ADVANCING THE ECONOMICS OF NETWORKING

Juniper Networks Ethernet Switching Solutions Reduce Capital and Operational IT Expenses

Table of Contents

Table of Figures

Executive Summary

Aging network systems and old habits have dictated how businesses spend their IT budgets. As a result, a large percentage, if not a majority, of IT dollars are being spent to merely "stay in the race" and keep pace with the competition.

While this model keeps revenue streams flowing for legacy network vendors, it doesn't necessarily help businesses gain a competitive advantage by "winning the race" or "changing the rules."

Juniper Networks® proposes to change this economic model by delivering a new family of solutions that reduce capital and operational expenses, freeing up IT budget dollars and allowing businesses to invest in innovative technologies that will reduce the cost of doing business while improving the bottom line.

Introduction

Today's corporate network is more than just a communications medium connecting employees on a common system. Now more than ever, the corporate network is a strategic business tool—an indispensable weapon that businesses rely on to support their day-to-day operations.

Virtually all business processes today are conducted online. Whether supporting mission-critical transactions for internal employees, enabling collaboration with outside partners and customers, or delivering new capabilities that improve the business' competitive advantage, the network plays an integral role, making it arguably the most valuable asset in the corporate arsenal.

Given its critical nature, it's no surprise that businesses continue to make considerable investments in their network infrastructure. However, how they spend that money—and what they spend it on—may come as a bit of a surprise.

According to a study by McKinsey & Company[1], IT investments fall into three basic categories:

- *"Staying in the race"*: Technology investments that maintain and enhance basic IT services such as core business applications, regulatory compliance, email, and Web services.
- *"Winning the race"*: Implementing technologies that help a business gain a competitive advantage by significantly lowering costs or improving productivity by automating an online loan-approval process, for instance, or automatically providing call center agents with a customer's service history.
- *"Changing the rules"*: Deploying innovative, high-risk/high-reward technologies that open new markets or enable the business to offer new products or services that are substantially different and more desirable than anything else on the market, redefining the competitive landscape.

All businesses, according to the report, invest to some degree in each of these three basic categories. However, the percentage of the IT budget that a business commits to each category depends largely on its competitive position and its future aspirations.

For instance, low-risk businesses with a strong position in a mature market may be more concerned with operating performance. These businesses will typically allocate more of their IT budget—up to 60 percent—to "staying in the race" in order to maintain the status quo.

[1] **"Divide and conquer: Rethinking IT strategy" © 2006 McKinsey & Company**

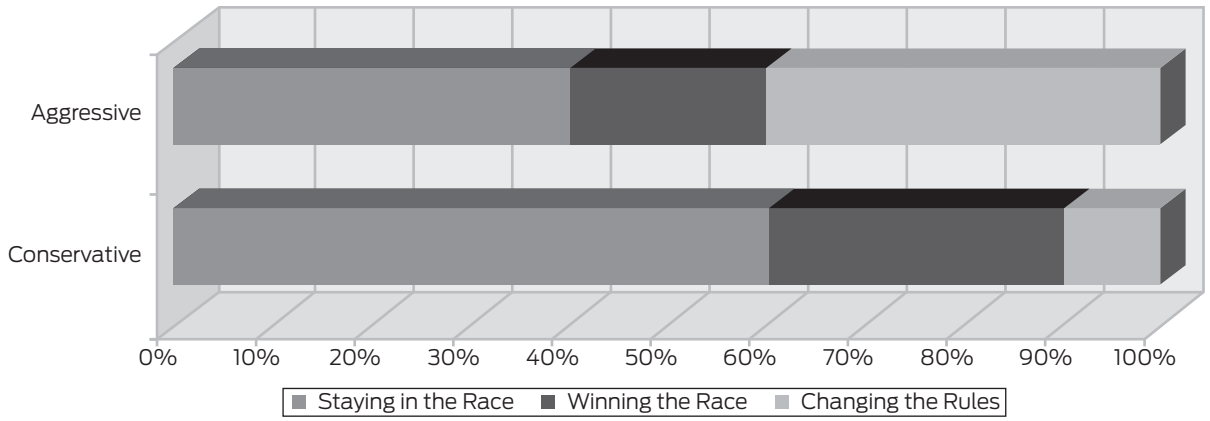

Figure 1: Both conservative and aggressive businesses that spend a large portion of their IT budget on operational and capital "staying in the race" expenses want to spend more on "winning the race" and "changing the rules" initiatives.

On the other hand, high-performance businesses, which are continually looking for ways to streamline business processes, quickly capture new opportunities, mitigate security, continuity and compliance risks, and attack operational inefficiencies, are investing more in innovative "winning the race" and "changing the rules" technologies. With these businesses, the investment distribution is reversed, with an average of 60 percent committed to innovation and the remaining 40 percent devoted to operational considerations.

Of course, none of these are hard-and-fast rules. They merely reflect what McKinsey has observed in the "real world" businesses it has studied. But one inescapable conclusion that emerges from the report is that on average, all businesses—even the most ambitious and technologically aggressive—still spend at least 40 percent, and in many cases much more, of their IT budget on simply "staying in the race," just keeping the network up and running. Given the evolution of networking technologies, that seems excessive.

The Economics of Networking

All businesses, even the most conservative, strive to be more competitive. So why do they spend half or more of their IT budget on "operational" issues rather than invest in innovative new technologies that could increase revenue and improve their competitive position?

In many cases, it's because the existing infrastructure leaves them no choice. Recent and not so recent advances in networking vividly demonstrate the incongruity of the current situation. Take switching, for example: its evolution over the past decade seems to suggest that businesses should be spending far less on this core technology than they used to. In 1997, a Cisco 7500 router offered 22 routed sub wire-speed 100BASE-T Fast Ethernet ports and cost in the neighborhood of $200,000. Today, thanks to newer, more efficient and cost-effective ASIC technology, switches offering 24 wire-speed Layer 3 Gigabit Ethernet switch ports are available in the $2,000 range. That translates to more than 10 times the performance at one one-hundredth of the cost—a dramatic improvement by any measure.

Such advancements should have significantly reduced the cost of implementing the underlying foundation of today's corporate networks, in turn liberating a considerable chunk of the IT budget. Even allowing for budget cuts of 50 percent over the same period, such a dramatic price reduction would still leave a large amount of money to safely invest in leading-edge "winning the race" and "changing the rules" technologies.

