BENEFITS OF DEPLOYING VIRTUAL CHASSIS TECHNOLOGY ON THE EX8200 LINE OF ETHERNET SWITCHES
Table of Contents

Executive Summary ............................................................................................................. 3

Introduction ......................................................................................................................... 3

Juniper's Virtual Chassis Technology on EX4200 and EX8200 Lines of Switches .................. 3

EX4200 Ethernet Switch with Virtual Chassis Technology ..................................................... 3

EX8200 Line with Virtual Chassis Technology .................................................................... 4

Benefits of Virtual Chassis Technology ................................................................................ 4

EX8200 Line External Routing Engine (XRE200) .................................................................. 4

Connecting an XRE200 to an EX8200 Line Virtual Chassis Configuration ................................ 6

Advantages of Externalizing the Routing Engine .................................................................... 7

Function of Internal Routing Engine in an EX8200 Virtual Chassis Configuration ................. 8

Deploying an EX8200 Virtual Chassis Configuration ............................................................. 8

Building Virtual Chassis Configurations over Long Distances ................................................. 10

Non-Stop Software Upgrade on the EX8200 Virtual Chassis Configuration ............................ 10

Conclusion ......................................................................................................................... 10

About Juniper Networks ...................................................................................................... 11

Table of Figures

Figure 1: EX4200 Virtual Chassis configuration ................................................................. 3

Figure 2: Juniper Networks EX8200-XRE200 ................................................................. 5

Figure 3: EX8200 Virtual Chassis configuration with XRE200 connecting to every member ... 6

Figure 4: EX8200 Virtual Chassis configuration with XRE200 connecting to one member .... 7

Figure 5: Intra-EX8200 Virtual Chassis configuration connection failure .............................. 7

Figure 6: EX8200 Virtual Chassis configuration with two chassis ......................................... 8

Figure 7: Connecting adjacent devices to the EX8200 Virtual Chassis configuration using fabric mode ................................................................. 8

Figure 8: Connecting adjacent devices to the EX8200 switches in a Virtual Chassis configuration using non-fabric mode ................................................................. 9

Figure 9: Using L2 switches to extend an EX8200 Virtual Chassis configuration ..................... 10
Executive Summary

This paper describes the benefits of deploying Virtual Chassis configurations based on Juniper Networks® EX8200 line of Ethernet switches deployed in a variety of environments.

Introduction

Layer 2 networks depend on a loop-free network topology for their operation. While traditional Spanning Tree Protocol (STP) technologies allow redundant links to exist in a network by blocking all but one of the connections at any given time, these technologies also have several significant negative side effects. First, they force half of the network’s available capacity to sit idle at any time, increasing the cost required to achieve a particular level of performance. Second, if STP is incorrectly configured for any reason, the unblocked redundant connections will cause a Layer 2 loop, resulting in a traffic storm that is not only extremely difficult to troubleshoot but will also bring useful data transfers to a halt. Finally, running STP in a virtualized network with redundant switches requires compute-intensive protocols such as Virtual Router Redundancy Protocol (VRRP) on each switch, limiting the number of simultaneous logical connections that can be supported.

True Layer 2 multipath technologies enable customers to build L2 domains without having to rely on STP to eliminate loops or lose redundant connectivity and full utilization of available link capacity (active/active load sharing of redundant links). These technologies should deliver the resilience of multichassis network designs without imposing the scaling limitations of protocols such as VRRP. In addition, existing network components such as servers and storage devices, other L2 and L3 switches, security appliances, and routers should be able to attach transparently to the L2 multipath-enabled device. Juniper’s Virtual Chassis technology meets all of these requirements.

Juniper’s Virtual Chassis Technology on EX4200 and EX8200 Lines of Switches

Juniper’s Virtual Chassis technology enables customers to interconnect multiple individual switches (physical chassis) to create a single logical switch from a management, control, and data plane perspective. Because it allows multiple physical switches to appear as a single “virtual” switch to other attached network devices, Virtual Chassis technology allows multiple, simultaneously active L2 connections to any network device using link aggregation rather than STP.

EX4200 Ethernet Switch with Virtual Chassis Technology

Juniper first delivered Virtual Chassis technology on the Juniper Networks EX4200 Ethernet Switch. Up to 10 EX4200 switches can be interconnected in a Virtual Chassis configuration using any combination of dedicated high-speed Virtual Chassis ports (VCPs) on the switch’s rear panel or front panel gigabit Ethernet (GbE) or 10 GbE fiber links.

