WHITE PAPER

NETWORK SIMPLIFICATION WITH JUNIPER NETWORKS VIRTUAL CHASSIS TECHNOLOGY

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Executive Summary

With the proliferation of mobile devices and the corresponding rise in rich media consumption, demands for resiliency and security from today's networks are increasing. As a result, modern day campuses as well as data center networks are becoming more complex, adding to IT's economic burden by creating networks that are inherently difficult to manage and operate.

Most vendors have not paid sufficient attention to this increasing complexity in the network, which is arguably the single biggest problem needing resolution before campus and data center networks can scale to meet the growing demands of today's enterprises and consumers. The solution, which reinvents the network architecture itself, is Juniper Networks Virtual Chassis technology—the industry's first attempt at truly addressing the problem of network complexity.

Juniper Networks® EX Series Ethernet Switches were built from the ground up and designed for simplicity. The first EX Series switch to ship, Juniper Networks EX4200 Ethernet Switch, was enabled with Virtual Chassis technology to address these problems by liberating networks from the restrictions imposed by legacy solutions and architectures—systems that are incapable of addressing the needs of modern day networks, let alone those of the future. Since then, Virtual Chassis technology has been enabled on several EX Series switch lines and has fundamentally changed network architecture by focusing on making it simpler, more reliable, and more cost efficient for businesses. This paper describes how the innovative Virtual Chassis technology available on the EX Series switches resolves the challenges of network complexity by simplifying network design and operations to improve performance, increase scalability, and reduce resource (rack space and power) consumption.

Introduction

Data Center Network Challenges

Most data center networks today employ legacy three-tier architectures. These networks are plagued by complexity and inflexibility in the various network layers, leading to poor performance and excessive resource consumption (Figure 1).