So why haven't businesses realized such a windfall? Because legacy switch vendors—those providers who initially installed these solutions 10 years ago, establishing a solid foothold in the corporate enterprise network—have a revenue stream to protect. These vendors have a vested interest in maintaining the status quo and preserving "old" technology alongside the new in order to keep revenues growing and customers dependent on their support. Over the years, as the number of users grew exponentially and corporate networks expanded to encompass the globe, vendors simply delivered new products and technologies designed to complement the existing infrastructure while satisfying immediate needs.

As a result, corporate networks have grown top heavy and unwieldy, requiring multiple layers of technologies and multiple generations of solutions intended to satisfy the same common objectives: to provide employees, partners and customers with fast, reliable and secure access to applications and services to collaborate efficiently, effectively and productively. To maintain this system, enterprises spend an inordinate amount of time, money and resources not only keeping their patchwork of networking solutions operational, but also ensuring that the products—released at different times over many years—are compatible and working together.

Redefining the Economic Landscape

Juniper Networks, the leading provider of high-performance networks for the high-performance business, believes this approach is fundamentally flawed. Tradition is no reason to continue doing things the wrong way.

Instead, by leveraging the latest technological advances in networking combined with innovative new switching and routing techniques, Juniper changes the existing paradigm and advances the economics of networking. By eliminating unnecessary switching layers, delivering wire-speed, high-port densities on compact platforms, enabling pay-as-you-grow scalability, and providing the high availability (HA) features businesses demand on all switching platforms, Juniper is dramatically reducing the equipment and the resources required to plan, deploy, implement and operate today's corporate network.

Such efforts will have the desired effect of lowering the capital and operational expenses that currently consume up to 60 percent of the IT budget. This in turn will enable businesses to reallocate a portion of their IT budget dollars—not to mention personnel—and spend more on "winning the race" and "changing the rules" technologies. Such investments will make high-performance businesses even more competitive without sacrificing the network infrastructure.

Reducing Capital Expenses

To understand how Juniper Networks will advance the economics of networking, it is first necessary to understand the composition of today's corporate networks.

The typical enterprise network is built upon multiple levels of switches deployed in three general layers: access, aggregation and core. These layers exist at various locations throughout the network, including remote and regional offices, campus buildings and the data center.

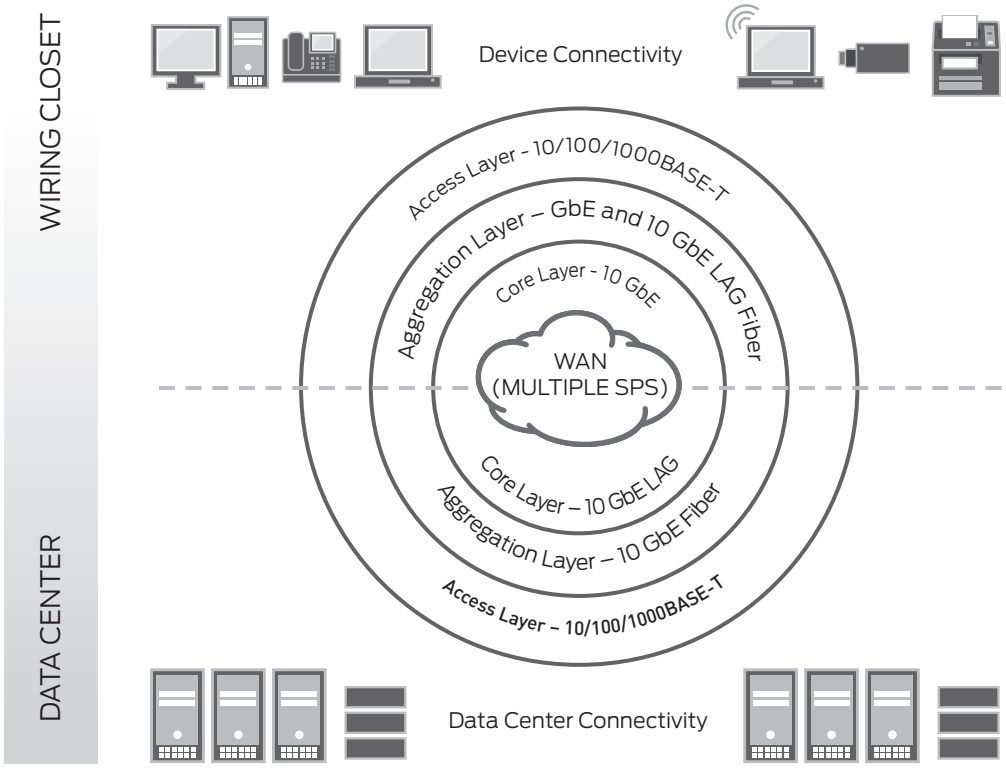

Figure 2: Multiple layers exist throughout the corporate network to facilitate communication and collaboration by connecting users to applications.

In remote/regional office and campus locations, access-layer switches reside in wiring closets where they connect networked devices such as PCs, printers, IP-enabled phones, wireless access points, CCTV cameras and others to the corporate network. Features such as compact form factor, high port density, Power over Ethernet (PoE), quality of service (QoS), network access control, and integrated security are important at this location.

In the data center, access-layer switches provide high-speed connectivity to application servers. In this location, high port densities, wire-speed performance, and HA are the most critical features.

