Network Automation and Orchestration

Building an Agile Data Center Infrastructure with Juniper Networks

Table of Contents

List of Figures

Executive Summary

Effective data centers are central to the success of any enterprise, and the flexibility and agility of data center operations is essential to successful mission and business outcomes. As technology has evolved, so too have data center capabilities, including the introduction of virtualization strategies that have enabled some level of agility and flexibility. However, network operations still tend to rely on many manual processes that require the expertise of highly-trained professionals and may be subject to vulnerabilities introduced by human error. These operational realities can lead to higher data center management costs and, in some cases, loss of business or missed opportunities due to lack of agility or data center downtime.

Juniper Networks offers switching solutions that are designed to address and neutralize these data center management issues by enabling more agile networking infrastructure. A fundamental principle of Juniper's approach is that a simplified network architecture will lead to more simplified operations. Consequently, Juniper Networks' operations strategy is based on automating provisioning, streamlining day-to-day management, and orchestration of networking platforms that combine to enable faster response to dynamic business environments. In addition, Juniper's switching platforms and management tools provide open interfaces to integrate seamlessly with third-party automation and orchestration tools, so that network operations are integral to the data center workflow.

Introduction

Data Center Evolutions and Trends

As a foundational enterprise component, data centers are continuously evolving to meet the demands of business, mission, and operational requirements. Data centers have undergone a series of transformations, from the days of mainframe computing to the client-server PC era to a world of distributed applications. Today, applications are defining how data centers are designed and operated. Applications management must provide capabilities for applications to be quickly brought up, brought down, and moved to respond to changing conditions and to make best use of underlying resources. To meet the growing need for agility and flexibility, the data center components (compute, network and storage) also need to evolve and provide a level of automation and orchestration that can meet present and future demands.

Need for Network Automation

Server virtualization initially was designed to improve resource utilization. It has quickly evolved to provide a server environment that is more agile, a significant benefit that is proving to be increasingly critical in the efficient data center. In the past, deploying a server could take days, if not weeks. Today, virtual machines and applications can be deployed in seconds, helping organizations meet their business requirements while reducing operational expenses.

This agility comes from the fact that the compute infrastructure has been integrated with external automation tools and management systems. However, a data center is an ecosystem of multiple elements, and changes made to the compute infrastructure require corresponding updates to the network infrastructure. Unfortunately, the provisioning and management of the network often has not kept pace with those of virtual machines and applications. It can still take days, if not weeks, to provision the required flow across an entire network, mainly due to the fact that network provisioning and configuration are primarily manual processes. For many organizations, the network has become a bottleneck, preventing those enterprises from deploying a robust, agile, and highly responsive data center infrastructure.

Network Operations and Automation

Data center network operations can be categorized as three specific tasks: provisioning, management, and orchestration. Provisioning involves the initial deployment of networking equipment; once provisioning is complete, management covers the day-to-day operational decisions, and lastly, orchestration focuses on the ability to manage the different data center elements, servers and storage in concert with each other. To implement a data center that can adapt and respond rapidly to changing business and environmental conditions, it is necessary to automate all these tasks. Let's look more closely at each of these tasks and understand how we can begin to automate them.

- **Provisioning:** Network provisioning is a complicated process. Typically, a top-of-rack (ToR) switch that is deployed in the data center is staged, a process where the correct image and configuration is loaded before it is placed into production. Usually, this is a manual process, performed by trained networking professionals. As a result, provisioning the network is not only time-consuming, but also error-prone. This initial process can clearly benefit from automation where switches are able to download the correct image and configuration as soon as they are racked, stacked and powered on.

- **Management:** Once a switch is provisioned, it needs to be constantly managed. This is where the bulk of a network administrator's time is spent and where automation can make a real difference. The switches need to have a flexible scripting mechanism that allows them to respond automatically to simple alerts and events. In addition to scripts, switches also need to be programmable by third-party tools which will allow for better integration into the data center workflow.

- **Orchestration:** Data centers are an ecosystem of compute, storage, and networking equipment. Unfortunately, these elements often are managed by different teams as separate entities. This approach has resulted in a rigid infrastructure that is not agile enough to adapt to an ever-changing business environment. As an example, today Virtual Machines can be spun up on demand, but the required VLAN provisioning on the network may take several days because of an archaic change request process. Creating a truly agile data center infrastructure requires that different elements of the data center are managed in concert and across these subject-matter teams.

