual Chassis configuration with little loss of traffic. The master switch stores the configuration, including the member ID of the removed switch, so that it can be reapplied when the switch (with the same MAC address) is reconnected.

To remove, repair, and reinstall a switch, follow these steps:

1. Power off and disconnect the switch.
2. Repair the switch, as necessary.
3. Reconnect and power on the switch.

Removing a Member Switch, Replacing it with a Different Switch, and Reapplying the Old Configuration

A member switch may be replaced with a different switch that retains the configuration of the original switch. The master switch stores the configuration of the member that was removed. When a replacement member switch is connected, the master switch assigns it a new member ID. The old configuration remains stored under the member ID of the previous switch. Renumbering the replacement switch with the member ID of the old switch applies the configuration of the old switch to the replacement switch.

To replace a switch and reapply configuration, perform the following steps:

1. Power off and disconnect the switch to be replaced.
2. If the replacement switch has been previously configured, reset its configuration to the factory default values. (For instructions about how to load factory default values, please see the "[Non-Provisioned Installation](#)" section.)
3. Connect the replacement switch in place of the old switch and power it on.
4. Note the member ID that displays on the front-panel LCD. It should be the next lowest member ID that was available before the replacement.
5. Use the following CLI command to change the current member ID of the replacement switch to the member ID of the switch that you removed:

```
user@host> request virtual-chassis renumber member-id <member-id> new-  
member-id <member-id>
```

6. If you used a preprovisioned configuration, use the following CLI command to change the relevant serial number in the Virtual Chassis configuration file. Substitute the serial number of the replacement switch (on the back of the switch) for the serial number of the switch that was removed.

```
user@host# set virtual-chassis pre-provisioned member <removed member-id>  
serial-number <replacement switch serial number> role <removed member old  
role>
```

Removing a Member Switch and Making Its Member ID Available for Reassignment to a Different Switch

When removing a member switch from the Virtual Chassis configuration, the master switch keeps the member ID of that switch in reserve.

In addition, the configuration of the old switch applies only to the valid parts of the new member. For example, if a 24-port switch is replaced with a 48-port switch, the old configuration applies to the first 24 ports of the new switch. The other ports have no configuration.

Virtual Chassis Management

A Virtual Chassis configuration is composed of multiple switches; therefore, it offers multiple console ports and multiple out-of-band management Ethernet ports on the switches. Following are some ways to access the CLI on a Virtual Chassis.

- Console: You can connect a PC or laptop directly to a console port of any member switch to set up and configure the Virtual Chassis. When you connect to the console port of any member switch, the console session is redirected to the master switch.
- Out-of-band management: An out-of-band management Ethernet port is often referred to simply as a management Ethernet port. It uses a dedicated management channel for device maintenance and allows a system administrator to monitor and manage the switch by remote control.

The Virtual Chassis configuration can also be managed remotely through SSH or Telnet using a global management interface called the virtual management Ethernet (VME) interface. The VME interface is a logical interface representing all of the out-of-band management ports on the member switches. When you connect to the Virtual Chassis configuration using the VME interface's IP address, the connection is redirected to the master member. This VME interface is a logical IP interface associated with the Virtual Chassis internal management VLAN that connects the me0 interfaces of all member switches in a Virtual Chassis configuration. To assign an IP address, use these CLI commands:

```
user@host> configure  
  
user@host# set interfaces vme unit 0 family inet address <ip-  
address>/<subnet-mask>
```

If the master management Ethernet link is unavailable, the session is redirected through the backup management Ethernet link. If there is no active management Ethernet link on the backup, the VME interface chooses a management Ethernet link on one of the line-card members, selecting the line-card member with the lowest member ID as its first choice.

You can configure an IP address for the VME global management interface.

- In-band management: If the Virtual Chassis configuration has a Layer 3 interface like a routed VLAN interface (RVI) or an integrated routing and bridging interface (IRB), it can be managed remotely through SSH or Telnet using the Layer 3 IP address.

Synchronizing Virtual Chassis Members

Virtual Chassis configurations have two Routing Engines, one in the master and the other in the backup. Therefore, we recommend using the “commit synchronize” command rather than simply committing to save configuration changes made to a Virtual Chassis. This ensures that the configuration changes are saved in both REs.