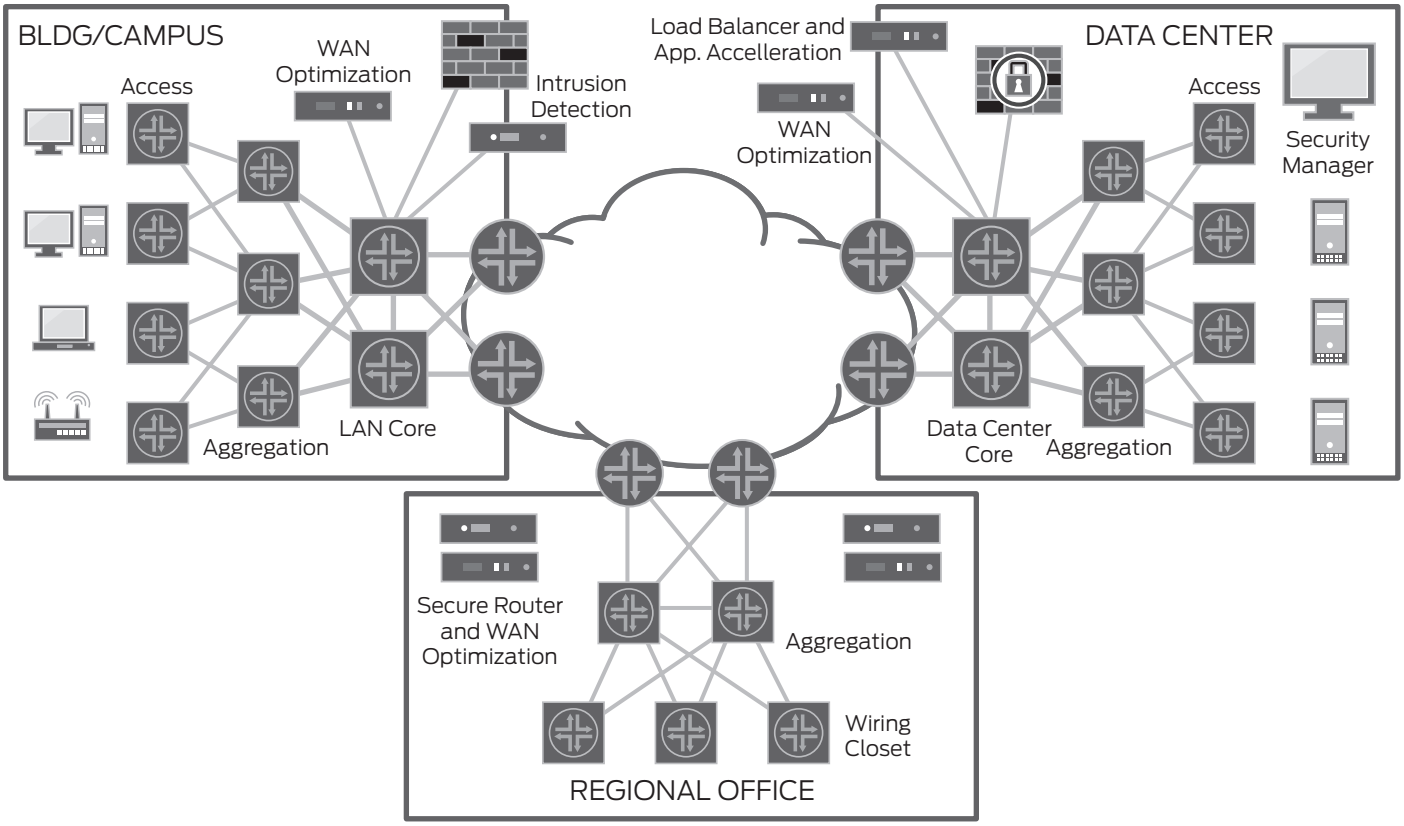

Figure 3: Corporate networks are composed of core, aggregation, and access switch layers in the campus, regional office, and data center.

The aggregation layer, sometimes called the distribution layer, aggregates connections and traffic flows from multiple access-layer switches to provide connectivity to core-layer switches. Due to their location in the network and data center, aggregation-layer switches must provide high-density, wire-rate ports—Gigabit Ethernet in campus and remote office locations, and 10-Gigabit Ethernet in the data center—as well as HA hardware and software features that deliver carrier-class reliability and robustness.

Core switches in the campus and data center provide high-speed 10-Gigabit Ethernet connectivity between aggregation-layer devices and the WAN, as well as across the Internet to enable business-to-business collaboration.

Like the aggregation-layer devices, core-layer switches connecting to routers at the network edge must offer high port densities, high-performance connectivity and maximum availability. Typically a firewall and an intrusion prevention system (IPS) are deployed between the routers and the core switches to protect against both external and internal threats. As more applications migrate to IP and converge on a single network, both firewall and IPS appliances are being deployed ubiquitously throughout the network to provide application-specific security as well.

History and evolution are responsible for this large number of switch layers in today's corporate network. As networks have grown, the previous generation of already-deployed switches hasn't been able to offer the throughput or port densities required to support rapidly escalating demands for high-speed connectivity and bandwidth. To overcome these limitations, switch vendors offered a triage approach that allowed customers to introduce new devices into their networks that complemented the existing infrastructure, while offering new features required to grow the business.

Naturally, switch vendors took advantage of these conditions and used the opportunity to boost revenues by selling myriad add-on devices and platforms designed to help customers "stay in the race" with their expanding enterprise. Over time, networks have grown predictably bloated with hardware that not only fails to meet business' emerging requirements, but also adds considerable management complexity, reduces network availability, and drives up capital and operational expenses.

Learning from the Past

As a recent entrant into the evolving switching market, Juniper Networks has factored lessons from these experiences into the development of a new portfolio of Ethernet switch products and network solution designs that address contemporary issues. These new products are designed to eliminate unnecessary network layers while providing a platform for delivering higher availability, converged communications, integrated security and higher operational efficiency. With these solutions, Juniper Networks delivers a greater value at a far lower total cost of ownership that advances the economics of networking.

Simplifying the LAN Core and WAN Edge

The Juniper solutions begin their transformation of the corporate network at the LAN core, adjacent to WAN routers providing multiple interfaces such as OC-12 and Ethernet, as well as the essential media conversion services between legacy media and Ethernet. Today, more and more WAN services are delivered via an Ethernet handoff, obviating the need for media conversion since both the WAN and the LAN are speaking the same "language." Ideally, an Ethernet-optimized WAN router with high-density high-speed ports can collapse both WAN router and LAN core switching functionality into a single device, thereby eliminating an expensive switching layer while providing the necessary software functionality and connectivity between the WAN and the aggregation layer.

The Juniper Networks MX Series 3D Universal Edge Routers represent such a class of device. Purpose-built to deliver Internet-class routing combined with the port density of Ethernet core switches, the MX Series establishes a new industry standard for Ethernet density and performance, delivering up to 960 gigabits per second (Gbps) of capacity to power wire-rate switching and routing performance of up to 480 Gigabit Ethernet ports or 48 10-Gigabit Ethernet ports. The MX Series also runs the proven Juniper Networks Junos® operating system for routers, delivering the same reliable routing protocols that currently power the top 100 global service provider networks and providing the HA functions that keep high-performance, revenue-generating networks running non-stop. This unique combination enables the MX Series to collapse the WAN router and core LAN switch layers in large data center and campus networks into a single platform.