Figure 1 depicts an EX4200 Virtual Chassis configuration used as an aggregation switch, where multiple links from an IEEE 802.3ad link aggregation group (LAG) are terminated on different Virtual Chassis switch members. From the perspective of either Access Switch 1 or Access Switch 2, the LAG is a standards-based interconnection and does not require any proprietary technology to connect to the EX4200 Virtual Chassis configuration. In addition, since the access switches are not aware of the LAG being terminated on multiple switches, they do not have to modify the behavior of L2/L3 protocols or forwarding.

Figure 1: EX4200 Virtual Chassis configuration
EX8200 Line with Virtual Chassis Technology

The Virtual Chassis technology available on the EX4200 Ethernet Switch is now also available on the EX8200 line of modular Ethernet switches. Two EX8200 chassis can be interconnected to form a single Virtual Chassis configuration. (Note that Virtual Chassis technology does not limit an EX8200 Virtual Chassis configuration to just two members; future extension to four or more chassis is currently under evaluation). The EX8200 can be deployed in a collapsed aggregation or core layer Virtual Chassis configuration, creating a network fabric for interconnecting access switches, routers, and service-layer devices such as firewalls and load balancers using standards-based Ethernet LAGs.

Members of an EX8200 Virtual Chassis configuration, which can include a mix of the Juniper Networks EX8208 Ethernet Switch (eight-slot) and EX8216 Ethernet Switch (16-slot), can be interconnected using standard line-rate 10 GbE interfaces as Virtual Chassis intra-connections. The connection between any two chassis in a Virtual Chassis configuration can either be a single line-rate 10 GbE link or a LAG with up to 12 10 GbE line-rate links. Since the Virtual Chassis intra-connections use small form-factor pluggable transceiver (SFP+) interfaces, Virtual Chassis member switches can be separated by distances of up to 40 km. If the Virtual Chassis members are located in the same or adjacent racks, low cost direct attach cables (DACs) can be used as the interconnect mechanism.

The network fabric created by an EX8200 line Virtual Chassis configuration does not present network loops, eliminating the need for protocols such as STP or for forklift upgrades to support unproven technologies such as TRILL. The fabric also simplifies the network by eliminating the need for VRRP, reducing the number of managed devices in the core layer to a single fabric. In addition, since the Virtual Chassis Control Protocol (VCCP) used to form the EX8200 Virtual Chassis configuration (as in the EX4200 line) does not affect the function of the control plane, Juniper Networks Junos® operating system control plane protocols such as 802.3ad, OSPF, Internet Group Management Protocol (IGMP), Physical Interface Module (PIM), BGP, etc., running on an EX8200 Virtual Chassis system, do not require any modification; they behave in exactly the same way as those running on a standalone chassis.

Benefits of Virtual Chassis Technology

Virtual Chassis technology brings a number of benefits to networks based on the EX8200 line. For example, EX8200 Virtual Chassis configurations are highly resilient, with no single point of failure. This means that no single element—whether a chassis, a line card, a Routing Engine, or an interconnection—can render the entire fabric inoperable following a failure.

Virtual Chassis technology also makes server virtualization at scale feasible thanks to the fabric’s ability to provide simple L2 connectivity over a very large pool of compute resources located anywhere within a data center, whether those resources are across racks or across pods.

In addition, Virtual Chassis technology can also be used to extend EX8200-based VLANs between data centers. This can be accomplished by placing an equal number of Virtual Chassis switch members in both data centers, or by interconnecting two separate Virtual Chassis configurations using a simple L2 trunk.

EX8200 Line External Routing Engine (XRE200)

When deploying an EX8200 Virtual Chassis configuration, Routing Engine functionality is externalized in a special, purpose-built, server-class appliance called the XRE200. With its 2.1 GHz dual core CPU, 4 GB DRAM, 160 GB RAID hard disk, and dual redundant power supplies, the XRE200 supports control plane processing requirements for large-scale systems such as EX8200 Virtual Chassis configurations, and also provides an extra layer of availability and redundancy.

All control protocols such as OSPF, IGMP, Link Aggregation Control Protocol (LACP), 802.3ah, VCCP, etc., as well as all management plane functions, run or reside on the XRE200. Junos OS high availability (HA) features such as graceful Routing Engine switchover (GRES), nonstop active routing (NSR), and nonstop bridging (NSB) are enabled on the two XRE200s required in a redundant EX8200 Virtual Chassis configuration. In the event of an active XRE200 failure, the standby XRE200 takes over and Junos OS HA features ensure that the state of the Virtual Chassis, L2/L3 protocols, and forwarding information are not lost.
Figure 2: Juniper Networks EX8200-XRE200

Two XRE200s are required in an EX8200 Virtual Chassis configuration to provide an active/standby pair for control plane and management plane redundancy.

