JUNOS OS: THE POWER OF ONE OPERATING SYSTEM

Reduce Complexity to Increase Availability and Deploy Services Faster with Lower TCO

Overview

Juniper Networks® Junos® operating system provides a common language across Juniper's routing, switching and security devices. The power of one Junos OS reduces complexity in high-performance networks to increase availability and deploy services faster with lower TCO.

What sets Junos OS apart from other network operating systems is the way it is built—one operating system delivered in one software release track and with one modular architecture.

The consistent user experience and automated toolsets of Junos makes planning and training easier, day-to-day operations more efficient, and changes faster in the network. Further, one operating system integrating new functionality in software protects customer investment, not only in hardware, but also in internal systems, practices, and knowledge. And that means not only lower TCO, but also greater flexibility in meeting the new needs and opportunities of the business.
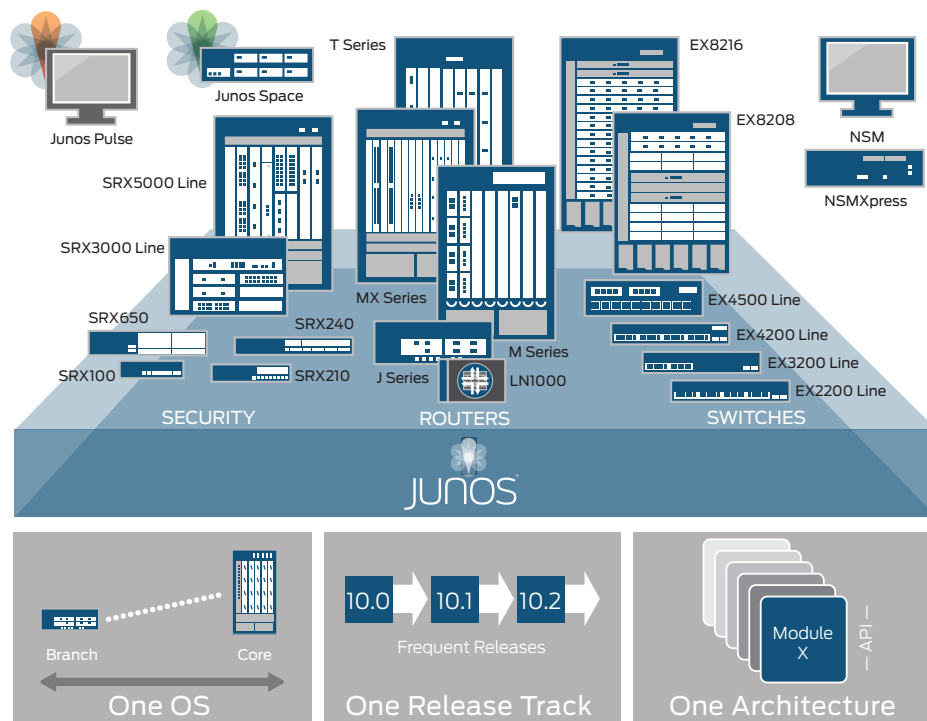
Increasing Demands on the High-Performance Network

The network fundamentally runs the operations of high-performance enterprise and service provider businesses. Complex networks that require extensive rework to scale and change can slow down marketplace response and new business initiatives.

While old hardware and outdated or poorly integrated technologies present challenges, it is the software running in IP networks that consumes the most operational time, causes the majority of operational headaches, and creates obstacles to change. Largely based on source code initially built decades ago, legacy network software carries a number of limitations, including:

- **Complex, error-prone administration tasks**, which add not only time and effort to routine activities but also multiply the risk of human error that can lead to outages or create security vulnerabilities.
- **Multiple release trains and software versions**, which slow down network upgrades with requirements for extensive testing, qualification, and training while impacting the predictable delivery of new service features and fixes.
- **Monolithic software architectures,** which impact network stability, performance, and security with comingled operating system processes vying for the same shared computing resources, and where even a small problem in one process can cascade to affect many others.

So, how can you develop a network that cost-effectively scales with traffic growth, adapts along with changing business needs, and delivers new services, all while maintaining the operational stability of your infrastructure?

The solution begins with greater confidence in the underlying network foundation. If you can trust the software supporting your infrastructure, particularly in its most strategic and distributed components, your team can focus more of its time and effort keeping up with traffic demand as well as new application and business requirements.