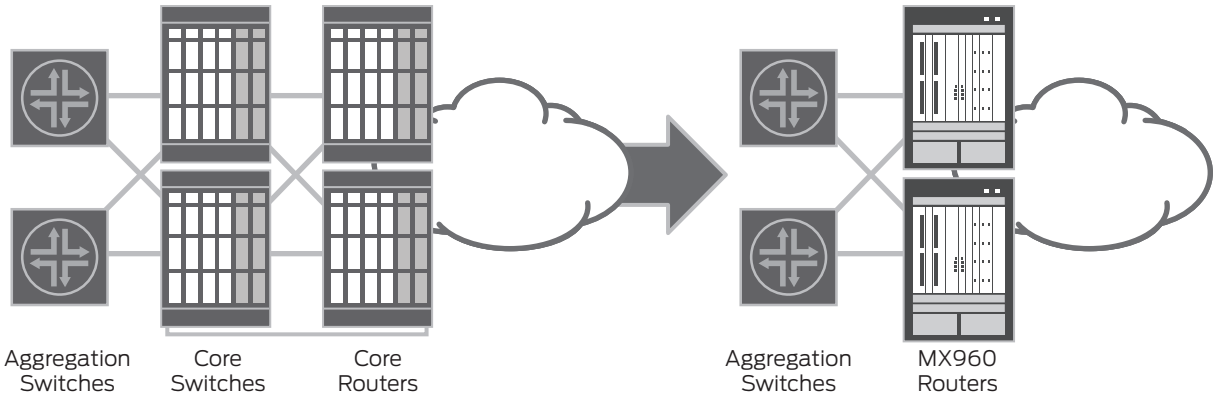

Figure 4: By collapsing core routing and switching into a single platform, the Juniper Networks MX960 Ethernet Services Router eliminates a layer in the data center, increasing efficiency.

Consolidating Network Layers

Juniper Networks EX Series Ethernet Switches are also having an impact on the economics of networking by enabling the collapse of the LAN core and aggregation layers. Typically, more than two layers of legacy Layer 3 switches are required to achieve the wire-speed port densities demanded by today's high-performance enterprises.

Most core switches, designed for an earlier time when Gigabit Ethernet was the newest and fastest technology, deliver a limited number of 10-Gigabit Ethernet ports to support high-performance, high-speed uplinks from aggregation switches deployed throughout the campus. While the limited port densities offered on these devices may have been sufficient at some point, constant network expansion means that they have long outgrown their efficacy.

In order to scale efficiently and provide the necessary 10-Gigabit Ethernet port densities in today's LAN core, these legacy switches must be deployed in multiple layers within the core. While ultimately effective, this approach requires an extra layer of core switches. Not only does it add tremendously to capital expenses by consuming a large chunk of the IT budget, it also complicates operations, adding an additional maintenance and management burden, increasing network latency, and creating unwanted oversubscription ratios that reduce overall application performance.

Raising Port Densities

The Juniper Networks EX8200 line of Ethernet switches offers a high-density solution with up to 64 (eight-slot chassis) or 128 (16-slot chassis) wire-speed 10-Gigabit Ethernet ports. The EX8200 provides a powerful, high-performance solution that easily scales to meet the demands of today's constantly expanding enterprise.

The EX8200 advances the economics of networking in two ways. First, the EX8200 delivers the high-density, 10-Gigabit Ethernet wire-rate ports in the core, eliminating the need to deploy multiple layers of switches that add complexity, cost, oversubscription, and latency. Second, the 10-Gigabit Ethernet port density is sufficient to eliminate the aggregation layer entirely for medium-sized enterprise networks, enabling the access switches to connect directly to the core over wire-speed 10-Gigabit Ethernet links. Eliminating a full layer of aggregation switches will dramatically reduce capital expenses, lower power consumption and simplify network operations—everything from OS upgrades and moves, adds and changes to troubleshooting and problem resolution.

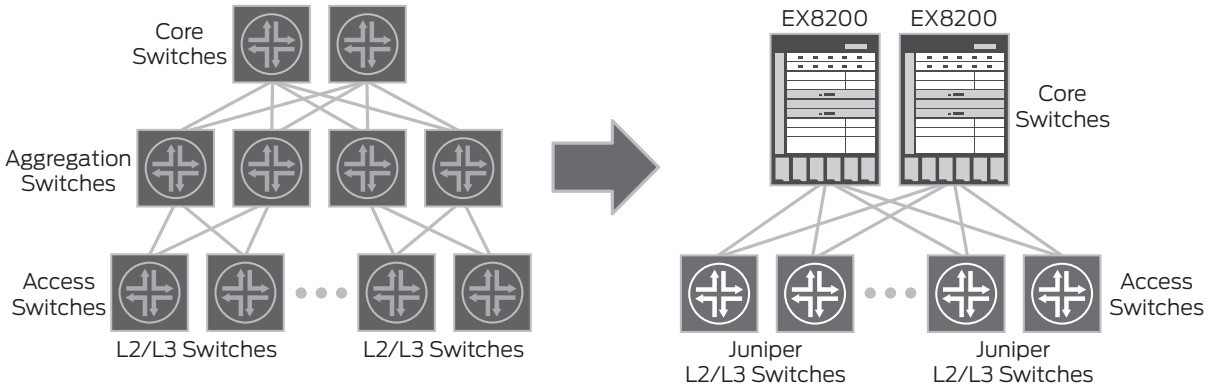

Figure 5: Multiple layers of switches are currently required to achieve the same 10-Gigabit Ethernet port densities available with the Juniper Networks EX8200 line of Ethernet Switches.

For large enterprise networks that require an aggregation layer, Juniper Networks extends those CapEx reductions to the aggregation layer. Aggregation switches, which consolidate distributed wiring closets on a single platform and connect them to core switches, require high-density fiber interfaces to support potentially long runs between floors or even buildings. Due to their critical role of providing connectivity between distributed users and centralized servers in the corporate network, aggregation switches also require HA features to ensure continuous delivery of applications and business processes.

Previously, only expensive chassis-based switches could provide the combination of high 1000BASE-X fiber port densities and the HA features required to satisfy aggregation requirements. While certainly scalable and highly available, these modular chassis-based switches are not a very cost-effective solution for such applications. First, they require a considerable up-front investment for the chassis and common equipment, even if not fully populated. Second, because of their size, modular chassis require more space in already crowded server racks, taking up valuable real estate. Third, modular chassis require more power and cooling—recurring costs that increase capital expenses and contribute to the production of greenhouse gasses that threaten the environment.

Virtual Chassis Technology

Juniper Networks addresses these requirements with a true innovation: the Juniper Networks EX4200 Ethernet Switches with Virtual Chassis technology. The EX4200 advances the economics of networking by delivering the high availability and high port densities of a modular chassis in a compact, cost-effective, pay-as-you-grow platform.