Ideally, network configuration changes need to happen automatically and immediately. When a new Virtual Machine is spun up, the VLANs it belongs in need to be configured automatically on the ToR switch. To achieve this kind of integration, it is imperative that switches provide support for orchestration tools such as OpenStack and CloudStack. In addition, by supporting IT automation solutions like Puppet or Chef, the network now can be managed in concert with the overall data center infrastructure.

Juniper Network's Strategy for Network Automation

Juniper Networks takes a holistic approach to network automation and orchestration and has designed a strategy for providing networking professionals with tools and technologies that reduce the operational burden of managing a network. This strategy begins with simplified architectures that are easy to manage, reduce the number of managed devices, and abstract the complexity of the network topology. In addition, the inherent flexibility of Juniper Networks® Junos® operating system enables integration with external tool chains to increase operational efficiency, minimize downtime from configuration errors, and reduce operational overhead.

Simplified Architectures

Historically, data center networks were built to emulate a conventional LAN environment, providing connectivity between a small set of clients and a few servers. While the three-tier design that emerged worked well for campus LANs, where most traffic flows "north and south," it has not proven to be the ideal design for data centers, where 75% of traffic is "east and west"—that is, between servers and storage systems operating as peers.

Compounding the problem is the fact that, in today's virtualized data center, applications no longer are tied to specific servers whose physical locations and associated network configurations are known. Consistent performance requires location independence, where resources are flexibly allocated to whatever Virtual Machine (VM) the application uses.

Additionally, the three-tiered network architecture resulted in numerous switches to manage. The key to simplicity and efficiency is to minimize the number of managed devices to reduce the required management overhead.

Juniper provides a unique architectural approach that simplifies and flattens the data center network by:

- Providing location independence for facilitating network planning and design;
- Optimizing the system for east-west traffic and lower latency between applications; and
- Simplifying management by reducing the number of managed devices.

Juniper accomplishes these objectives by supporting a broad range of switching architectures, each designed to improve network performance, increase network availability and simplify data center operations.

Juniper's switching platforms act as flexible building blocks that can be used to support any data center switching architecture, scaling from dozens to thousands of ports. All architectures are capable of supporting the latest data center automation and orchestration tools and applications, providing a solid foundation for software defined networking.

- **Virtual Chassis:** Virtual Chassis technology enables up to 10 interconnected switches to operate as a single, logical device, simplifying management. In addition, Virtual Chassis technology lets users mix 1GbE and 10GbE platforms, enabling plug-and-play operation and seamless migration from 1GbE to 10GbE.
- **Virtual Chassis Fabric:** Virtual Chassis Fabric is optimized for small, mixed 1GbE/10GbE/40GbE data center environments, enabling up to 20 interconnected switches to operate as a low-latency, high-performance data center fabric that is managed as a single device.
- **Junos Fusion:** A centrally managed fabric that features plug-and-play provisioning and auto-configuration capabilities, Junos Fusion greatly simplifies operations at scale and reduces operating expenses while accelerating the deployment of new applications and services. Industry-leading scale, performance, and density make Junos Fusion ideally suited to the needs of highly virtualized business-critical IT data centers and software-defined cloud data centers.
- **QFabric:** QFabric™ technology, designed for medium to large data centers, reduces the data center network to a flat, high-performance fabric where all access points are equal, eliminating the effects of network locality. Each QFabric System operates as a single switch, supporting up to 6,144 10GbE ports and Fiber Channel gateway capabilities.
- **Open Fabric Architectures:** Juniper switches support any open network topology, including MC-LAG-based spine and leaf and very large-scale Layer 3 fabrics.

