

Sustainable WAN Transformation for the AI Era

Juniper Experience-First Routing portfolio for 400G, 800G, and beyond



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Executive Summary

Service and cloud providers face exploding demand for greater capacity and new capabilities in the emerging AI era. As demands continue to grow and change, providers need agile transport networks that adjust on the fly. Networks will need to smoothly transition to higher speeds and capacity where needed, including up to 800G for critical WAN transport roles, while improving sustainable and operational efficiencies.

This paper details how Juniper's Experience-First routing portfolio delivers ease of automation, multilayer sustainability, and proven performance for WAN transport use cases. Juniper can help providers meet evolving needs while assuring security and experience quality, simplifying operations, reducing carbon footprint, and lowering total TCO.

Rethinking transport networks for the AI era

For modern cloud and service providers, the need for new levels of throughput, quality, and efficiency demands careful planning and concrete action. In large-scale transport networks worldwide, service and cloud providers face:

- **Nonstop traffic growth:** Analysts forecast a 300% increase in internet traffic through 2028¹. Video, which demands even higher throughput and quality, will make up 80% of all network traffic by 2028²
- **More cloud and edge workloads:** Traffic from SD-WAN and secure access service edge managed services will grow at a 32% compound annual growth rate through 2033³. By 2026, the market for data center interconnect (DCI) transport will reach \$17 billion⁴, most of it 400G
- **Explosive growth in AI:** Nowhere is traffic growing faster than in AI clusters and the networks connecting them. Generative AI use cases are causing unprecedented traffic growth, with models growing 1,000x more complex every three years—and generating 4x the related traffic every two years⁵

This flood of WAN and AI traffic creates mounting pressure across transport infrastructures—from metro aggregation and edge sites to core and peering roles, DCI, and data center edge use cases. If operators want to stay ahead of network traffic trends, WAN transformation is a business imperative.

¹ Analysys Mason. *Fixed network data traffic: worldwide trends and forecasts 2022-2028*. March 2023.

² Ericsson. *Ericsson Mobility Report*. November 2023.

³ Future Market Insights, Inc. *Managed SD-WAN Services Market*. June 2024.

⁴ Markets and Markets. *Data Center Interconnect Market by Type, Application, End User and Region*. January 2022.

⁵ Dell'Oro Group. *Webinar: The Impact of AI Workloads on Modern Data Center Networks*. September 2023.

800G: A better solution at any gig

Every operator will follow their own path toward 800G, migrating networks organically as customer needs change. But those decisions should not be made based on capacity requirements alone. Migration delivers benefits beyond supporting 800G links for key WAN transport use cases. When you move to 800G-capable routing platforms, such as Juniper's PTX Series Routers, you gain:

- **Better 400G** with the ability to support double density 2x400G in a single port, with discrete LC connectors
- **Better power and space efficiency** thanks to next-generation ASICs that deliver up to double the speed and density in a smaller footprint while consuming less power per gigabit
- **Better flexibility and longevity** by supporting any combination of interface and modulation techniques (1x800G, 2x400G, or 8x100G, including client and coherent optics) to change speeds and reaches as the network evolves

By migrating to next-generation routing technology, you effectively upgrade to “magic ports” that will support whatever interface you need up to 800G, wherever and whenever you need it. Meanwhile, in locations that do not yet need 800G capacity, you will gain superior density, efficiency, performance, and TCO—at any gig.

Choose the right transport partner

When adopting next-generation network technologies, it is important to carefully evaluate suppliers. Support for 800G is not merely a box for vendors to check. 800G evolution touches almost every aspect of the network, from power and space consumption to traffic encryption, service assurance, and the flexibility to adopt higher-speed interfaces as demand grows. It's essential to partner with a networking provider that does 800G right. After all, you're tying your organization's future to that partner and their roadmap.