Five versions of the EX4200 Ethernet Switch are available, supporting:

- 24 10/100/1000BASE-T ports with full and partial PoE
- 48 10/100/1000BASE-T ports with full and partial PoE
- 24 100BASE-FX/1000BASE-X fiber ports

Each EX4200 also supports optional field-replaceable front panel uplink modules supporting either four Gigabit Ethernet or two 10-Gigabit Ethernet ports for high-speed connections to aggregation or core switches.

To scale switching throughput with port density, the Virtual Chassis technology uses a 128 Gbps virtual backplane that enables up to 10 EX4200 switches to be resiliently interconnected and managed as a single unit, supporting up 240 100BASE-FX/1000BASE-X ports, 480 10/100/1000BASE-T ports, or any combination of the two, plus up to twenty 10-Gigabit Ethernet uplink ports. Businesses can start with a single one-rack-unit (1 RU) EX4200 and, using Virtual Chassis technology, incrementally add up to nine more at any time for a total of 10.

The 128 Gbps virtual backplane protocol can also be extended across the 10-Gigabit Ethernet uplinks to interconnect switches that are more than a few meters apart, creating a single virtual switch that spans multiple wiring closets, floors or even data center server racks. Even when separated by long distances, interconnected EX4200 switches can be managed, monitored, upgraded, and otherwise treated as a single resilient switch, dramatically reducing recurring management and maintenance costs.

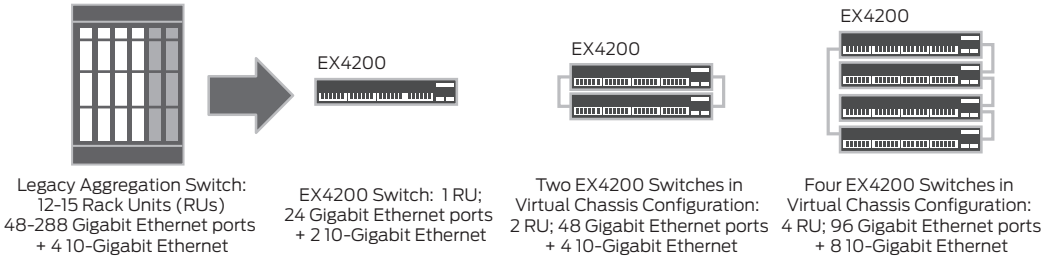

Figure 6: The Juniper Networks EX4200 switches with Virtual Chassis technology represents a compact, scalable solution that avoids large up-front investments while imposing a much smaller footprint and lower power and cooling requirements.

The EX4200 also provides the same HA features as modular chassis-based systems. Each EX4200 switch supports redundant, load-sharing, hot-swappable AC or DC power supplies, as well as a field-replaceable hot-swappable fan tray with redundant blowers, any of which can fail without affecting operations. When deployed in a Virtual Chassis configuration, the Junos OS that powers the switches takes full advantage of the multiple routing engines present to deliver graceful routing engine switchover and non-stop forwarding to ensure uninterrupted operation. In the future, Junos OS will enable the switches to support in-service software upgrades (ISSU) and non-stop routing—direct benefits of the multiple active routing engines in a Virtual Chassis configuration that will keep data flowing under all conditions.

By offering greater flexibility at comparable Gigabit Ethernet port densities, the pay-as-you-grow approach of the Juniper Networks EX4200 Ethernet Switches represents a much more scalable and economical configuration with 10-Gigabit Ethernet uplinks than chassis-based switches. At one-eighth the footprint and less than one-third the cost of the most commonly purchased chassis-based switch offering 48 fiber Gigabit Ethernet ports and four 10-Gigabit Ethernet wire-speed ports, the EX4200 represents the new generation of switching, delivering greater value while reducing capital expenses, and freeing up IT budget dollars to implement technologies for “winning the race” or “changing the rules.”

For more demanding 10 GbE applications such as top-of-rack server access, Virtual Chassis technology will also be available with the Juniper Networks EX4500 Ethernet Switch, designed for data center and campus aggregation and core deployments.

Reducing Operational Expenses

Juniper Networks helps businesses reduce operational expenses by collapsing layers such as the WAN edge and LAN core into the MX Series router, or the LAN core and aggregation layer into the EX8200 line of Ethernet switches—thereby reducing the number of devices in the network.

These same capabilities enable the EX4200 and EX4500 lines of Ethernet switches with Virtual Chassis technology to reduce the overall number of access and aggregation switches by allowing multiple units to act as a single device, reducing network complexity and management requirements. This directly impacts operational expenses by requiring fewer financial and human resources to operate the network.

Consider access-layer switches deployed in wiring closets. A typical floor in a networked building has two wiring closets in order to serve all users without violating distance limitations. The wiring closets are the termination point for connecting all PCs and IP phones in the immediate vicinity, including surrounding cubes, offices and conference rooms, as well as wireless LAN (WLAN) access points, building automation systems and security cameras.

Traditionally, "stackable" switches are deployed in the separate wiring closets to support the local users. These switches are typically deployed in pairs to provide a backup that limits failure domains to a single switch, and they must be managed and maintained separately.

The EX4200 advances the operational economics of this scenario by reducing the management and maintenance burden. Since the EX4200 can be interconnected over the 128 Gbps Virtual Chassis backplane protocol or via the front-panel 10-Gigabit Ethernet links, IT can create a single "virtual" device on each floor. As a result, the total number of wiring closet access switches that need to be actively managed is cut in half, producing direct and immediate operational savings. When more than two stackable switches are deployed in each wiring closet, the savings are that much greater.