Together, these unique Juniper technologies offer tremendous flexibility for designing modern data center network.
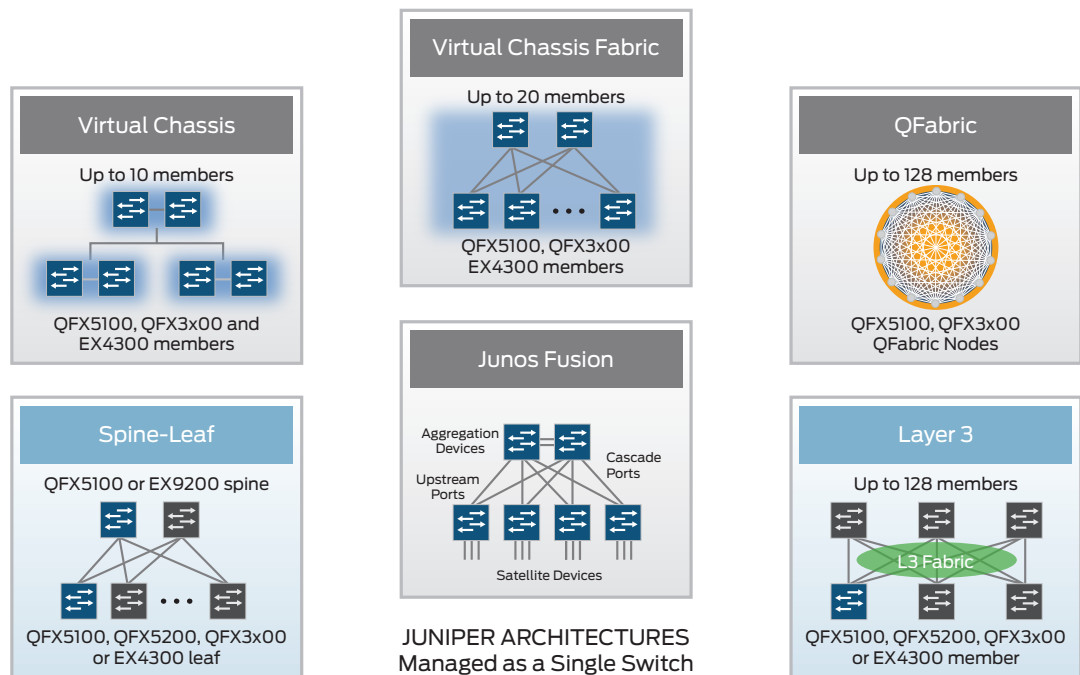
Figure 1: Juniper Network's Simplified Architectures

Simplified Operations

Once the physical topology has been simplified, it becomes easier to simplify operations by introducing capabilities that automate various tasks involved in running a data center network. Juniper takes a three-pronged approach to automating the network—one that is built around the task of network automation (i.e., provisioning, management, and orchestration to create a more agile and responsive data center infrastructure). Juniper switching platforms support a variety of built-in features like Zero Touch Provisioning (ZTP), along with open interfaces that allow integration with third-party tools, and open standards-based orchestration systems such as OpenStack. In addition, Juniper provides a single pane-of-glass management solution with Junos Space Network Director, which manages both physical and virtual networking environments while integrating with management tools from VMware.

- **Zero Touch Provisioning (ZTP):** Juniper's EX Series and QFX Series switches automate the provisioning process with Zero Touch Provisioning. ZTP allows a networking professional to load the image and configuration of a switch in a central location, typically a Dynamic Host Configuration Protocol (DHCP) or a Trivial File Transfer Protocol (TFTP) server. A switch is then racked, stacked and powered on. When powering up, the switch sends out a DHCP request and receives the location of its images and configuration in response. The switch then downloads the image and configuration and is fully operational, requiring no human intervention. This process is repeatable and customizable to different switches. ZTP can dramatically reduce the time to provision the network in a data center and decrease the opportunity for introduction of human error into the network.

  To better understand ZTP benefits, consider a data center with 1,000 servers that would require hundreds of thousands of lines of configuration, typically entered through a Command Line Interface (CLI). If the switches are provisioned in the traditional manner, the provisioning process would take days, even for the most efficient network administrator. With ZTP, these tasks can be completed must faster since only the DHCP server needs to be configured and the switches automatically receive their image and configuration instructions when they boot. Additionally, since fewer CLIs were typed, the chance for human error is dramatically reduced, thereby ensuring less network downtime. ZTP provides a trusted and effective way to significantly reduce costs associated with provisioning and prevent data center outages.

- **Junos Space Network Director:** Junos Space Network Director provides a smart, comprehensive and automated network management solution that enables network administrators to visualize, analyze and control their entire enterprise network through a single pane of glass. In the data center, Network Director helps administrators manage and synchronize both physical and virtual environments, ensuring network policies follow workloads as they move from server to server. Network Director integrates with VMware vCenter to increase operational efficiency and enable the server and network teams to avoid the tedious and antiquated change request processes. Increasingly, virtual switches or routers that are part of the hypervisor are beginning to play an important role in modern data centers and are becoming the de facto access layer switch in many environments. Therefore, it is imperative that network management tools be able to manage the virtual and physical environments.