As a trusted partner to the world's largest network operators and a global leader in 400G, Juniper understands successful WAN transformation. In the last few years, we have introduced multiple transport innovations:

- **Doubling power efficiency** with Juniper's Express 5 and Trio 6 custom silicon
- **Raising the bar for performance and sustainability** with 800G-capable PTX10000 and 400G-capable MX10000 and ACX7000 routers
- **Driving down TCO** with our comprehensive IP-over-dense wavelength division multiplexing (IPoDWDM) solution, with support for 100G, 400G, and 800G coherent optical transceivers across those platforms

We also recently announced the [Juniper AI-Native Networking Platform](#) and our commitment to extend AI operations (AIOps) intelligence across our portfolio. These innovations all converge toward a common goal: creating an automated, experience-centric WAN that will scale cost-effectively to 800G.

Juniper experience-first routing

Juniper helps service and cloud providers transition to next-generation speeds and interfaces, wherever and whenever they need them. Across our routers, optics, silicon, and system innovations, we combine proven performance with simplified automation to enable more sustainable and future-proof networks. We achieve this by embedding three core capabilities into our transport portfolio:

- **Ease of automation:** To keep OpEx and complexity under control and assure the best experience for every user, automation cannot be an afterthought. It must be built into the WAN infrastructure itself. Next-gen transport networks should be able to automate device lifecycle management (LCM) tasks, optimize capacity, assure user experiences, and take closed-loop corrective actions autonomously. That is exactly what Juniper routing solutions deliver
- **Multilayer sustainability:** 800G represents a massive capacity increase. As the WAN transports ever-increasing traffic volumes, power consumption (and the associated OpEx and carbon emissions) can quickly spiral out of control. In recent years, Juniper has revamped our entire transport portfolio to help providers lower costs and meet environmental, social, and governance commitments. From silicon to systems to software, Juniper meets the demands of the AI era using less power in less space with reduced emissions and waste per gigabit
- **Proven performance:** Next-generation transport performance is about more than just pushing packets. Can your routers support up to 400G and 800G coherent or client optics on all ports so you can reconfigure ports as your needs evolve? Can your routers secure and encrypt traffic with no performance penalty? Will your observability and assurance tools still work? Service and cloud providers need the freedom to move to 400G and 800G with no limitations—and that is what our routing solutions deliver

A strategic blueprint for WAN transformation

We know that service and cloud providers won't transition to 400G and 800G overnight. This shift will happen gradually, responding to specific pressures and choke points as they arise. Some suppliers use less efficient technologies that limit interface options or impose restrictions on throughput and other essential capabilities. This makes migration unnecessarily hard.

Juniper takes a different approach. Using the same PTX platform, you can scale from 100G to 400G, 800G, and beyond incrementally using the mix of interfaces and sub-rates that works best for each use case. And your investment will generate value far into the future.