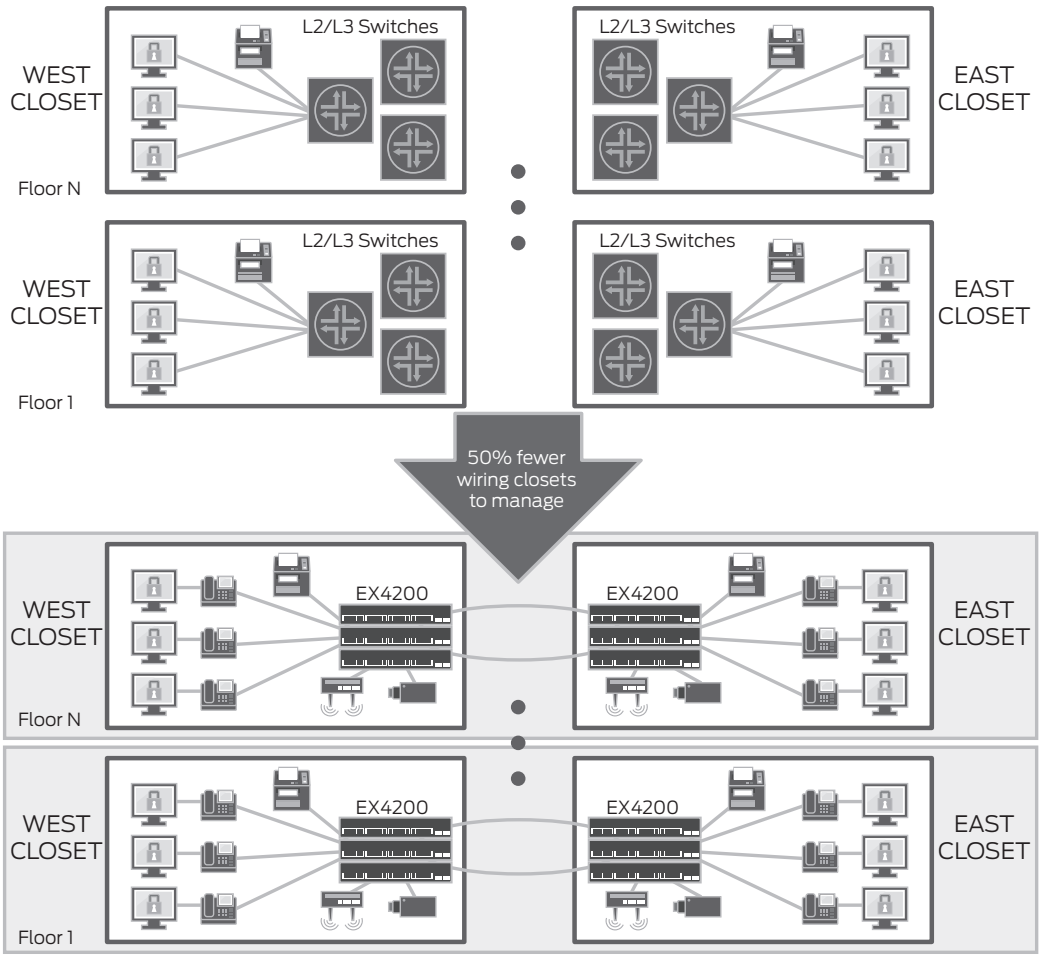

Figure 7: The Juniper Networks EX4200 Ethernet Switches with Virtual Chassis technology reduces operational overhead in the wiring closet by enabling multiple devices to operate as a single unit, cutting the effective number of switches in half.

The same principle applies to top-of-rack applications in the data center. In top-of-rack deployments, it is common for stackable switches to be deployed in pairs at the top of each server rack to provide redundancy and ensure high availability, as well as to provide sufficient Gigabit Ethernet port densities for server connectivity.

With the EX4200 switches with Virtual Chassis technology, up to 10 top-of-rack switches across five server racks, can be interconnected over the 128 Gbps virtual backplane or the optional 10-Gigabit Ethernet uplink modules to create either one or two Virtual Chassis configurations. Those interconnected switches can then be managed and maintained as a single device (see Figure 8) or as two virtual devices composed of five switches each (see Figure 9). These Virtual Chassis configurations reduce the number of data center top-of-rack access switches by a factor of 10 or 5, depending on the configuration, reducing operational expenses a commensurate amount. For 10 GbE server access applications, the EX4500 will support high-performance top-of-rack or end-or-row deployments, which also benefit from Virtual Chassis technology by creating a single virtual device that greatly reduces network complexity in the data center.

Multiply these savings by the total number of server racks and the OpEx savings grow accordingly. Again, the EX4200 produces dramatic savings that can now be spent on innovation rather than maintenance—without sacrificing performance.

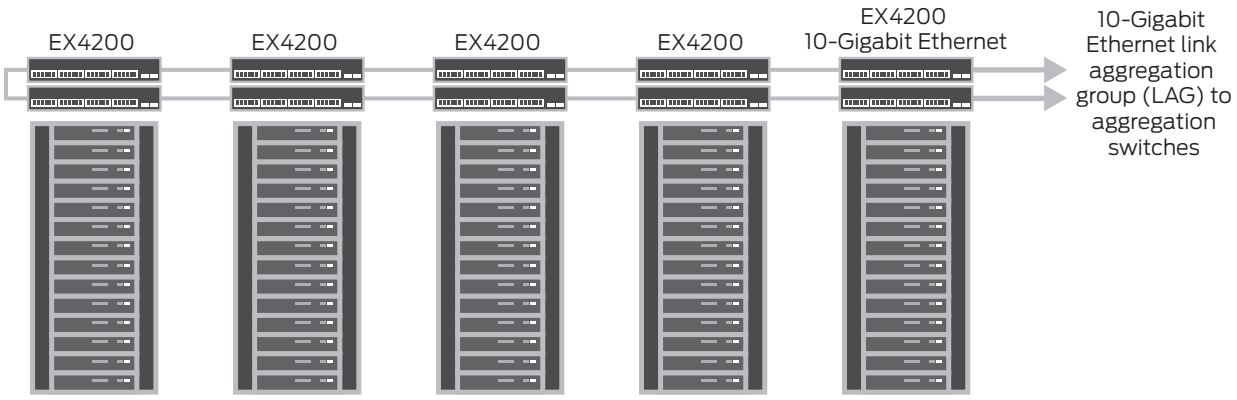

Figure 8: The Juniper Networks EX4200 Ethernet Switches with Virtual Chassis technology reduces management overhead by creating a single managed top-of-rack device consisting of 10 switches (two in each rack).

In both the wiring closet and data center access deployments, the 10-Gigabit Ethernet uplinks may be distributed across any combination of switches that form a single Virtual Chassis configuration to ensure higher availability. In addition, multiple 10-Gigabit Ethernet uplinks from any of the switches that are members of the Virtual Chassis configuration—regardless of whether they are in separate wiring closets or at the top of separate racks—can be link-aggregated for higher bandwidth connections to other aggregation or core switches.