In a Virtual Chassis environment, committing the configuration by “commit” command only commits the configuration on the master. To synchronize the configuration on all other Virtual Chassis members, the “commit synchronize” command needs to be executed each time. This default behavior can be changed by adding “set system commit synchronize” to the existing configuration.

Loading Factory Default Settings

EX Series and QFX Series switches are programmed with a factory default configuration stored in a default configuration file. This default configuration includes values for system parameters such as system logging and commit, configures Power over Ethernet (PoE) and Ethernet switching on all interfaces, and enables Link Layer Discovery Protocol (LLDP) and Rapid Spanning Tree Protocol (RSTP).

When committing changes to the configuration, a new configuration is created and becomes active. You can revert to the factory default configuration at any time.

Virtual Chassis Failover

Unlike chassis-based systems, there are no fabric links or switch fabrics in these platforms. Most of the hardware failures, such as power supplies or fans, will result in a system halt.

- VCP link failure: If the VCP link goes down, VCCP can detect this failure and recalculate the alternate path for Virtual Chassis traffic. When fast failover is activated, each VCP is automatically configured with a backup port of the same type (dedicated VCP, SFP uplink VCP, or 10-gigabit small form-factor pluggable transceiver uplink VCP). If a VCP fails, its backup port is used to send traffic. These backup ports act as standby ports and are not meant for load-balancing traffic or any other purpose.
- Virtual Chassis member power down: Virtual Chassis member shutdown will have the same effect as a VCP link failure. The neighbors detect the physical links going down and recalculate alternate paths or use a backup port if fast failover is activated.
- PFE failure: In those rare cases where a PFE failure occurs and the VCP link does not go down physically, VCCP will detect this failure based on the timeout for VCCP hello messages. VCCP hellos are exchanged every second; if the neighbor does not receive these hellos for 10 consecutive intervals, the neighbor is assumed to be down and VCCP recalculates alternate paths.

Monitoring a Virtual Chassis Configuration

The following sections provide information about monitoring the operation of a Virtual Chassis configuration.

Monitoring Operation with CLI Commands

The Junos OS CLI provides commands which display information for all members in a Virtual Chassis configuration or for a specific member.

To view member details for all members in a Virtual Chassis configuration, enter the following CLI command:

```
user@host> show virtual-chassis status
```

This command displays the following information:

- Virtual Chassis ID
- Member ID
- Status
- Serial number

- Model
- Membership priority
- Role
- Neighbor list

To view Virtual Chassis port traffic statistics for a specific member in a Virtual Chassis configuration, enter the following CLI command, replacing `<member-id>` with the ID of the member for which you want to view information:

```
user@host> show virtual-chassis vc-port statistics member <member-id>
```

This command displays the following information:

- Member ID
- Virtual Chassis port information

Monitoring with SNMP

The Juniper Networks enterprise-specific Virtual Chassis MIB, whose object identifier (OID) is `{jnxExSwitching 4}`, contains information about Virtual Chassis on EX Series and QFX Series Ethernet Switches.

`jnxVirtualChassisMemberTable`

The `jnxVirtualChassisMemberTable` enterprise-specific Virtual Chassis MIB, whose object identifier is `{jnxVirtualChassisMemberMIB 1}`, contains information about the switches that form a Virtual Chassis configuration.

`jnxVirtualChassisPortTable`

The `jnxVirtualChassisPortTable`, whose object identifier is `{jnxVirtualChassisPortTable 1}`, contains information about the ports of Virtual Chassis member switches.

Check Virtual Chassis port traffic utilization using SNMP. The following knowledge base provides this information: <https://kb.juniper.net/InfoCenter/index?page=content&id=KB27711>.

Virtual Chassis Technology Deployment Options

The following sections provide overviews of various Virtual Chassis deployments.

Data Center, Top-of-Rack Deployment

The data center, top-of-rack (ToR) deployment is suitable for data center environments in which Virtual Chassis members are colocated with servers in the same rack. A single Virtual Chassis configuration consisting of multiple switches in the same rack simplifies management by reducing the number of logically managed devices, and it offers flexible options for the number and deployment of uplinks. This deployment also gives servers the ability to configure network interface card (NIC) teaming (LAG) to multiple members of the same Virtual Chassis configuration, increasing the total server network bandwidth while providing server link redundancy.