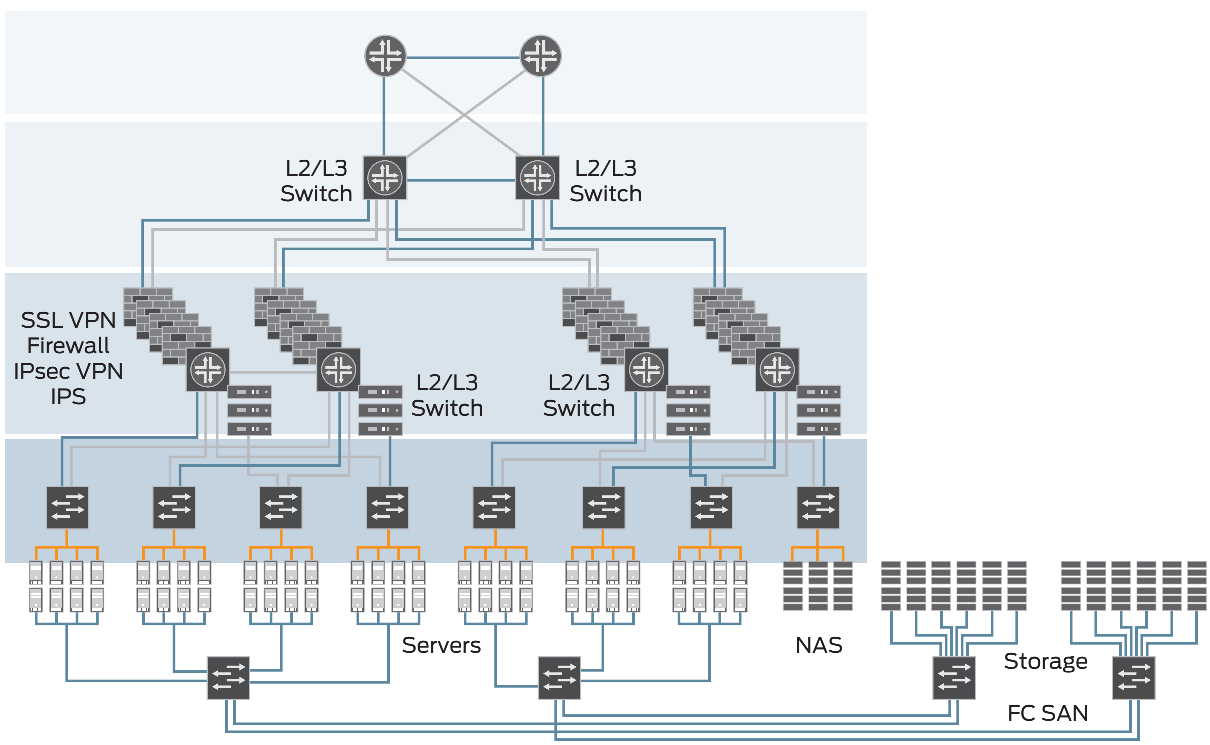

Figure 1: Legacy data center architecture

Design and Operations

Data center networks typically use a variety of design architectures to provide access layer connectivity. Two of the methods are top-of-rack and end-of-row deployments. While these deployment methods have their advantages, they also suffer from excessive resource consumption, inefficient bandwidth utilization, and costly cable management. In addition, server virtualization, which is growing increasingly popular in today's data center, demands networks that are nimble and adaptable enough to react quickly to changes and maintain efficient delivery of mission critical services. Virtual servers, for example, can be moved from one part of the data center to another with a simple command to better meet demand, and networks must adapt quickly to these changes or risk service disruption. Such changes require that devices appear to be seamlessly connected on the same LAN, regardless of their physical proximity to each other. Legacy network architectures lack the flexibility to react to these types of changes, and this adversely affects the operational efficiency of the entire data center.

In addition to the way boxes are physically connected and oriented, keeping the network running becomes a challenge when existing technologies prevent network engineers from doing their jobs efficiently. Everyday tasks such as monitoring devices, troubleshooting, configuration management, and software upgrades become increasingly difficult as the number of independent devices in the network increases.

Such operational challenges are further compounded if these devices are running different versions of software or have different configurations, since software must be carefully managed across devices to ensure consistent functionality and limit exposure to bugs or other vulnerabilities. Special training or expertise may also be needed to support these configurations. As a result, the manpower required to adequately operate, maintain, and troubleshoot the unique requirements of each network device can be enormously time-consuming and costly.

Performance

The complexities of today's data center architectures lead to increased latency, delays in network convergence, and limited bandwidth availability.

- Latency caused by the network architecture: **Approximately 75% of all traffic in today's data center is server-to-server,** which means it travels laterally, or east to west, across the infrastructure. However, due to the multilayered architecture employed by most data center networks, this traffic must first travel north and south from the access layer up to the aggregation and core layers and then back down again before it reaches its final destination—a costly, inefficient use of network assets that adds latency and complexity to each transaction.
- **Suboptimal use of access and uplink ports:** In today's data center, approximately 50% of access layer switch ports are used for inter-switch connections to higher layer devices in the hierarchal tree, limiting the bandwidth available for supporting customer connections.
- **Layer 2 control plane scaling:** Spanning Tree Protocol (STP) is typically employed to prevent network loops from occurring in the data center. However, STP can take up to 50 seconds to converge in a network following a failure—even the Rapid Spanning Tree Protocol (RSTP) can require tens of seconds to converge in some topologies. Plus, both STP and RSTP render half the ports in the core and aggregation layers unusable, leading to inefficient bandwidth utilization.

Virtualized servers compound these problems, since they too require high performance and low latency.

Resource Consumption

The inability to efficiently scale bandwidth in modern data centers compels operators to actually add more of the same inefficient devices to meet growing bandwidth demands. These extra devices consume additional rack space, power, and cooling. And this excessive resource consumption is detrimental to the data infrastructure, because once a data center runs out of power, a new one will have to be built—an enormously costly and ineffective way to conduct business.

Campus Network Challenges

Many campus networks are also built with a 3-tier architecture (Figure 2) and feature the same complexities that plague legacy data centers. As the campus network grows, the sheer number of devices that need to be managed grows exponentially, increasing the burden on network administrators.