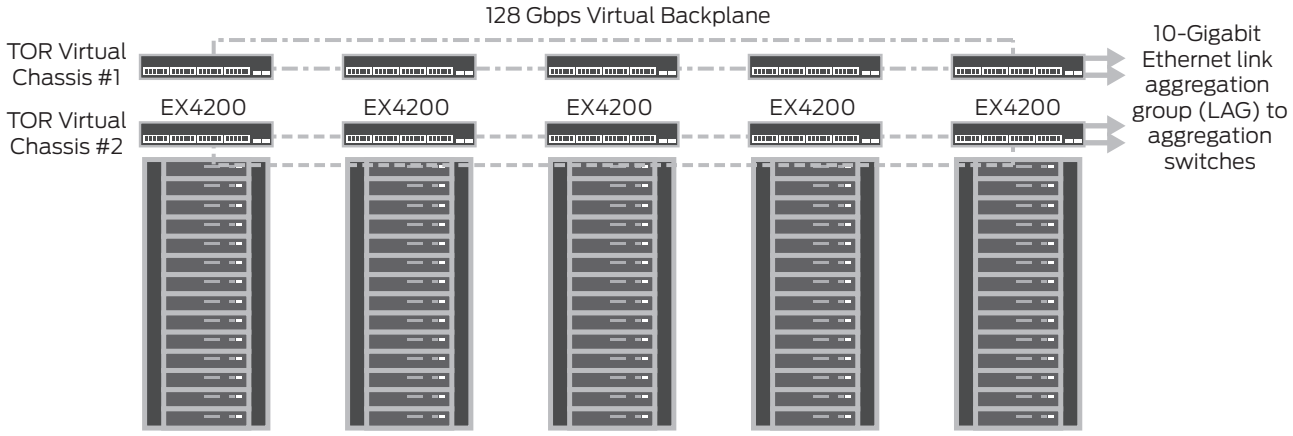

Figure 9: To provide the highest level of access connectivity and availability, two EX4200 top-of-rack Virtual Chassis configurations can be created, each consisting of one switch from each rack for a total of five switches per Virtual Chassis.

Energy Efficiency

In addition to OpEx savings, the Juniper Networks EX Series Ethernet Switches also reduce power, cooling, and space requirements—a direct result of eliminating network layers and replacing chassis-based solutions with switches equipped with Virtual Chassis technology.

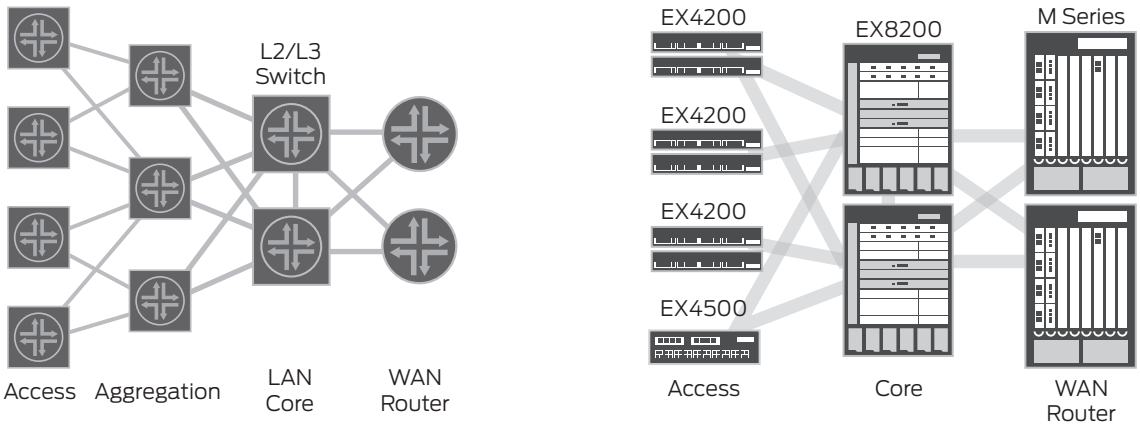

Figure 10: By collapsing or eliminating network layers, the EX Series Ethernet Switches lower power and cooling requirements and reduce greenhouse emissions.

In the campus, for instance, the EX4200 offers the HA features, management simplicity, high port densities, and scalability required to collapse access and aggregation layers. Working in conjunction with Juniper routers, the EX Series Ethernet Switches realize similar savings in data center deployments supporting five rows of ten server racks.

As a result, not only does the EX4200 consume a fraction of the power, cooling, and space of traditional wiring closet chassis switches, it also reduces greenhouse emissions, making a Juniper Networks infrastructure a truly green choice.

Junos OS: The Silver Bullet

While the switches produce considerable OpEx reductions, those savings aren't limited to the hardware alone. Juniper Networks also reduces network operational expenses by delivering the single, common, and consistent portfolio-wide Junos OS. A study commissioned by Juniper and conducted by Forrester Consulting* found that the Junos OS, working with Juniper switches and routers, helped companies achieve a 40% reduction in operations costs for certain network tasks including planning and provisioning, deployment, and planned and unplanned network events.

Juniper switches and routers employ the Junos OS, ensuring consistent and predictable behavior across the product family. Fundamental to the value of Junos OS are the "three ones"—one operating system, one release track, and one modular architecture. Running a common operating system across Juniper products dramatically reduces maintenance and management overhead while ensuring a single, consistent implementation of control-plane feature, as well as a consistent management of those features.

Figure 11: Junos OS ensures stable operations across the entire product family.

* "The Total Economic Impact™ of Juniper Networks' Junos network operating system" by Forrester Consulting. A commissioned study conducted by Forrester Consulting on behalf of Juniper Networks.

One Source Code

The truly unique nature of Junos OS begins with its most fundamental virtue: a single source base of code. Unlike other network operating systems that share a common name but splinter into many different release trains, Junos OS has remained a single, cohesive operating system throughout its development.

Juniper Networks engineers develop Junos OS control plane features only once, and then apply them to all platforms where they are required, ensuring a common user experience across devices. A single common interface lets users configure and manage features in the same way—from chassis management to OSPF and BGP routing—with the same effect throughout the network. As a result, the operations team can be trained once and use those skills on every Junos OS-based product in the network.

One Release Track

Each new version of the Junos OS is a superset of the previous version. The single release train means new Junos OS features are implemented in the mainline, never in bug-fix releases, ensuring stability from one release to the next. Test engineers must achieve zero critical regression errors for all previously released features, fixing any and all critical bugs for new and previously-released features, ensuring reliable operations for the entire release. This regression testing mandate gives customers the highest confidence that prior features will work reliably in a new release, enabling them to gain business speed by deploying the release immediately rather than allocating several man-months to test and validate each release for their environment.

One Modular Architecture

The Junos OS adheres to a disciplined development process that builds upon a modular software architecture, ensuring that the software is more tightly controlled than if it were part of a monolithic code base.