The figure below shows a data center deployment with virtual and physical switches. VLANs are used to segment the network and provide multi-tenancy support. When a virtual machine is moved from one ToR switch to another, the VLANs associated with the virtual machine need to be migrated on both the physical and virtual switches. Since the virtual switches reside on the hypervisor, they are managed by the server administrators and the physical switches are managed by the network administrator. This operational dichotomy slows down the process and hampers business agility. Using Junos Space Network Director solves this problem by integrating the vCenter and vSphere solutions from VMware. When virtual machines move from one location in the data center to another, Network Director is immediately aware of this change. In this way, a network administrator can now change the VLAN configurations on the virtual and physical switches, greatly simplifying operations and optimizing business agility. In addition to integrating with VMware tools, Network Director also provides open north-bound APIs that third-party tools can use to orchestrate the network infrastructure in the data center.
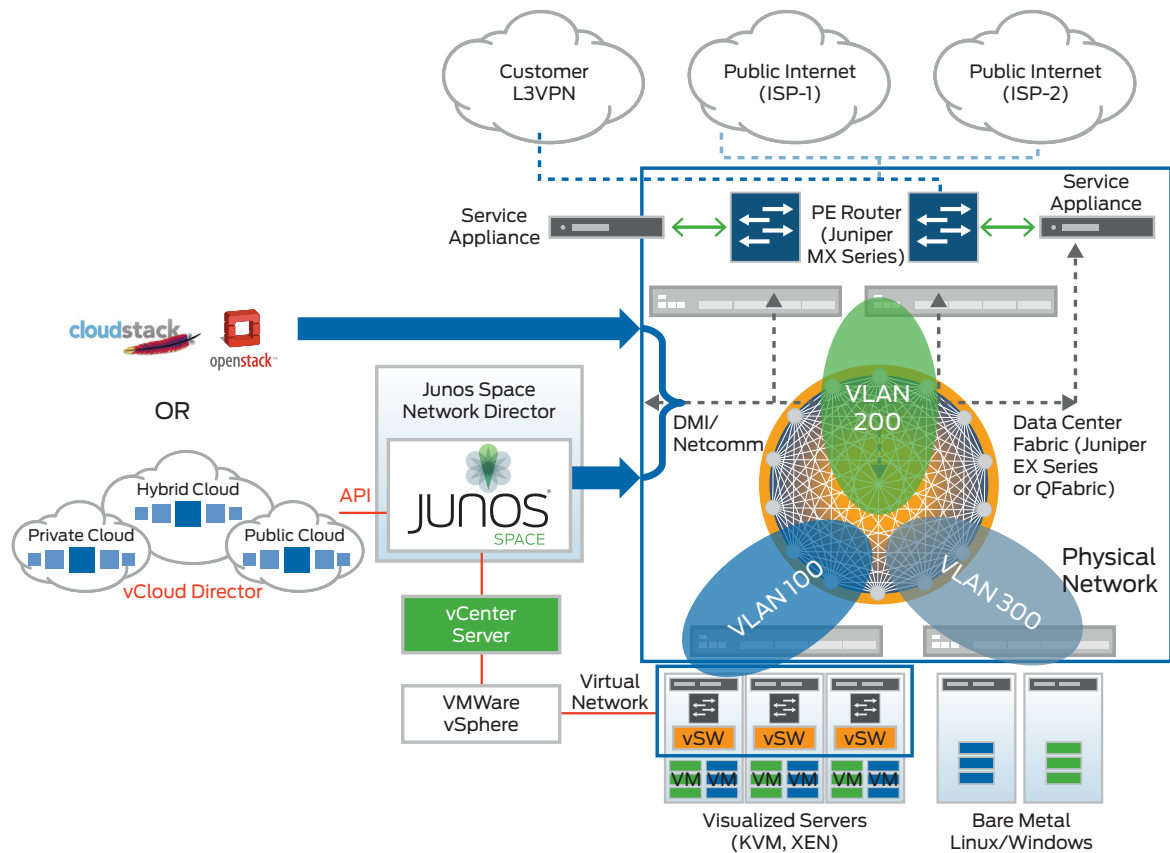

Figure 2: Virtualized Data Center – Bridging the Virtual and Physical with Network Director

Junos Space Network Director incorporates key functions that address the challenges posed by rapid virtualization across data center and cloud deployments. In addition, Network Director provides open RESTful APIs for service orchestration and integration with third-party orchestration platforms such as OpenStack and CloudStack. These smart network management solutions are delivered through the following key capabilities:

Automate

- Zero Touch Provisioning (ZTP): Network Director also provides the ability to automatically provision the network. Network Director can manage the DHCP and TFTP servers that store the configurations and images, enabling switches to automatically download the correct version of the image and configuration.