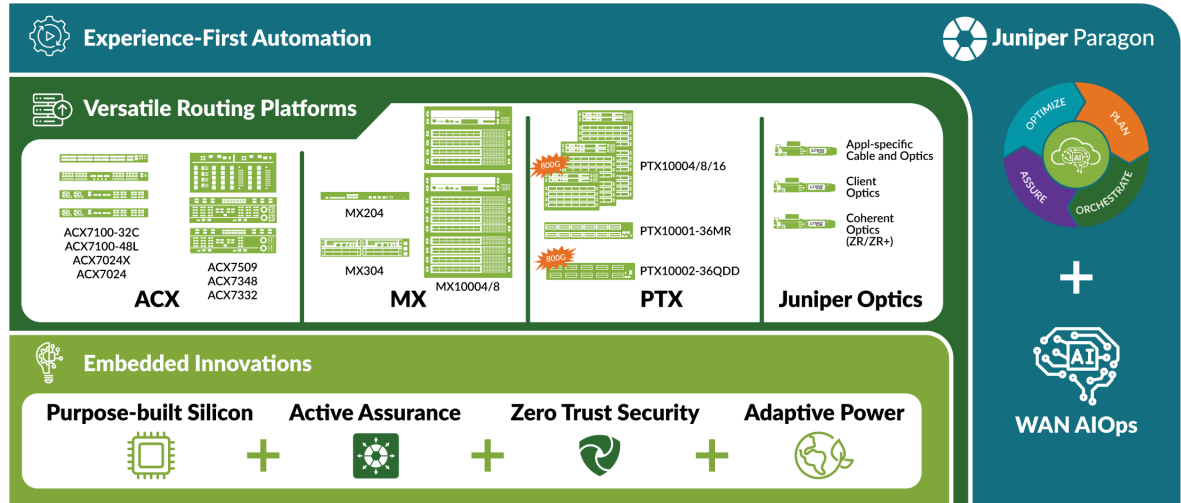


Figure 1: Scale from 100G, 400G, to 800G

Combining experience-first automation, proven performance, and embedded innovations, Juniper's versatile routing portfolio can address every transport use case:

- **ACX Series** routers provide a comprehensive access/aggregation solution with up to 400G throughput required for metro use cases, including advanced timing and synchronization, Zero Trust security, and temperature-hardened platform options
- **MX Series** platforms for the multiservice edge combine 400G throughput with logical service scale and multiservice edge features with adaptive power efficiency and investment protection
- **PTX Series** routers provide the foundation for the world's largest core and peering networks, and increasingly for DCI and data center edge use cases as well. These platforms support 800G or double density 400G, delivering 36 ports of 800G or 72 ports of 400G per slot
- **Juniper and partner optics** provide diverse client and coherent optical transport options, including DWDM 400G ZR/ZR+ pluggable transceivers, and soon, 100G ZR and 800G ZR/ZR+ options as well

The right path to 800G

Not every Juniper router will support 800G immediately. We have brought 800G speeds and density to those network locations and use cases that need it, and we'll expand next-generation capabilities to solutions across our portfolio in the coming years.

Juniper WAN solutions evolve with your business. You can move from short-reach client to coherent optics—and shift from metro to regional to long haul use cases—with the same routing solutions. Across our portfolio, you can expect the same sustainable design innovations, flexibility, and commitment to our customers' long-term success.

Experience-first automation

Juniper's approach to WAN automation puts experience front and center for end users and the network teams tasked with implementing and assuring services. Drawing from intelligence in our routers, Juniper delivers automation focused on real-world use cases to help network teams achieve results quicker. Examples include:

- **Automated device lifecycle management:** Juniper Paragon Automation provides guided onboarding and automated circuit testing, helping network engineers quickly and successfully perform LCM tasks. These capabilities reduce device onboarding times from hours to as little as five minutes
- **Closed-loop automation:** The Juniper experience-first routing portfolio supports multiple use cases where the network takes automated action in response to changing conditions. These include traffic engineering, active assurance to detect and fix performance issues, and trust and compliance verification
- **Autonomous capacity optimization:** The Juniper experience-first routing portfolio uses segment routing and software-defined networking (SDN) capabilities to sustain higher traffic loads with the same resources. You can build a network that continually monitors traffic and re-routes services to optimize bandwidth and capacity on the fly and achieve TCO savings of 27% or more⁶
- **Green networking:** Juniper automation use cases also help reduce power consumption and CO2 emissions. Features like on-box adaptive power management and power-optimized traffic engineering help providers achieve power savings of 73% or more⁷

⁶ ACG Research. *The Economic Benefits of Automating Capacity Optimization in IP Networks*. 2022.

⁷ Based on Juniper proof-of-concept demonstration with a Tier-1 service provider.

Model-driven automation

Juniper delivers use cases like these “out of the box,” and we give providers the ability to customize automation to suit their needs. Our programmable, model-driven WAN implements automation in an open, standards-aligned way.

Juniper uses standard APIs across our entire transport portfolio. We support closed-loop, model-driven automation, and any standards-aligned automation tools. We enable proactive monitoring with built-in procedure calls. And we use YANG models across our product lines to provide the foundation for adopting more sophisticated automation as the network evolves.