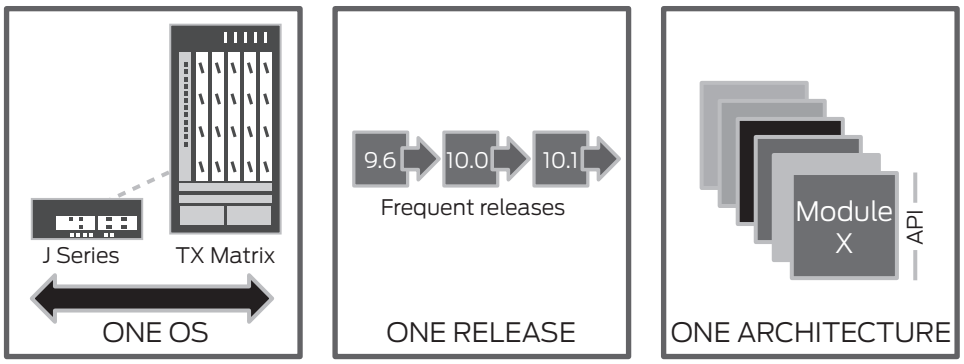

Figure 12: Junos OS follows a single release track to ensure consistent implementation of features across the entire Juniper Networks product family.

The modular Junos OS architecture ensures that the control plane features are similar across the broad product portfolio so that OSPF on, say, the EX Series is identical to OSPF on the MX Series, T Series, and M Series—even though each product family implements different ASIC- and CPU-based packet forwarding engines (PFEs).

The modular design of the Junos OS architecture also enhances fault-tolerance. Since each Junos OS daemon runs in its own protected memory space and can restart independently, one module cannot disrupt another by "scribbling" on its memory. If a malfunction occurs in one module, the rest of the system continues to function—unlike monolithic operating systems where a similar malfunction could possibly cause a full system crash and restart.

One-of-a-Kind Operating System

No other network operating system follows the same strict, disciplined development process as the Junos OS. As a result, competitive operating systems have splintered into multiple disparate release trains, creating several levels of inconsistency and adding untenable complexity to the network. Businesses deploying the latest version of these operating systems and implementing new features risk potentially disrupting the network. To avoid such risks, many businesses dedicate teams of engineers to test and verify new operating system updates before they are deployed; other businesses simply avoid upgrades and make do with old software, sacrificing functionality for stability.

By contrast, the Junos OS—which runs in one-third of the Fortune 100—remains a single, cohesive operating system throughout its development process. Thanks to that consistency, the learning curve for Junos OS is substantially reduced; the software's single-implementation architecture means that IT can use the same tools to monitor, manage, and update multiple devices.

Another benefit of the Junos OS single release train is interoperability. A single software implementation, regardless of platform or release version, greatly simplifies new feature deployment, software upgrades and other network modifications.

Finally, Junos OS offers error-resilient configuration that helps prevent operators from inadvertently bringing down the network. The Junos OS commit model updates all configurations via a candidate configuration, which is a copy of the running configuration. IT must explicitly commit changes after entering and reviewing all modifications, and the system automatically checks for syntax errors or incorrectly constructed configurations that could cause potential problems.

A confirm function then requires the user to approve configuration changes within a specific period of time or the system will revert to the previous configuration. This prevents unintended or incomplete configuration changes from isolating remotely managed devices. If a new configuration degrades operations, a rollback command quickly restores any of the 50 prior configurations.

Managing the Network

Four options are available for managing the Juniper Networks EX Series Ethernet Switches, delivering complete flexibility for any corporate network.

First, a Junos OS-based command-line interface (CLI) or Web-based J-Web tool is available for individual device configuration and management. With the CLI, repetitive configuration and other operational tasks can be automated and repeated as needed, while J-Web provides scripts for automating routine tasks, providing additional time savings for overburdened IT resources.

For managing a network of switches and other Juniper products including Juniper Networks J Series Services Routers, firewall, IDP Series Intrusion Detection and Prevention Appliances, SRX Series Services Gateways, and remote access devices, Juniper's Network and Security Manager (NSM) provides discovery, configuration and policy, inventory and log management tools that enable users to monitor performance and troubleshoot problems from a central location.

Additional management is provided by Juniper Networks Junos® Space, an open, extensible network platform for developing and hosting custom network management applications that reduce cost and complexity. A core member of the Juniper Networks Junos® Platform, Junos Space uses the same design principles and open systems approach as the Junos OS to enable programmability at the network application layer.

If users haven't invested in the NSM platform, the switches can also be managed by leading third-party management applications such as HP OpenView NMM, IBM Tivoli NetView, and Computer Associates Unicenter, delivering maximum flexibility for diverse network environments.

Conclusion

Aging network systems and old habits have dictated how businesses spend their IT budgets. As a result, a large percentage, if not a majority, of IT dollars are being spent to merely "stay in the race." While this model keeps revenue streams flowing for legacy network vendors, it doesn't necessarily help businesses gain a competitive advantage by "winning the race" or "changing the rules."

Juniper Networks proposes to change this economic model by delivering a new family of solutions that reduce capital and operational expenses. By freeing up these IT budget dollars, Juniper Networks allows businesses to invest in other innovative technologies that will further reduce the cost of doing business while improving their competitive position and focusing on activities that will have the greatest positive impact on their bottom line.

Juniper Networks products, including a new family of high-performance Ethernet switches, redefine the way businesses build their networks. Offering high port densities, wire-speed connectivity and high availability in compact, pay-as-you-grow platforms, the Juniper Networks EX Series Ethernet Switches represent a powerful yet cost-effective alternative to the aging and expensive solutions pushed by today's dominant switch vendors. By offering a smaller footprint in the wiring closet and data center, combined with lower power and cooling requirements, the Juniper solutions represent the efficient and "green" solutions users are looking for to power the networks of the future.

And because the switches are powered by a single, consistent operating system—the same operating system employed by Juniper router and firewall products—the network infrastructure is exceedingly easy to deploy, configure and upgrade, saving considerable resources that can be reallocated to further improve business operations and increase revenue. Juniper has an aggressive strategy designed to simultaneously advance the fundamentals and economics of high-performance networking, enabling high-performance businesses to "change the rules" with respect to their IT budget to expedite workforce productivity, support revenue and profitability goals, assume a proactive stance to risk mitigation, and realize a quick time-to-value from their high-performance network infrastructure investments. This will help to ensure that the Juniper Networks high-performance network infrastructure remains the preferred choice for high-performance businesses.

About Juniper Networks

Juniper Networks, Inc. is the leader in high-performance networking. Juniper offers a high-performance network infrastructure that creates a responsive and trusted environment for accelerating the deployment of services and applications over a single network. This fuels high-performance businesses. Additional information can be found at **www.juniper.net**.

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2000251-003-EN April 2010