- Bulk Provisioning enables faster service rollout and activation while protecting against configuration errors with profile based pre-validated configurations.

Analyze

- VM Analyzer provides real-time physical and virtual topology views, tracks vMotion activity including virtual machine creation, deletion and moves, and maintains complete virtual network inventory.

- Fabric Analyzer monitors and analyzes the health of the entire network fabric, including QFabric Systems, increasing service availability.

- Performance Analyzer provides real-time and trended monitoring of VMs, users, ports and RF environments, as well as queue depth for microbursts*, devices and networks. Analysis of the entire network helps identify heat-maps*, over and underutilized ports, and top VMs, users, devices and ports.
- Cloud Analytics Engine, available as part of Junos OS, provides visibility into application workloads and behavior across both the physical and virtual data center network infrastructure. Cloud Analytics Engine performs coordinated, end-to-end data collection, analysis, correlation and visualization operations to present an application-centric view of the network.

Orchestrate

- Network Director API is a set of RESTful APIs that provide a single-point interface to all orchestration tools for end-to-end configuration and management of network services. Network Director API abstracts L2/L3 connectivity as well as security device configuration complexity, enabling orchestration tools to distribute services across Juniper infrastructure elements. Network Director API completely abstracts the network, making it easier to create self-service portals so users can automatically and dynamically provision the services they require.
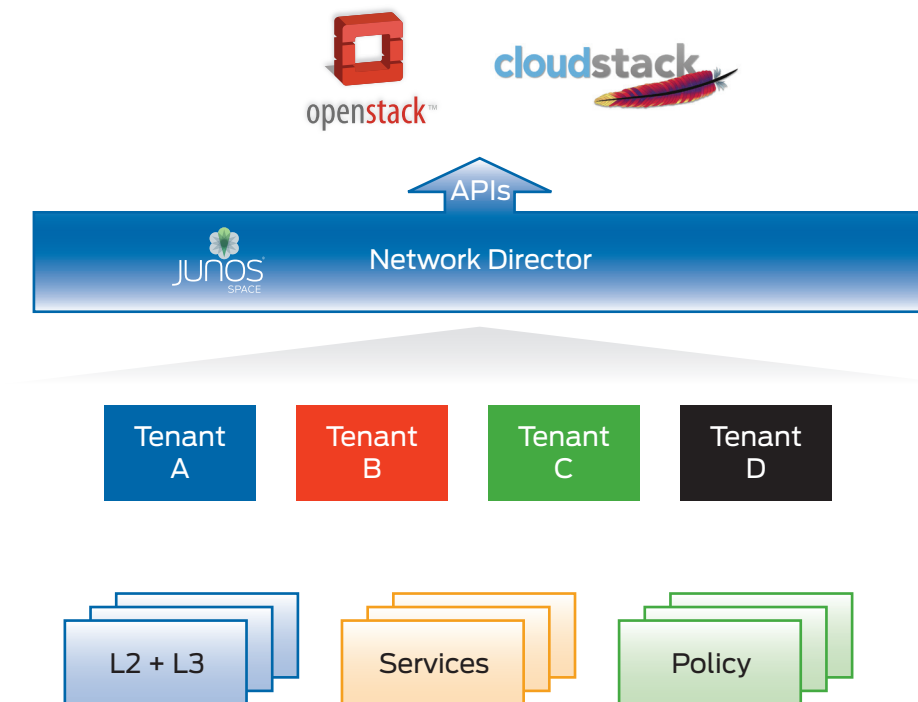
Figure 3: Open RESTful APIs for Service Orchestration