Junos OS: The Foundation of High-Performance Networks

The Junos operating system provides a common language across Juniper's routing, switching and security devices and that reduces the complexity of not only the network design, but also its operation.

Different by Design

The key advantages of Junos OS derive primarily from how it is built—what Juniper calls the power of one differences:

- One operating system across all types and sizes of platforms reduces the time and effort to plan, deploy, and operate network and security infrastructure.
- One release track meets changing needs in software with stable delivery of new functionality in a steady, time-tested cadence.
- One modular software architecture provides highly available, secure and scalable software open to automation and partner innovation.

One Operating System

The truly unique nature of Junos OS begins with its most fundamental virtue: a single source code base. This means that Juniper Networks engineers can develop new features one time and then share the code, as applicable, across the many platforms running Junos OS.

A single, cohesive operating system providing a consistent user experience makes planning easier, day-to-day operations more intuitive, and changes faster. Administrators can configure and manage functionality from the basic chassis to complex routing using the same tools across devices to monitor, manage, and update the entire network. Juniper Networks Junos Space provides one system to manage security, switching, and routing platforms. Inherent interoperability simplifies new feature deployment, software upgrades, and other modifications, allowing operations teams to function more efficiently with less training time and lower costs.

One Software Release

Juniper builds Junos OS along a single "release train" — a disciplined plan for development with strict engineering principles that include rigid quality metrics and testing. Juniper does not replicate or recreate code to form multiple software trains or many different sets of feature packages as is the standard practice for other vendors. Rather, new releases build-up on the prior, creating the single release train delivered in a series of numbered versions. The Juniper Networks approach to software development produces a stable code base that not only reduces the number of unplanned system events, but also the time and trouble of planned maintenance and upgrades.

In over eleven years of development, Juniper has delivered new releases of expanding functionality four times each year, year after year. Each new release supports each product family for its role and application in the network. Whenever you are ready to upgrade, you simply choose and qualify a higher release number than your current version. Juniper provides over three years of support for its extended end-of-life releases. Customers count on the reliability and predictable behavior of the single Junos OS release train and confidently upgrade when they want to enable new functionality in their network.
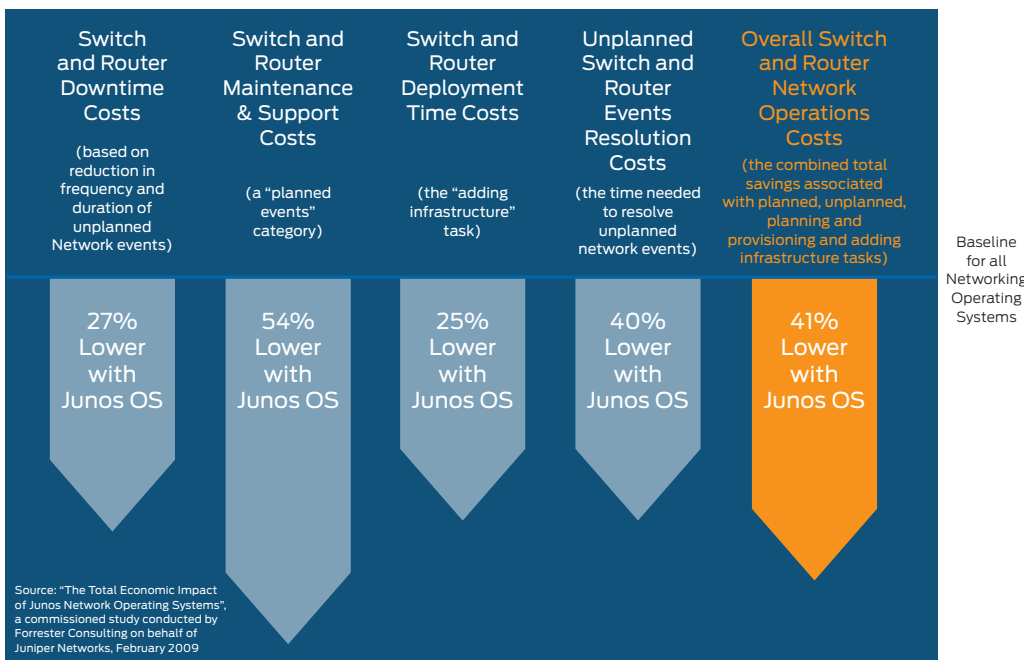
One Modular Software Architecture

The software architecture of Junos OS is a modular design conceived for flexible, yet stable, innovation across many types of networking functions and sizes of platforms. Modularity and well-defined interfaces throughout the architecture streamline new development and enable complete, holistic integration of services. Through the delivery of one operating system that meets an expanding set of integrated requirements, customers can utilize hardware that can be incrementally expanded to support new growth and services for years to come. The approach extends customer investment not only in devices, but also in their internal systems, practices, and knowledge.