Each XRE200 features:
- 2.1 GHz Intel® Core™2 Duo Processor with 2 MB L2 cache
- 4 GB DRAM
- Internal 4 GB flash
- Redundant 160 GB hard disk drive
- LCD panel
- 10/100/100BASE-T RJ-45 port for out-of-band management
- Console port for out-of-band management
- USB drive for file storage
- One 10/100/100BASE-T RJ-45 for XRE200-to-XRE200 connection or XRE200-to-Virtual Chassis connection
- Two slots for 4x1GbE I/O cards, with customers able to choose between two I/O cards
  - 10/100/100BASE-T RJ-45 (one I/O module included with XRE200)
  - 1 GbE SFP (future)
- Two redundant hot-swappable power supplies
- Two redundant hot-swappable fans

The XRE200 ships with the 4xGbE RJ-45 I/O card. Customers can choose to buy a second I/O card from the two available models. The fiber I/O card (future) can be used to connect the active and standby XRE200s when the distance between them exceeds the span of the Cat5 or Cat6 cable—for instance, when a Virtual Chassis configuration is set up between buildings on a campus. It is important to note that the active and standby XRE200s need not be directly connected, although there are advantages to connecting them directly as shown in the next section.
Connecting an XRE200 to an EX8200 Line Virtual Chassis Configuration

The GbE interfaces on the active XRE200 (up to eight) can be used to connect to the active Routing Engines in each of the EX8200 chassis participating in the Virtual Chassis configuration. Similarly, the GbE interfaces on the standby Routing Engine (again, up to eight) can be used to connect to the standby Routing Engines in each of the EX8200 chassis in the Virtual Chassis configuration. The two XRE200s can also be connected to each other directly over any available GbE interface (Figure 3).

Other methods of connecting the XRE200 to the EX8200 Virtual Chassis configuration are also available. In Figure 4, each of the two XRE200s is connected to only one internal Routing Engine of the EX8200 line Virtual Chassis member switch. In this connection mode, control plane messages received by any Virtual Chassis member switch are relayed over the intra-Virtual Chassis connections to the member switch that is directly connected to the XRE200.

One of the implications of this connection mode is that the active and standby XRE200s can be deployed in two physically different locations.
Advantages of Externalizing the Routing Engine

The “out-of-the-box” XRE200 provides significant advantages apart from control plane scalability. For instance, with an external Routing Engine, if one or more switches in the Virtual Chassis configuration lose their connections to adjacent chassis, access switches connected to the EX8200 Virtual Chassis will not lose connectivity with the network. Figure 5 shows the traffic flow in the event of an intra-Virtual Chassis connection failure.

As shown in Figure 5, traffic flowing from an access switch to any other access switch or to any core/WAN router connected to the same EX8200 Virtual Chassis member will not be affected even when the intra-Virtual Chassis connection goes down. This is a significant improvement over alternate solutions, where the loss of the intra-system link leads to complete connectivity loss between any nodes (access switches or core routers) interconnected via the aggregation layer. This advancement is only possible by externalizing Routing Engine functionality.
Function of Internal Routing Engine in an EX8200 Virtual Chassis Configuration

In addition to providing direct connectivity between the EX8200 chassis and the XRE200, the internal Routing Engines in an EX8200 Virtual Chassis configuration serve the purpose of controlling, monitoring, and maintaining the chassis. Chassis functions like chassis and line-card bring up, environmental monitoring, and power management are some of the typical functions performed by internal Routing Engines when the chassis is a member of a Virtual Chassis configuration. However, the internal Routing Engines do not process any control plane functions. Any L2/L3 control plane protocol packets received on an interface are sent to the XRE200 via the shortest path available. When the XRE200s are directly connected to the EX8200 chassis via the GbE port on an internal Routing Engine, all protocol data units (PDUs) are transmitted from the chassis to the XRE200 via the directly connected GbE link.

Deploying an EX8200 Virtual Chassis Configuration

Initially, an EX8200 Virtual Chassis configuration will consist of a maximum of two member chassis. The EX8200 switches can be interconnected via a single 10 GbE port or through a LAG consisting of multiple 10 GbE links. In either case, the 10 GbE interfaces used for Virtual Chassis connectivity must be on a line-rate 10 GbE line card installed in the chassis.