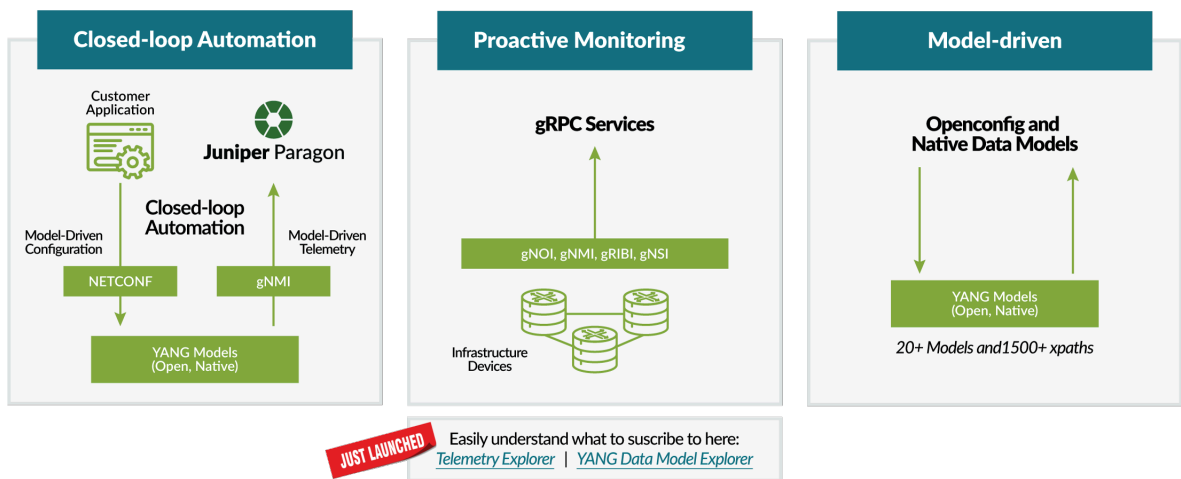


Figure 2: Providers can customize automation to suit their needs

Embedded active assurance

Juniper embeds active assurance capabilities directly into our routers. Embedded probes and synthetic monitoring tools let you observe the data plane from the end user’s perspective. You can monitor performance across the full stack to understand exactly what is affecting service quality. The network can take closed-loop actions and deliver flawless customer experiences with zero unplanned outages.

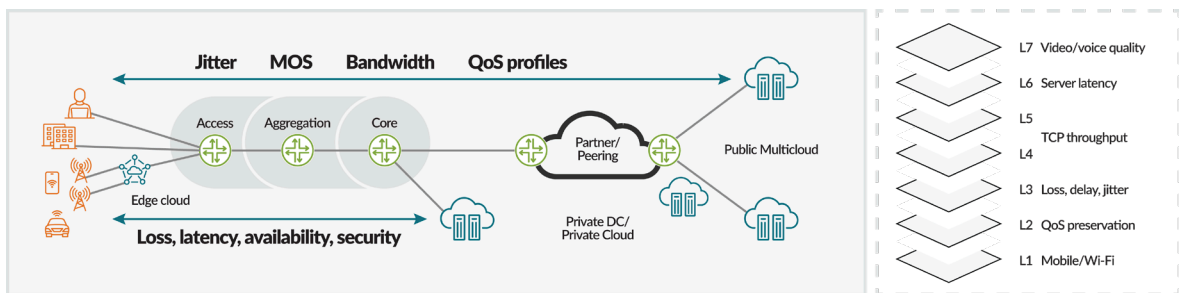


Figure 3: Monitor performance across the full network stack

Zero Trust security

To protect subscribers at higher speeds and capacity, security cannot be bolted on after the fact. Juniper embeds automated security and threat protection capabilities into every router we produce. These include:

- **Automated hardware integrity checks:** Each Juniper router features a unique, cryptographically signed device identity stored in Trusted Platform Module (TPM) 2.0 silicon at the time of manufacture. When the router boots, it automatically verifies that the device hardware and software is tamper free
- **Line-rate encryption:** Every product in our portfolio features inline MACsec encryption. For any workload, at any capacity, you can encrypt traffic with no performance penalties
- **Embedded threat protection:** Juniper also provides the option to integrate Corero SmartWall® Threat Defense Director (TDD) into edge routers. The embedded automated, real-time protection shields networks with up to 40 Tbps of edge bandwidth against distributed denial of service attacks

Multilayer sustainability

Juniper is a longtime leader in sustainability. We have committed to achieving net-zero emissions by 2040, and we're incorporating green innovations into our WAN portfolio.