The advantages of modularity reach beyond the stable, evolutionary design of the software. For example, the process modules of the architecture run independently in their own protected memory space, so one module cannot disrupt another by scribbling on its memory. And, the architecture provides separation between control and forwarding functions to support predictable high-performance with powerful scalability from small to very large platforms. The modularity of the Junos OS architecture is thus integral to the high reliability, performance, and scalability delivered by its software design.

Delivering a High-Performance Network Foundation

Propelled by the power of one differences, Junos OS has rapidly evolved over the years in many dimensions to accommodate increasingly complex application and service needs. Juniper Networks platforms simultaneously scale integrated security and networking capabilities without compromising high performance and reliability.

Junos OS helps customers to save time and lower costs by reducing operational challenges and improving operational productivity. A commissioned study conducted by Forrester Consulting on behalf of Juniper Networks, The Total Economic Impact™ of Juniper Networks' Junos network operating system, examines the total economic impact and potential return on investment (ROI) enterprises may realize by deploying Junos OS in an enterprise network environment. (see Figure 1). Among other top-line results, the independent study found that interviewed companies, through the use of Junos OS and Juniper switches and routers, achieved a 40% reduction in operations costs for certain network operations tasks including planning and provision, deployment, and planned and unplanned network events.

Switch and Router Downtime Costs	Switch and Router Maintenance & Support Costs	Switch and Router Deployment Time Costs	Unplanned Switch and Router Events Resolution Costs	Overall Switch and Router Network Operations Costs	
(based on reduction in frequency and duration of unplanned Network events)	(a "planned events" category)	(the "adding infrastructure" task)	(the time needed to resolve unplanned network events)	(the combined total savings associated with planned, unplanned, planning and provisioning and adding infrastructure tasks)	Baseline for all Networking Operating Systems
27% Lower with Junos OS	54% Lower with Junos OS	25% Lower with Junos OS	40% Lower with Junos OS	41% Lower with Junos OS	

Source: "The Total Economic Impact of Junos Network Operating Systems", a commissioned study conducted by Forrester Consulting on behalf of Juniper Networks, February 2009

Deploying routing, switching, and security platforms run by Junos OS deliver three key advantages to your networking infrastructure:

Continuous Systems: Improve network availability and the delivery of applications and services through high-performance software design, high availability features, prevention of human errors, and proactive operations measures.

Automated Operations: Increase productivity to lower operational expenses by reducing complexity with time saving configuration, automation of operations tasks, and centralized management.

Open Innovation: Enhance flexibility to deliver new services and applications, including secure interfaces and tools that open development to partners and customers for developing and deploying onboard applications on the Junos OS.

Continuous Systems

The consequence of an outage in a modern multiservice network can be extraordinarily expensive in terms of lost customer connections and transactions, as well as damaged customer confidence and penalties. Many different types of events and errors can cause disruption to network availability. Network equipment downtime can come from planned maintenance activities, unplanned hardware or software events, and most often according to many different studies, human error.

Addressing downtime, therefore, requires a multifaceted design approach that proactively considers all underlying factors. Devices running Junos OS have a well-deserved reputation for continuous performance and operational stability. The engineering foundations of continuous systems are rooted in the long standing design and software development philosophies of Junos OS; this is not a feature or attribute that can be easily retrofitted. Junos OS functionality for high availability includes expected failover and other service mechanisms, along with a range of capabilities unique to Juniper Networks, such as our disciplined processes for software development, error-resilient configuration, unified in-service software upgrade (ISSU), and automation of technical support services, among others.

Tools for automating operations are essential to maintaining high uptime. They not only reduce the severity and duration when unplanned network events do occur, but also can proactively prevent events from even happening, as discussed in the next section.

Automated Operations

The operational benefits of Junos OS derive not only from the reliability, performance, and security of its design, but also from a dedicated focus on simplified, error-resilient tasks across all operations functions. The hindsight that comes from prior experience has helped Junos OS engineers find better ways to design operations steps, interfaces, and tools. Many of these improvements simplify operations and reduce human error through increased automation.