The Virtual Chassis configuration may be extended across multiple racks within the same row in a data center. ToR switches can be in daisy-chained/ring cabling configuration, which allows spacing of up to 5 meters between adjacent racks and requires one or more uplink extensions to complete the ring. Extending the Virtual Chassis across racks further eases management, lowers inter-rack server-to-server latency, and increases uplink flexibility, ultimately leading to lower total cost of ownership (TCO).

Data Center, End-of-Row Deployment

The data center end-of-row deployment allows the installation of EX Series and QFX Series switches as end-of-row devices in a data center. Virtual Chassis members can be interconnected using the daisy-chained or braided-ring cabling configuration; uplinks will provide connectivity to core switching devices.

Campus or Building Wiring Closet Deployment

The Virtual Chassis configuration may be used in campus or building wiring closets. A single wiring closet may include up to 480 10/100/1000BASE-T ports. The Virtual Chassis configuration may be extended across multiple wiring closets to ease management and provide design flexibility for uplinks into the LAN core. Figure 15 illustrates the deployment of a Virtual Chassis configuration within a single wiring closet. Figure 16 illustrates the deployment of a Virtual Chassis configuration when the Virtual Chassis configuration spans more than one wiring closet.

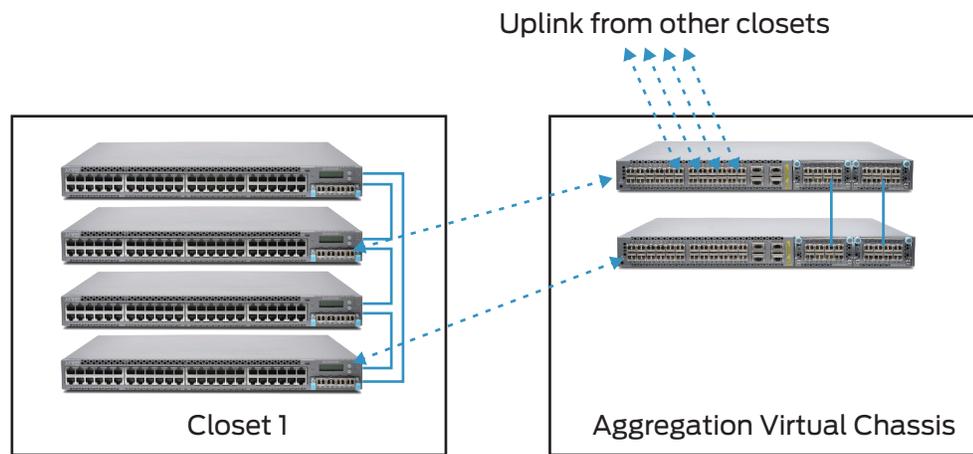


Figure 15: Campus or building wiring closet deployment, single wiring closet

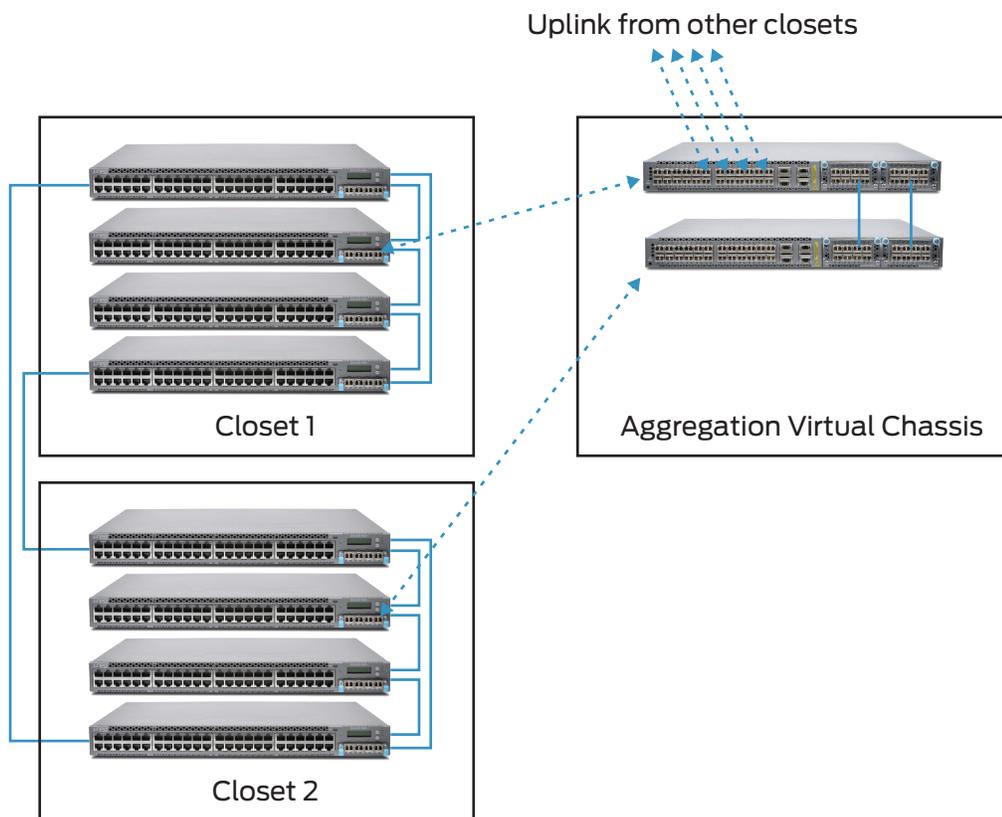


Figure 16: Campus or building wiring closet deployment, multiple wiring closets

Campus or Building Aggregation Deployment

The EX4200-24F (featuring 24 SFP ports), EX4300-32F (featuring 32 SFP ports), or EX4600 switches are designed for aggregating access switch devices from wiring closets or data center deployments. These switches provide options of physical placement and port density to meet a range of requirements. For maximum availability, a pair of Virtual Chassis configurations can be located in the aggregation layer with each access switch (or Virtual Chassis configuration) dual-homed. Or, a single Virtual Chassis configuration can be deployed at the aggregation layer, providing ease of management and eliminating the active use of Layer 2 redundancy protocols such as Spanning Tree.