Juniper Routing Spearheads Sustainability

Measurable outcomes across the WAN portfolio

| | | | |
|---|--|---|---|
| <p>Up to 77% Lower power consumption than competition – with ACX7509</p> | <p>Up to 12 years System life for reduced e-waste – with ACX7509</p> | <p>7-12% More power efficiency than leading competitor – with JCO400 ZR+</p> | <p>54% More power efficiency than traditional transport systems – with Coherent optics/systems</p> |
| <p>Up to 64% More space efficient than competition – with ACX7509</p> | <p>Up to 90% More space efficient than previous generation – with MX10000 platforms</p> | <p>71% More power efficiency than previous generation – with MX10000 Platforms</p> | <p>75% More power efficiency than previous gen fixed router – on PTX10000 Platforms</p> |
| <p>49% Improved Watt/Gbps with Juniper Express 5</p> | <p>50% to 70% Capacity utilization optimization – with Paragon Pathfinder</p> | <p>15% More power efficient than competition – with MX10000 Platform</p> | <p>vJunos Transforming labs with virtual environments, minimizing power and cooling with less hardware</p> |

Figure 4: Juniper provides measurable sustainability outcomes across its WAN portfolio

We have reimagined our WAN portfolio to include these groundbreaking innovations that are helping service and cloud providers upgrade WAN infrastructures for the AI era while reducing power consumption by as much as 77%:

- **Sustainable silicon**, using 7nm ASICs in Trio 6 and Express 5 custom silicon to deliver breakthrough performance with less power
- **Adaptive power innovations** that turn off packet forwarding engines (PFEs) and software features when not in use
- **Advanced digital signal processing (DSP) technologies** that make our pluggable optical transceivers more efficient than competing solutions
- **Sustainable system design**, including modular upgradeable power shelves, Titanium-rated power supplies, and air flow and thermal improvements to support higher port density and line card capacity
- **Compact form factor options** for chassis and modular routers that deliver higher throughput in less space
- **“Green mode” traffic engineering** that uses Paragon Automation intelligence to automatically reroute traffic to the most efficient network paths
- **Future-proof scalability** that extends the service life of Juniper routers up to 12 years—more than double that of other solutions—reducing CapEx and e-waste

The next level of transport efficiency: IPoDWDM

Some providers are going even further to maximize transport flexibility. Using Juniper’s Converged Optical Routing Architecture (CORA), they’re building more agile and extensible networks with IPoDWDM. By collapsing disparate IP and optical networks into a single, converged infrastructure, they are eliminating the need for dedicated DWDM transponders. As a result, they are dramatically reducing power consumption and OpEx—achieving 45% or higher TCO savings—while freeing up massive amounts of reserved optical bandwidth.

The foundation of these CORA capabilities lies in new coherent DWDM optics from Juniper and our partners. Leading service providers, cloud providers, and enterprises use our 400G ZR/ZR+ pluggable transceivers in converged transport networks. We are building on this success with new 800G ZR/ZR+ and 100G ZR optical pluggables. These versatile optics increase capacity and reach, opening up diverse fronthaul, mid-haul, and backhaul implementations. They enable direct router-to-router links up to 80km with no amplification—greatly reducing network complexity and costs.