- **Integration with IT Automation Tools:** As part of its holistic approach to automation, Juniper also provides integration with third-party IT automation tools such as Puppet and Chef, and plans are underway to extend support to similar tools from other vendors. Puppet and Chef for Junos OS brings system and network administrators closer together by allowing them to seamlessly manage computing and networking infrastructures in concert. With Puppet for Junos OS, system administrators can easily add VLANs to a ToR switch themselves, the same way they manage servers today. There is no need to open a "change request" ticket and wait for a network administrator to do the job. Conversely, with these solutions, network administrators can delegate small tasks in a controlled manner and not be inundated with change requests. By improving the application deployment process, Puppet and Chef for Junos OS create a much more agile IT infrastructure that allows IT teams to respond faster to changing business environments.
- **Support for Open Source Orchestration Tools:** Juniper switching platforms provide integration with open source tools like OpenStack, which allows users to orchestrate the data center infrastructure with increasing agility while saving on operational expenses. OpenStack has three major components: 1) Nova for computing; 2) Neutron for networking; and 3) Swift for storage. Juniper provides Neutron plug-ins that simplify network configuration for the deployment of private, public and hybrid clouds through a set of standard Application Programming Interfaces (APIs). Moreover, Juniper offers Neutron plug-ins that enable management of physical and virtual networks, resulting in faster deployment of multi-tiered data center applications. In addition to providing OpenStack plug-ins, Juniper also integrates with turnkey private cloud solution providers Piston and Cloudscaling to enable an agile private cloud deployment for enterprises based on OpenStack. Juniper and Cloudscaling together are delivering a data

center networking solution that enables elastic private cloud deployments for the enterprise and service providers. Select Juniper switching platforms have also been qualified on Cloudscaling's Open Cloud Systems. By partnering with Piston, Juniper enables customers to benefit from an OpenStack private cloud solution and automate the provisioning of both the virtual and physical infrastructure, dramatically increasing operational efficiency.

- **Junos Automation:** With an eye towards simplifying day-to-day management tasks, Juniper switches support Junos Automation through flexible scripting mechanisms. These scripts can be used to respond automatically to alerts and events. This utility ensures greater uptime and faster mean time to repair (MTTR), which in turn delivers greater network agility and higher customer satisfaction. In addition to scripts, Juniper switches also have an open programmable interface, which allows external tools to programmatically configure the network. Traditionally, tools had to ssh to the switch and do something called "screen scraping," a process that read the output on the screen, but it that process was error-prone and required retooling every time the CLIs change. By providing an open programmable API, external tools now can configure the switch automatically and provide better workflow integration.

Future with SDN

As data center technology evolves, it is imperative that organizations ensure the investments they make today align with the vision of Software-Defined Networking (SDN), an approach to networking in which control is decoupled from forwarding hardware and given to a software application called a controller. Juniper switching platforms are designed to work with a variety of controllers and will support protocols like OpenFlow and VXLAN. Juniper supports the following SDN solutions today:

- **VMware NSX:** In a VMware environment, Juniper provides integration with VMware's NSX controllers, enabling a cloud infrastructure that is flexible and easy to manage. Juniper is participating in the VMware NSX partner program and plans to deliver NSX L2 gateway functionality in select switching and routing platforms.

- **Juniper Contrail Networking:** Juniper also offers a solution that automates and orchestrates the creation of highly scalable virtual networks. Contrail Networking SDN uses industry-standard protocols to create overlay networks that seamlessly virtualize the infrastructure to accommodate virtualized, multi-tenant data centers and clouds. Contrail Networking is ideally suited for cloud environments based on open, standards-based solutions.

Conclusion

Automation and orchestration of the data center network enable business agility in the data center. Juniper Networks offers simplified network architectures as essential components for simplified overall IT operations. Designed with a flexible and open standards-based framework, Juniper Networks tools and strategies help data center infrastructures by enabling automation across the full operations lifecycle—from network provisioning to management to orchestration. By leveraging these technologies, networking professionals are able to reliably streamline processes, eliminate the human errors, and maximize uptime. For the longer term, these solutions allow enterprises to capitalize on the benefits of network automation today, with the flexibility to implement new and emerging technologies like Software-Defined Networking, in the future.

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.

Corporate and Sales Headquarters

Juniper Networks, Inc.

1133 Innovation Way

Sunnyvale, CA 94089 USA

Phone: 888.JUNIPER (888.586.4737)

or +1.408.745.2000

Fax: +1.408.745.2100

www.juniper.net

APAC and EMEA Headquarters

Juniper Networks International B.V.

Boeing Avenue 240

1119 PZ Schiphol-Rijk

Amsterdam, The Netherlands

Phone: +31.0.207.125.700

Fax: +31.0.207.125.701

juniper
NETWORKS