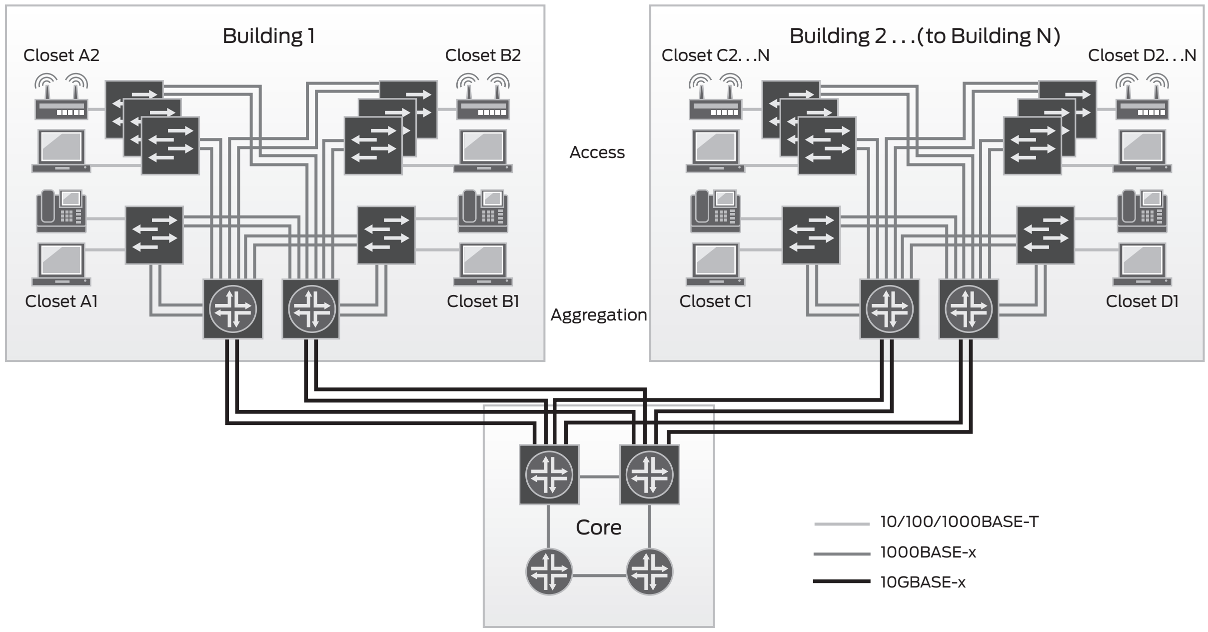

Figure 2: Traditional campus network

Bandwidth Utilization

Today's applications and business processes are bandwidth hungry. Unfortunately, the traditional campus network architecture does not utilize bandwidth efficiently. For instance, while access layer switches connect to the aggregation layer using redundant links, Spanning Tree effectively blocks one of those links, reducing available bandwidth by 50%. Compounding the problem, as more ports are used to connect to aggregation layer switches, the number of ports available to connect desktops, IP phones, and access points is reduced as well.

Manageability

As campus networks grow, managing them becomes increasingly challenging. In traditional campus network architectures, even a small campus of 500 users will need 10 access switches. Everyday tasks like configuration management, image upgrades, and monitoring increase operational expenses. It also becomes difficult for networks to scale as the campus grows in size.

Juniper Networks Virtual Chassis Technology

Juniper Networks Virtual Chassis technology, available on the Juniper Networks EX3300, EX4200, EX4500, and EX8200 lines of Ethernet switches, addresses many data center and campus challenges by allowing multiple interconnected switches to behave, operate, and be managed as a single, logical, high bandwidth device. Virtual Chassis technology simplifies the network by reducing the number of managed devices, while helping networks scale without the operational overhead associated with maintaining a system of independent switches.

Virtual Chassis technology on the fixed configuration EX3300, EX4200, and EX4500 switches allows multiple devices to be interconnected over a high-speed backplane using dedicated Virtual Chassis ports, or through optional GbE and 10GbE uplink ports configured as Virtual Chassis ports. Overall system maintenance and management is greatly simplified, since up to 10 switches on the EX4200 and EX4500 lines, and up to six switches on the EX3300 line, can be managed as a single entity through a single management interface. In other words, Virtual Chassis technology can reduce the number of managed devices by up to a factor of 10, dramatically lowering operational expenses.

Virtual Chassis technology also delivers the following benefits:

- Pay-as-you-grow scalability on fixed configuration switches, from 24 to 480 10/100/1000BASE-T ports with the EX4200, and from 40 to 400 10GbE small form-factor pluggable (SFP) transceiver ports on the EX4500
- The ability to extend Virtual Chassis configurations by up to 80 km with redundant fiber links in between
- Consistent control plane feature implementation through the modular Juniper Networks Junos® operating system
- Improved network convergence
- Lower latency
- Reduced rack space, power, and cooling resource consumption

Simplifying the Data Center

In the data center, Virtual Chassis technology simplifies the network by collapsing tiers and flattening the network from three to two layers (see Figure 3). This is accomplished by interconnecting Virtual Chassis switch members via high-speed backplane connections (Virtual Chassis ports), conserving valuable access ports and effectively merging what would normally be many LANs into one. As a result, the layers of switching required for network access are reduced. This flexibility extends a single Layer 2 access network beyond a single rack, reducing the effort required for network changes such as live server migrations. Moreover, a Virtual Chassis configuration can extend Layer 2 access between sites up to 50 km apart. This simplistic and innovative approach to networking, along with high-performance packet forwarding capabilities, greatly minimizes efforts required to deploy new services in today's virtualized data centers.