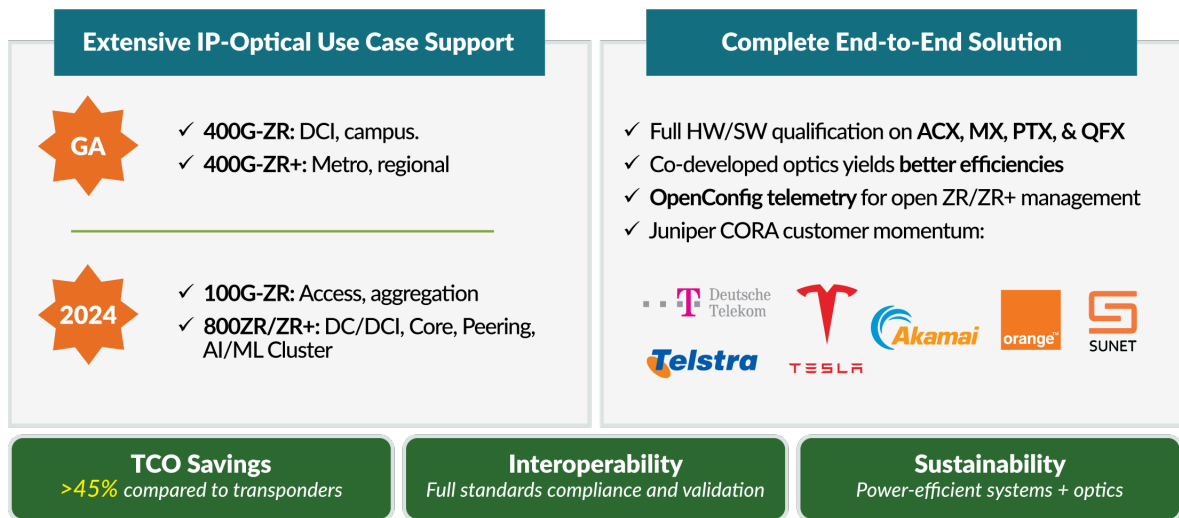


Figure 5: Versatile optics open up multiple use cases

With CORA, Juniper provides a comprehensive, end-to-end IPoDWDM solution. It includes fully validated hardware, software, and optics, along with OpenConfig telemetry for standards-based ZR/ZR+ management. We ensure flexible implementations, using any mix of standards-compliant optics and routing platforms. About Juniper Networks

Proven performance

Juniper delivers maximum performance for diverse transport use cases, and it starts with our silicon strategy. With Juniper custom and merchant silicon options, you can optimize for:

- **Blended performance:** In metro access networks, Juniper routers use merchant silicon to balance performance and scalability with economics
- **Flexible logical scale:** Trio silicon is optimized for multiservice edge use cases requiring logical subscriber scale, providing larger route forwarding tables, extensive memory allocation, flexible tunnel encapsulation, traffic management counters, and more
- **Throughput efficiency:** Juniper Express silicon provides a pipeline architecture and custom memory characteristics for core, peering, DCI, DCI edge, metro aggregation, and other use cases that demand the highest throughput efficiency.

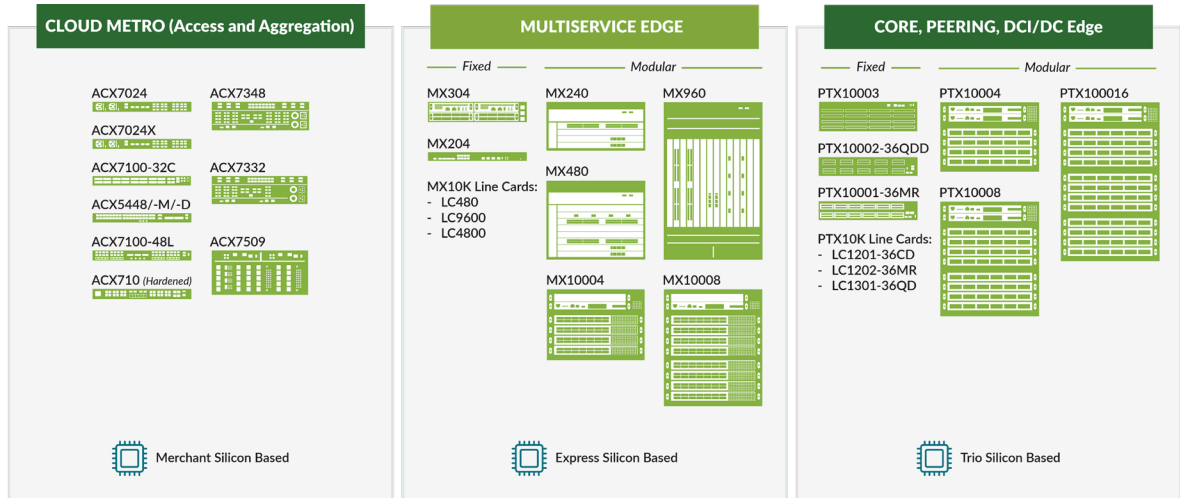


Figure 6: The Juniper experience-first portfolio delivers maximum performance

Take advantage of Juniper’s backwards-compatible silicon, modular and fixed form factor options, and embedded security across all use cases.