Configuration

The Junos OS command-line interface (CLI) is easy to learn, with a feel that is similar to other command sets. Prominent improvements over other systems include error-resilient configuration with changes posted to a candidate file, flexible editing with time-saving shortcuts, automated checks of configurations, version control and rollback flexibility to restore prior configurations, and automated rollback in systems inadvertently isolated by configuration changes.

The most frustrating of human errors are ones that have happened before because they are repeating known mistakes that operations teams could ideally prevent. Junos OS configuration automation directly addresses this challenge through the customization of the commit verifications that run before a configuration becomes active. A library of scripts can be developed and maintained by your most experienced engineers to ensure that configurations are compliant with your business, network, and security policies. Moreover, these advanced tools include a macro capability that can condense repeated complex configurations into only a few configuration lines and variables.

Monitoring, Troubleshooting, and Problem Resolution

While network operations teams frequently spend their time in reactive mode, proactive discovery of potential issues is the preferred approach. Extensive monitoring and instrumentation capabilities within Junos OS give operations teams broad visibility into system health and device performance, along with the operational status of the network.

One of the characteristics of complex systems is the cascade effect of issues, with small problems capable of rapidly escalating into major ones. Junos OS event automation allow network and security engineers to automate early warning systems that not only detect emerging problems, but can also take immediate steps to avert further issues and restore normal operations. Your operational procedures can be captured in on-box command sets, not just paper, leveraging expertise across your company. The approach enables a continuous improvement capability as each outage and issue is diagnosed and proactive avoidance steps are written by your top engineers.

Open Innovation

Juniper Networks has extensively adopted and promoted open standards and interfaces for customers to manage and operate its networking and security platforms in multivendor networks. Junos OS provides multiple open interfaces, such as RADIUS, NETCONF/XML and DMI, for policy control, network management, and integration to other operations systems. The time tested interoperability and integration capabilities of Junos OS are evident in deployments in the largest service providers worldwide, and in tens of thousands of enterprise and government networks.

The Junos operating system also offers a software development platform that allows customers and partners to develop and deploy their own unique applications. The Junos SDK provides the necessary tools, libraries, and interfaces to build secure applications that run on Junos OS. In its over two years of availability, Junos SDK application development has grown with partners such as Advanced Broadband Networks, Harris Stratex, Lockheed Martin, NEC, NTT, Telchemy, and Triveni Digital developing a diverse mix of network applications.

Junos Platform

The Junos operating system is a part of the Junos Platform, an open software platform enabling dynamic, network-aware applications that interact with the network from the client to the cloud. With the Junos Platform, Juniper's customers can expand network software and interfaces to the application space, deploy software clients to control delivery, and accelerate the pace of innovation with an ecosystem of developers.

The Junos Platform provides customers and third-party developers unmatched flexibility to build applications by providing development interfaces at multiple layers of the network: in the networking device, across the network application layer, and at the network client. Unlike other platforms that merely enable third parties to integrate through APIs, the Junos Platform provides a true development environment including SDKs to create applications. The components of the Junos Platform are the Junos operating system, the Junos Space network application platform, and the Junos Pulse integrated network client.

Junos operating system includes an SDK for the development of onboard applications that deliver new control and packet processing functionality. The intelligent and secure interfaces of the Junos SDK give developers powerful options to build applications leveraging the underlying control and packet processing functionality of the operating system.

Juniper Networks Junos Pulse is a standards-based, dynamic, integrated multiservice network client for desktops, notebooks, netbooks, smartphones and other mobile and non-mobile devices, interfacing with integrated, multi-service network gateways to deliver identity- and location-aware anytime/anywhere connectivity, security, acceleration and collaboration with a simplified user experience while also serving as a development and integration platform for select third party applications.

Juniper Networks Junos Space is a programmable and extensible multipurpose Web 2.0 network application platform that enables the rapid development and deployment of applications to reduce cost and complexity, and to open the network to new business opportunities. Junos Space includes a core set of network infrastructure and operations management applications, such as Junos Space Ethernet Design, Network Activate, Route Insight, Virtual Control and Service Insight, for scaling services, simplifying operations and automating support.

Junos Ready Software is a growing portfolio of third-party and Juniper-developed applications based on the Junos operating system, Junos Space and Junos Pulse:

- **Dynamic Application Awareness** – Advanced router-integrated application identification and statistics collection helps customers maintain tight control over network resources at the Universal Services Edge.