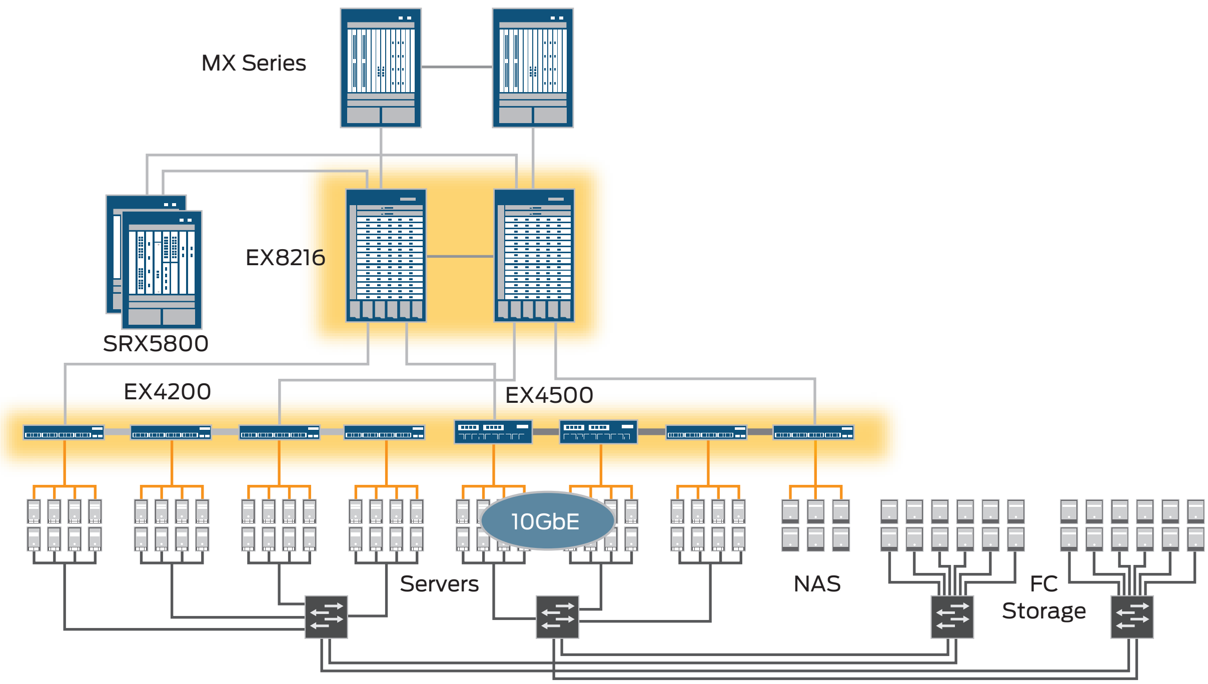

Figure 3: Data center EX Series Virtual Chassis technology

Reduced Complexity

Juniper's Virtual Chassis technology delivers the benefits of both top-of-rack and end-of-row access switch deployments without having to choose between the two. Virtual Chassis technology:

- Simplifies cable management, since customer connections are intra-rack (copper or fiber)
- Makes configuration changes easier
- Reduces maintenance efforts, because there is only one IP address, one image, and one configuration file to manage
- Provides flexibility with uplinks in the core

Cost-Efficient Use of Resources

Rack space, power, and cooling resources are optimized, since Virtual Chassis technology makes more efficient use of both access and uplink ports. Also, by eliminating unnecessary switching layers, a Virtual Chassis architecture dramatically reduces the equipment and the resources required to plan, deploy, implement, and operate today's corporate network.

Simplifying the Campus

Virtual Chassis technology also enables businesses to simplify their campus networks. Small to medium size campuses (up to 5,000 access ports) can collapse their aggregation and core switches using the EX4500 Virtual Chassis solution (see Figure 4). Fewer 10GbE uplinks are required when using this solution. Up to 10 EX4200 switches can be interconnected using Virtual Chassis technology, further simplifying the network by reducing the number of managed devices.