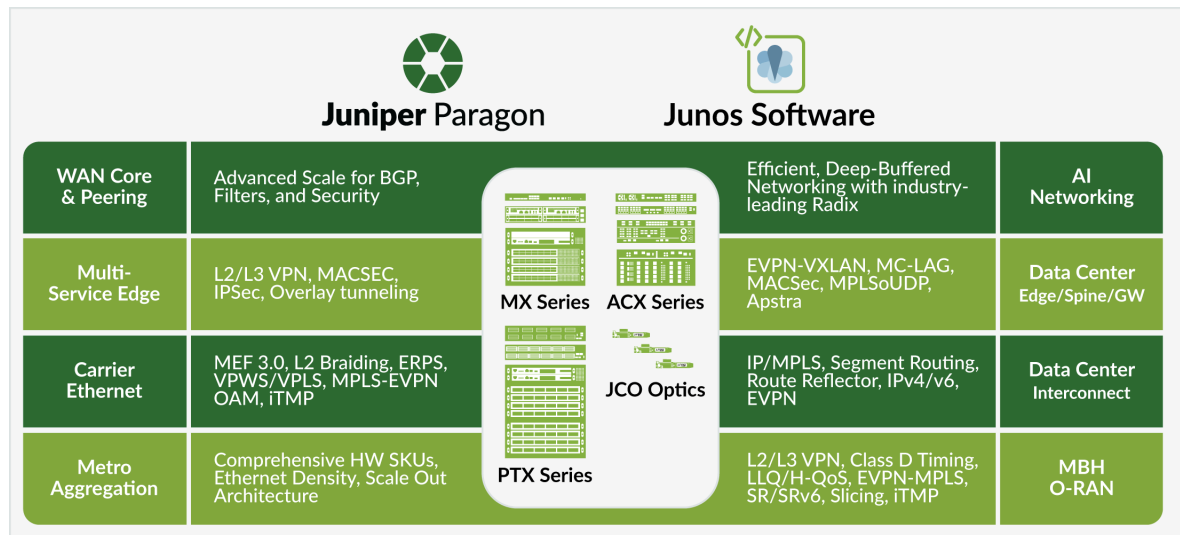


Figure 7: Gain versatility with future-proof performance, scale, and flexibility

As you move from 100G to 400G to 800G, the industry-leading density and longevity of Juniper routers will help you scale without limitations. Benefit from the same experience-first automation and sustainable system innovations using the same consistent Junos software end to end.

Juniper: Your partner for WAN transformation

With more than 20 years of transport innovation, Juniper is an industry leader in 400G networking. We provide scalable experience-first routing solutions for more than 3,000 service providers, cloud providers, and enterprises worldwide, including 100% of the Global Fortune 500. We have shipped more than 220,000 WAN routers to date. And Juniper is consistently ranked #1 in product reliability and technology innovation.

As our customers move into the AI era, we are committed to continuing our innovation and leadership with 800G. Our routers are designed for ease of automation, multilayer sustainability, and proven performance. Juniper's WAN portfolio delivers the right solutions to support your existing WAN while building toward the end-to-end 800G network of the future.

About Juniper Networks

Juniper Networks believes that connectivity is not the same as experiencing a great connection. Juniper's AI-Native Networking Platform is built from the ground up to leverage AI to deliver exceptional, highly secure, and sustainable user experiences from the edge to the data center and cloud. Additional information can be found at www.juniper.net or connect with Juniper on X (formerly Twitter), LinkedIn, and Facebook.



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