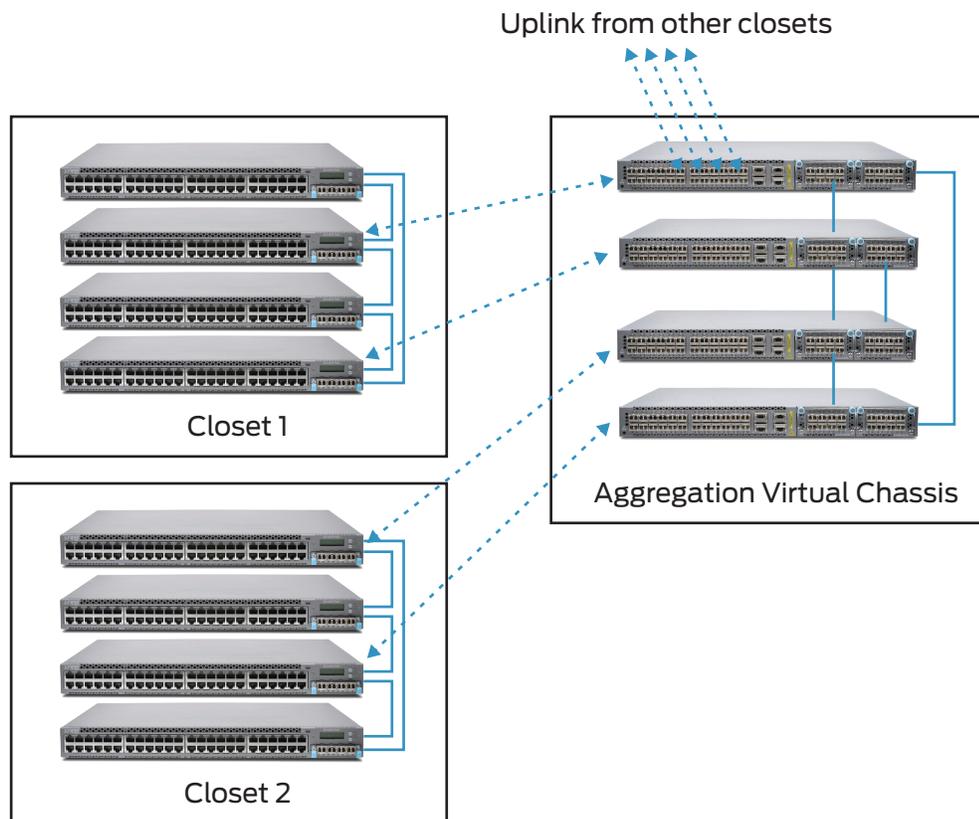


Figure 17: Campus aggregation, single Virtual Chassis configuration

Virtual Chassis Ring Deployment

The Virtual Chassis ring deployment would benefit metro Ethernet deployments, campuses, or retail operations. In this deployment scenario, switches can be located in several different buildings.

The metro/ring deployment provides benefits that include:

- One-switch LAN
- High availability
- Redundant power and fans
- Redundant switch fabric
- Sub-second convergence in case of a device or link failure
- Integrated access security
- Integrated quality of service (QoS) for voice, video, and data

Best Practices

This section provides a summary of the best practices that we recommend you follow when deploying and operating the Virtual Chassis technology.

- Use the VME interface as the management interface to configure Virtual Chassis technology options.
- When removing a switch from a Virtual Chassis configuration, immediately recycle its member ID so that the ID becomes the next lowest available unused ID. In this way, the replacement switch automatically is assigned that member ID and inherits the configuration of the original switch. For more information, please see the [“Member ID Numbering”](#) section.
- When deploying a Virtual Chassis, explicitly configure the mastership priority of the members that you want to function as the master and backup switches. For more information, please see the [“Mastership Priority Setting”](#) section.
- Specify the same mastership priority value for the master and backup switches in a Virtual Chassis configuration. For more information, please see the [“Mastership Priority Setting”](#) section.

- Configure the highest possible mastership priority value (255) for the master and backup switches. For more information, please see the [“Mastership Priority Setting”](#) section.
- When designing a Virtual Chassis configuration, consider a deployment in which ports are distributed across as many switches as possible to provide the highest resiliency and the smallest failure domain. For more information, please see the [“How Many Members Should a Virtual Chassis Configuration Have?”](#) section.
- Evenly space master and backup switches by member hop when possible. For more information, please see the [“Location of Master and Backup Switches”](#) section.