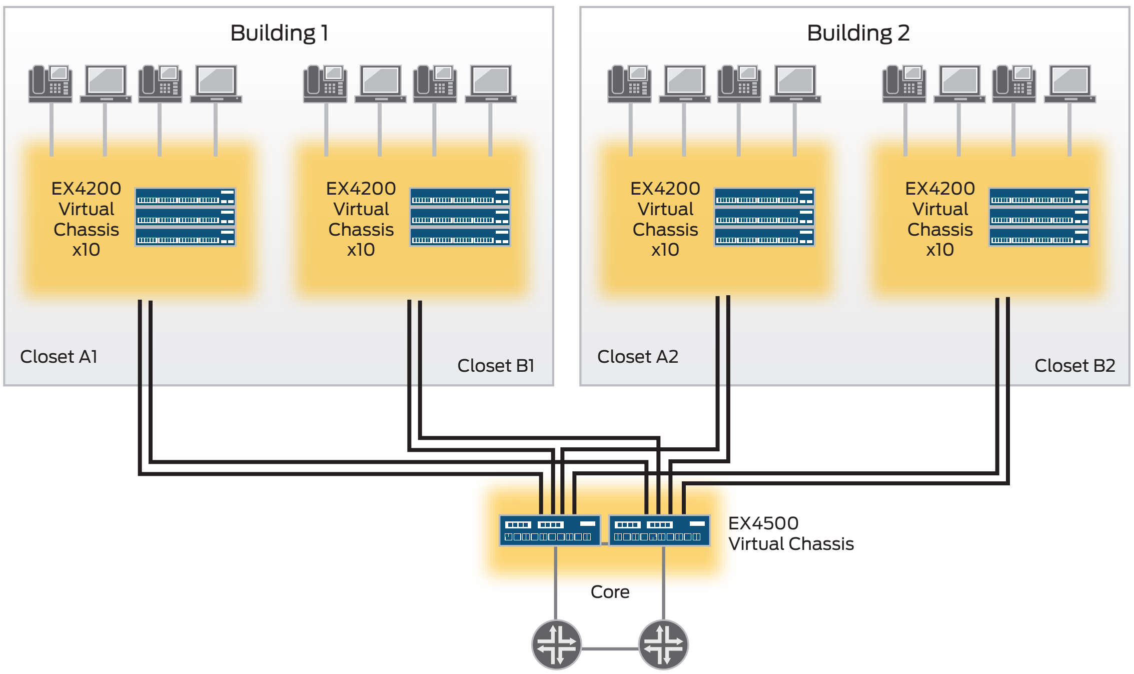

Figure 4: Small to medium size campus with Virtual Chassis technology

In large campuses, the EX8200 with Virtual Chassis technology can be deployed in the core and aggregation layers (see Figure 5) where it not only reduces the number of devices that need to be managed, but also eliminates the need for STP, enhancing performance and improving resource utilization.