- **Intrusion Prevention System (IPS)** – Tightly integrates Juniper Networks' latest and most advanced security features and provides protection from a wide range of threats and attacks in Universal Services Edge routers.

- **Media Flow Solution** – Scalable content delivery, distribution, and caching solution is purpose-built to address service providers' needs for a new media network. It combines intelligent, content-aware software running on high-performance hardware.

- **Session Border Control (SBC)** – Router-integrated session border control (SBC) products include a Border Signaling Gateway, a Border Gateway Function, and an Integrated Multiservice Gateway (IMSG) solution for routers at the Universal Services Edge to ensure the appropriate handling and quality delivery of real-time services over converged IP networks.

- **StreamScope eRM** – Comprehensive router-integrated video monitoring and analysis improves service availability and quality, while reducing operational complexity by eliminating standalone video probes in MX Series routers.

- **Telchemy ePM** – Sophisticated router-integrated, performance-monitoring application provides detailed analysis for a wide variety of IP services, including voice over IP (VoIP) in various edge and core routers.

- **Webroot** – Detection engine for malware protection in Junos Pulse enables customers to restrict access to corporate data and applications when security threats are detected, and to automatically eradicate threats so that mobile employees can stay connected and productive.

Portfolio of Platforms

Juniper Networks drives Junos OS innovation through its disciplined development as one network operating system. Juniper solutions provide consistency and reliability with routing, switching, and security platforms run by the same operating system across the high-performance network infrastructure. Our extensive portfolio connects branch, and regional offices, central sites and data centers, along with the metro, edge, and core sites of service provider networks. Juniper is leveraging its heritage of best-in-class services and security technology by delivering a broad set of intelligent and dynamic services in the Junos OS for security, broadband, voice, and video.

Routing, Switching, and Security

Juniper Networks EX Series Ethernet Switches address the access, aggregation, and core layers of branch office, campus, and data center networks, lowering operational expenses, including recurring power and cooling costs. The switches reduce capital expenses through innovative virtualization capabilities by collapsing network layers and reducing the amount of needed devices. The EX Series switches meet today's most advanced switching requirements for security and unified communications with integrated access control policy enforcement and extensive quality of service (QoS) features.

Juniper Networks J Series Services Routers offer predictable high performance and a variety of flexible interfaces that deliver secure, reliable network connectivity to remote, branch, and regional offices. The J Series consolidates market-leading routing, security, application optimization, and voice capabilities onto a single, easy-to-manage platform with options that include integrated Juniper Networks WXC Series Application Acceleration Platforms and integrated voice gateway technology from Avaya.

Juniper Networks JCS1200 Control System is the industry's first high-performance control plane scaling system. JCS1200 introduces independent scale of control and forwarding plane resources to maximize service growth, operational efficiencies, and control. This unique architecture enables service providers to rapidly expand their service offerings, and helps to reduce capital and operating expenditures.

Juniper Networks LN1000 Mobile Secure Router is an edge access router that delivers high-performance routing, firewall and intrusion prevention system technology (IPS) in a small form factor, energy-efficient package. Designed for the portable and transportable router markets, with the option to embed in a customer chassis, it's ideally suited to the most demanding mobile network applications.

Juniper Networks M Series Multiservice Edge Routers, spanning from 7 to 320 Gbps of throughput, uniquely combine best-in-class IP/MPLS capabilities with unmatched reliability, stability, security, and service richness. These multiservice edge routing platforms—deployed predominantly at the service-provider edge and in large, high-performance enterprise applications—enable consolidation of multiple networks onto a single IP/MPLS infrastructure without performance or feature compromise.

Juniper Networks MX Series 3D Universal Edge Routers, spanning from 80 Gbps to 2.6 Tbps of throughput, establish a new industry standard for Ethernet capacity, density, and performance. Offering efficient support of high-density interfaces and high-capacity switching throughput, the MX Series supports a wide range of business and residential applications and services, including high-speed transport and VPN services, next-generation broadband multiplay services, and high-volume Internet data centers.

Juniper Networks SRX Series Services Gateways secure enterprise and service provider infrastructure and applications with unrivaled performance and scalability. Based on the Dynamic Services Architecture, and engineered from the ground up to offer robust networking and security services, the SRX Series meets the network and security requirements of data center hyper-consolidation, rapid managed services deployments, and aggregation of security solutions.