- Place the master and backup switches in separate locations when deploying an extended Virtual Chassis configuration. For more information, please see the [“Location of Master and Backup Switches”](#) section.
- For maximum resiliency, interconnect Virtual Chassis member devices in a ring topology. For more information, please see the [“Cabling Options”](#) section.
- When possible, place uplink modules in the Virtual Chassis configuration line-card switches, and place uplinks in devices which are separated at equal distances by member hop. For more information, please see the [“Using Uplinks”](#) section.
- When changing configuration settings on the master switch, propagate changes to all other switches in the Virtual Chassis configuration. For more information, please see the [“Synchronizing Virtual Chassis Members”](#) section.

Conclusion

Juniper Networks Virtual Chassis technology allows the interconnection of up to 10 switches to form a single, logical device that is managed as a single chassis. Virtual Chassis technology provides the same level of availability, performance, and scale as a traditional modular chassis, with benefits that include smaller space and power requirements and a lower deployment cost. Additionally, the Virtual Chassis configuration provides flexibility in the physical deployment of devices across extended distances, enabling unique network designs to reduce deployment and operational costs.

Appendix A: Virtual Chassis Ports on EX Series Switches

Switch Model	Ports Capable of Being VCP	Default Virtual Chassis Ports
EX4300-24/48(T/P)	All 10GbE or 40GbE ports (fixed and modular)	All fixed QSFP+ ports in the rear panel are VCP by default.
EX4300-32F	All 40GbE ports; 10GbE ports on the modules (not supported on fixed 10GbE ports)	All fixed QSFP+ ports in the rear panel are VCP by default.
EX4600	All 10GbE or 40GbE ports (fixed and modular)	TBD
EX3300	All 10GbE uplink SFP ports	Uplink ports 2 and 3 are VCP by default.
EX2200	All 1GbE uplink SFP ports	
EX4550	Dedicated Virtual Chassis ports Uplink ports—including the ports on the SFP uplink module, SFP+ uplink module, or 10-gigabit small form-factor pluggable transceiver (XFP) uplink module	Dedicated VCPs.
EX4200	Dedicated Virtual Chassis ports Uplink ports—including the ports on the SFP uplink module, SFP+ uplink module, or XFP uplink module	Dedicated VCPs.