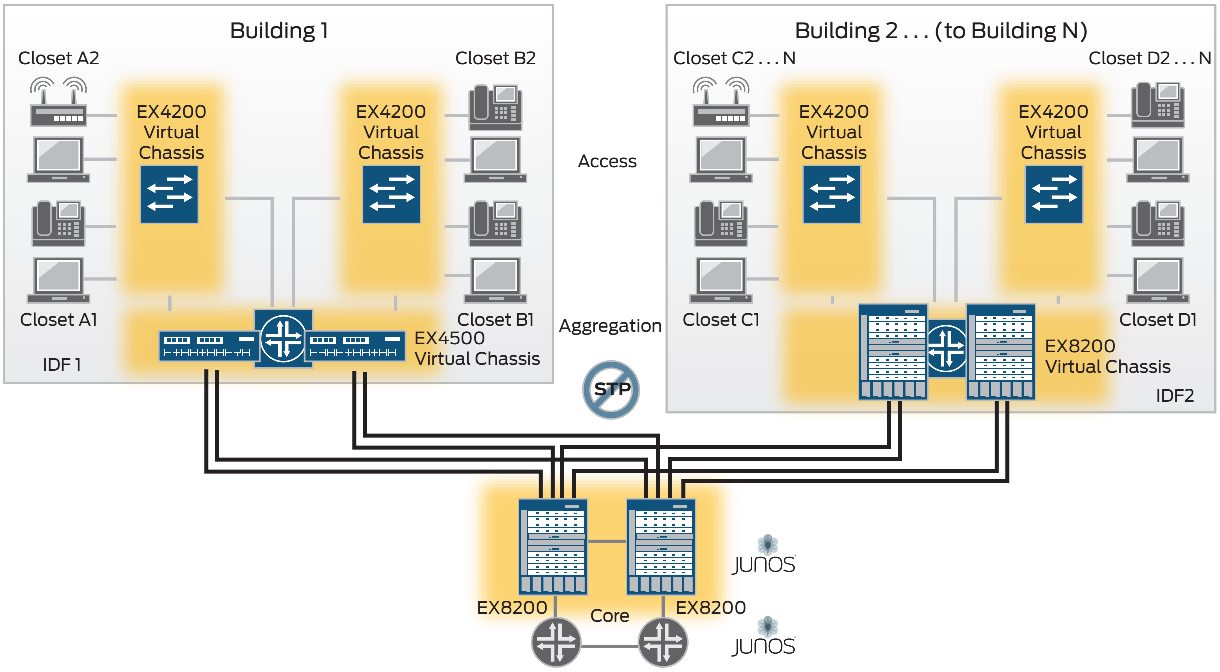

Figure 5: Large campus with Virtual Chassis technology

Improved Performance

Virtual Chassis technology also reduces latency by flattening the network. Inter-switch traffic is routed over a dedicated Virtual Chassis backplane at line rates for all packet sizes, rather than flooding traffic over access ports, to preserve valuable bandwidth. These backplane inter-switch connections reduce the number of devices, conserving valuable data center resources. Also, with Virtual Chassis technology, node and link failover times are measured in sub-seconds, without the need for an external Layer 2 control plane protocol like STP, creating a loop free topology.

Product Portfolio

Virtual Chassis technology is available on EX Series switches designed for every location in the network, from access to core.

EX3300 Ethernet switches: Up to six EX3300 Ethernet switches can be interconnected using four fixed 10GbE uplink ports. Two of the four uplinks are automatically configured for Virtual Chassis configurations, and can be implemented via the LCD without entering a single command-line interface (CLI) command.

EX4200 Ethernet switches: Up to 10 EX4200 Ethernet switches can be interconnected via a dedicated Virtual Chassis port on each device or through optional 1GbE or 10GbE uplink ports. The 1GbE and 10GbE Virtual Chassis connections allow switches up to 50 km apart to belong to the same Virtual Chassis configuration, allowing campuses to build a single logical switch consisting of devices residing in different wiring closets, buildings, or even cities.

EX4500 Ethernet switches: The EX4500 Ethernet Switch offers the same Virtual Chassis technology as the EX4200, but at 10GbE speeds. Two EX4500 switches can be interconnected to form a Virtual Chassis configuration, and 10 member EX4500 Virtual Chassis configurations will be available in the near future. Users can also interconnect two EX4500 switches with up to eight EX4200 switches—an industry first that allows for mixed 10GbE and 1GbE switches in the same Virtual Chassis configuration in data centers where both 1GbE and 10GbE servers are deployed. More details are available in the "Virtual Chassis Technology on EX Series Fixed-Configuration Switches" white paper.

EX8200 line of Ethernet switches: The EX8200 line offers Virtual Chassis technology on modular switches that can be deployed in collapsed aggregation or core layer configurations, significantly simplifying management and operations. Members of an EX8200 Virtual Chassis configuration, which can include a mix of the Juniper Networks EX8208 Ethernet Switch (8-slot) and EX8216 Ethernet Switch (16-slot) chassis, can be interconnected using standard line-rate 10GbE interfaces. The connection between any two chassis in a Virtual Chassis configuration can either be a single line-rate 10GbE link or a link aggregation group (LAG) with up to 12 10GbE line-rate links. The EX8200 Virtual Chassis solution is deployed using Juniper Networks XRE200 External Routing Engine, which externalizes the control plane functionality and provides true control and data plane separation. The same XRE200 can be used to extend the Virtual Chassis solution to four EX8200 switches in the near future. For more details, please refer to the "Virtual Chassis Technology on EX Series EX8200 Switches" white paper.

Conclusion

With the proliferation of mobile devices and the corresponding rise in rich media consumption, demands for resiliency and security from today's networks are on the rise. To adapt to these challenges, modern day campuses as well as data center networks are becoming more complex, creating networks that are inherently difficult to manage and operate. Juniper Networks EX Series Ethernet Switches with Virtual Chassis technology deliver a highly scalable solution that reduces network complexity, increases flexibility, improves performance, and reduces resource consumption. This technology, together with market-leading port densities and the consistent, reliable, stable Junos OS, increases operational efficiencies by improving resource and network asset utilization. The result is lower operational, maintenance, and troubleshooting costs, which translates to a more cost-effective solution for both data center and campus networks.

References

"Virtual Chassis Technology Best Practices." 2009. Juniper Networks implementation guide. **www.juniper.net/us/en/local/pdf/implementation-guides/8010018-en.pdf**

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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