Once the EX8200 switches are linked, the two XRE200s—one serving as the primary Routing Engine and one serving as a backup—must be connected. This is most easily accomplished by connecting the XRE200s to the out-of-band management ports on each switch's internal Routing Engine to provide the necessary redundancy and resiliency. For additional resiliency, and to reduce the number of hops between devices, a direct link between the two XRE200s can also be implemented (see Figure 6).

Figure 6: EX8200 Virtual Chassis configuration with two chassis

When adjacent devices such as switches, routers, or security devices must be connected to the EX8200 line Virtual Chassis configuration, one of two options can be used.

With the first option, called “fabric” mode, network devices connect to the EX8200 line Virtual Chassis configuration via a standards-based LAG, with members terminated on both switches participating in the Virtual Chassis. Network traffic entering either of the two EX8200 line Virtual Chassis switch members has a direct connection to any other network device, and it will use that direct connection to exit the Virtual Chassis (Figure 7).

For campus and data center environments, fabric mode is the recommended method for connecting access switches, WAN routers, or security devices to the EX8200 line Virtual Chassis configuration in the core because it provides the lowest latency for any network traffic and avoids use of the intra-chassis VCP link, thereby limiting potential congestion.
The second method of connecting network devices to an EX8200 Virtual Chassis configuration is called non-fabric mode (see Figure 8). In non-fabric mode, since network devices are not directly linked to all members of the Virtual Chassis, traffic between any two network devices might have to traverse the inter-chassis Virtual Chassis link. While this is not the recommended method for connecting devices to the Virtual Chassis configuration, users may be forced to employ non-fabric mode if the two EX8200 switches are in separate locations and there is not enough fiber to connect every device to both chassis. Users may also use non-fabric mode when deploying an EX8200 Virtual Chassis configuration as a dense 1 GbE or 10 GbE server access switch.
Building Virtual Chassis Configurations over Long Distances

In large campus or data center environments where the distance between XRE200s and the EX8200 line chassis exceed the maximum reach of a Cat5 or Cat6 cable, dedicated low-end Layer 2 switches such as the Juniper Networks EX2200 Ethernet Switch can be deployed in each location to act as media converters.

![Figure 9: Using L2 switches to extend an EX8200 Virtual Chassis configuration](image)

A port pair consisting of an RJ-45 and an SFP port on each L2 switch is required for every long-distance connection desired. All pair ports dedicated to supporting a long-distance connection are assigned to the same static VLAN. This simple configuration enables users to easily deploy EX8200 Virtual Chassis configurations in a wide variety of environments.

Non-Stop Software Upgrade on the EX8200 Virtual Chassis Configuration

Upgrading the Junos operating system on an EX8200 Virtual Chassis configuration can be accomplished in a non-disruptive fashion by using the non-stop software upgrade (NSSU) capabilities enabled by Juniper’s Virtual Chassis technology. As long as all network-attached devices are dual-attached to more than one line card, network traffic will continue to flow during the software upgrade process.

Conclusion

Juniper Networks EX8200 line of Ethernet switches with Virtual Chassis technology not only solves the loop-free L2 multipath problem in non-STP environments by delivering multichassis LAG, it also simplifies control plane operations at a larger scale while advancing the resiliency offered with similar solutions from other vendors.

Table 1: Product Capability Comparison

<table>
<thead>
<tr>
<th>SOLUTION</th>
<th>STANDALONE LINE RATE 10 GBE PORTS</th>
<th>VIRTUAL CHASSIS PORT INTERCONNECT</th>
<th>VIRTUAL CHASSIS LINE RATE 10 GBE PORTS</th>
<th>TYPICAL 10 GBE SERVER COUNT*</th>
<th>TYPICAL 1 GBE SERVER COUNT*</th>
</tr>
</thead>
<tbody>
<tr>
<td>EX8208 Virtual Chassis</td>
<td>64</td>
<td>20-120 Gbps</td>
<td>104-124</td>
<td>600</td>
<td>6,000</td>
</tr>
<tr>
<td>EX8216 Virtual Chassis</td>
<td>128</td>
<td>20-120 Gbps</td>
<td>232-252</td>
<td>1,200</td>
<td>12,000</td>
</tr>
</tbody>
</table>

* 5:1 OS from server access to aggregation EX8200 line Virtual Chassis configuration.
About Juniper Networks

Juniper Networks develops purpose-built, high-performance IP platforms that enable customers to support a wide variety of services and applications at scale. Service providers, enterprises, governments and research and education institutions rely on Juniper to deliver a portfolio of proven networking, security and application acceleration solutions that solve highly complex, fast-changing problems in the world’s most demanding networks. Additional information can be found at www.juniper.net.