Appendix B: Mixed Virtual Chassis Support

	QFX5100 (RE)	EX4600 (RE)	EX4550 (RE)
EX4300	Yes	Yes	No
EX3300	No	No	No
EX2200	No	No	No
EX4200	No	No	Yes

Appendix C: Glossary

Backup switch: The Virtual Chassis configuration member that takes over if the master switch stops operating.

Braided-ring: Method of cabling together switches in a Virtual Chassis configuration in which alternating devices connect to each other and the top two and bottom two devices, or device pairs on each end in a horizontal configuration, connect to each other.

Daisy-chained ring: Method of cabling switches together in a Virtual Chassis configuration in which each device connects to the device immediately adjacent to it, and the top and bottom devices or the two end devices connect to each other.

Dedicated configuration: A Virtual Chassis configuration which consists of adjacent switches interconnected with Virtual Chassis port cables.

Extended Virtual Chassis configuration: Also known as “extended configuration,” a deployment which includes uplinks to interconnect individual Virtual Chassis members or dedicated Virtual Chassis configurations across distances up to 50 km with redundant fiber links.

Forwarding path: Path for routing packets through switches in a Virtual Chassis configuration.

Graceful Routing Engine switchover (GRES): Enables the backup switch to take over for the master switch with minimal interruption to network communications.

Line-card switch: Also known as a “line card,” Virtual Chassis configuration member which is not assigned the master or backup role.

Link aggregation group (LAG): A logical point-to-point link which is created by combining ports that belong to different member switches in a Virtual Chassis configuration.

Master switch: The Virtual Chassis member switch that has full control over the Virtual Chassis configuration.

Mastership election process: Algorithm that the system runs to determine which member switches take the role of master switch, backup switch, and line cards.

Mastership priority: Value from 1 to 255 that the system uses when determining which switch functions in the role of master switch, backup switch, or line card.

Member switch: Also known as “member,” a switch that is part of a Virtual Chassis configuration.

Member ID: Number from 0 to 9 that distinguishes member switches from each other.

Packet Forwarding Engine (PFE): Portion of the router that processes packets by forwarding them between input and output interfaces.

Preprovisioning: A method for deterministically controlling the member ID and role which are assigned to a member switch by associating the switch to its serial number.

Routing Engine: Calculates and maintains the forwarding table and provides it to the PFEs in other member switches. The RE also receives and transmits routing information. The master switch is always the Routing Engine.

Uplink module: Optional add-on to a switch that allows the extension of a Virtual Chassis configuration across distances which are greater than the 5-meter limit imposed by a dedicated Virtual Chassis port cable.

Uplink port: Port on an uplink module which is used to interconnect switches in a Virtual Chassis configuration.

Uplinks: Enable the interconnection of remote switches, other Virtual Chassis members, and a variety of other devices to a Virtual Chassis configuration.

Virtual Chassis configuration: Implementation of Virtual Chassis technology across interconnected switches.

Virtual Chassis port (VCP): Any port whose function is to send and receive Virtual Chassis Control Protocol (VCCP) traffic to create, monitor, and maintain the Virtual Chassis. VCPs are responsible for creating, monitoring, and maintaining the Virtual Chassis as well as carrying data traffic through the Virtual Chassis.

Virtual Chassis port cable: Cable that interconnects switches through Virtual Chassis ports.

Virtual Chassis technology: Feature in select EX Series and QFX Series switches that allows you to interconnect switches and operate them as a unified, single, high-bandwidth device.

Virtual Management Ethernet (VME) interface: Enables remote management of a Virtual Chassis configuration by connecting to the out-of-band management port of any member switch through a single IP address.

About Juniper Networks

Juniper Networks is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at www.juniper.net.

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