Juniper Networks T Series Core Routers, spanning from 320 Gbps to 25 Tbps of throughput, provide high availability, reliability, performance, and scale, reducing operational and capital costs. The T Series offers sophisticated processing capabilities on a true multiservice platform with seamless integration with optical transport networks. Building core next-generation networks with T Series Core Routers offers a "pay-as-you-grow" path. Providers can reduce operational and capital expenses while customizing the network solution set and user experience.

Management, Identity and Policy, and Support Applications

Juniper Networks provides tools to centrally manage and support networking infrastructure. These products bring new capabilities to network and security management, and include a rich set of features that provide greater control for rapidly creating and deploying new IP services.

Juniper Networks Advanced Insight Solutions deliver a comprehensive set of tools and technologies to automate the delivery of network and device information for proactive network protection and support services offered by the Juniper Networks Technical Assistance Center (JTAC).

Juniper Networks J-Web is a Web-based GUI that provides users with simple to use tools to administer and manage Junos OS, including configuration, monitoring, and troubleshooting functions.

Juniper Networks Junos Scope software includes monitoring, configuration, inventory, and software management applications for managing IP services for the J Series, M Series, MX Series, and T Series routing platforms.

Juniper Networks Junos Space includes applications for network infrastructure automation with new management modules offered in each new release, such as:

- **Ethernet Design** – automates configuration, monitoring and administration of switch and router networks for campus and data center environments
- **Network Activate** – automates network discovery, design, deployment and validation for CE service provisioning
- **Route Insight** – audit-level visibility, troubleshooting and change modeling for L3 MPLS/IP networks
- **Security Design** – automates device and security service deployment, and policy lifecycle management
- **Service Insight** – proactive network state and device assessment against known issues
- **Service Now** – automates fault and case management
- **Virtual Control** – provides unified management of virtual and physical networks

Juniper Networks Network and Security Manager provides an easy-to-use solution that controls all aspects of firewall/VPN security platforms, J Series, M Series, and MX Series routing platforms, EX Series Ethernet Switches, SA Series SSL VPN Appliances, IC Series Unified Access Control Appliances, and IDP Series Intrusion Detection and Prevention Appliances, including device configuration, network settings, and security policy management.

Juniper Networks SDX300 Service Deployment System is a robust, customizable application that makes it possible for service providers to rapidly create and deploy new IP services to hundreds of thousands of subscribers.

Juniper Networks SRC Series Session and Resource Control Modules provide key policy and control layer functions including policy management, subscriber management, and authentication, authorization, and accounting (AAA), as well as network resource control.

Juniper Networks Steel-Belted Radius (SBR) Servers Enterprise Series provide uniform security policy enforcement across all network access methods, including WLAN, remote/VPN, dial, and identity-based (wired 802.1X). **Steel-Belted Radius Servers Service Provider Edition** servers support a broad range of network access and subscriber management database environments.

Juniper Networks STRM Series Security Threat Response Managers combine, analyze and manage an incomparable set of surveillance data --network behavior, security events, vulnerability profiles and threat information --to empower companies to efficiently manage business operations on their networks from a single console.

Solution Planning, Implementation, and Deployment

Getting Started with Junos OS

Adoption of any new product or technology initially requires some effort; however, our customers have consistently found the initial short-term activities of Junos OS adoption to be far outweighed by the long-term benefits. As a Juniper Networks customer, you have available all of the tools you will need to make the migration to Junos OS simple and safe, from the inherent characteristics of Junos OS itself to a wealth of education and support services.

Juniper Networks Education Services

Certified networking and security professionals are in greater demand than ever before, adding value to your organization through their skilled knowledge, particularly when that knowledge extends across multiple vendors to design best-in-class solutions for your organization. Juniper provides a wide array of training programs and a range of technical certifications. See the complete list of the Junos OS training and certifications at: **www.juniper.net/training**.

For teams new to Junos OS, the Juniper Networks Technical Certification Program (JNTCP) allows participants to gain practical competence with Junos OS deployment and operations. The Juniper Networks Certification Fast Track Program for enterprises significantly reduces the time and costs of training and certification for experienced networking and security professionals with existing routing, switching, and security knowledge. Find out more at: **www.juniper.net/training/fasttrack**.

Junos OS Offers the Power of One Operating System

Junos OS is a single network operating system providing a common language across Juniper's routing, switching and security devices. The power of one Junos OS reduces complexity in high-performance networks to increase availability and deploy services faster with lower TCO. Find out more by visiting: **www.juniper.net/junos**.

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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