

# MODERNIZE YOUR METRO NETWORK

*Simplify next-generation service delivery with Juniper's Metro Fabric enabled with edge compute and automation*

## Challenge

As services move to the cloud and edge to support the growth of multiple applications, service providers need to re-evaluate metro networks built on rigid infrastructure. Inflexible management adds complexity and constrains new service delivery. This must change.

## Solution

Juniper's Metro Fabric transforms the network into a highway for rapid service delivery, streamlining operations with automation and enabling instant control, visibility, and resolution. Highly dependable and infused with integrated security, metro fabric eliminates mistakes across IP and packet-optical platforms.

## Benefits

- Enable rapid service innovation over the metro network using agile infrastructure automated with adaptive software
- Achieve high resiliency and pervasive security across the metro fabric
- Increase profitability with a self-driving network focused on delivering simplicity
- Deliver remarkable customer experience built on a modernized metro network with edge compute

*Carrier Ethernet services have been growing at double-digit rates. That trend will continue, with revenue for mobile, business services, and the cloud approaching \$65 billion globally by 2020. This unabated network traffic growth—driven by video and mobility, edge compute from latency-sensitive applications, connectivity to cloud services, and the arrival of smart cities and the Internet of Things (IoT)—is contributing to the growing demand for more Ethernet services at lower cost per bit, higher bandwidth, and greater security.*

## The Challenge

The growing demand for bandwidth and next-generation services coming from xDSL/Gigabit PON, 4G/5G networks, and business services, coupled with the ongoing expansion of the cloud and applications moving to the edge, all present a significant challenge in service provider metro networks. How can businesses scale their Metro Ethernet networks to support high-bandwidth services across a diverse set of use cases? Assuming they can overcome the scalability issue, how do they create a 5G-ready network that will support ultra low-latency requirements, provide multilayer visibility to eliminate operational silos, or automate the metro fabric to increase agility?

Meanwhile, carrier Ethernet services are being offered by a number of service providers, driving the price of services down. How can service providers compete in this market and maintain profitability? Can automation help drive down OpEx? As enterprises move more applications to a "mix-and-match" distributed cloud combining Ethernet and IP VPN services based on their business application requirements, can service providers offer both L2 and L3 services in the metro network, while extending services to the distributed cloud, all over a common, secure infrastructure?

## The Juniper Networks Metro Fabric

Juniper addresses these challenges by offering a solution for the service provider metro network that enables the rapid delivery of services with high scalability, resiliency, operational efficiency, and agility. Leveraging Juniper's comprehensive portfolio across IP and optical driven with adaptive software, service providers can innovate on an open, disaggregated service fabric optimized to provide the best cost per bit across all layers. The result is a metro-wide service fabric that connects users to their applications and services, delivering innovation in 5G, IoT, and business services.

## Features and Benefits

### Scalability

With L2 or L3/MPLS architectures, decoupling physical topology for transport and service layers allows service providers to scale their networks to tens of thousands or even hundreds of thousands of nodes. Scalable platforms for 100GbE in the access, aggregation, and Data Center Interconnect (DCI) are fully optimized to reach new thresholds in Ethernet VPN (EVPN), segment routing, and MPLS. Segment routing is a significant improvement that reduces overhead in control plane signaling while improving path computations and retaining key features like MPLS fast reroute (FRR).

### Resiliency

Enabling MPLS significantly decreases the risk of L2 loops. Based on Layer 2 VPN (L2VPN) and virtual private LAN service (VPLS), including its variations—either LDP or BGP signaling-based—MPLS represents a critical step in preventing broadcast storms (compared to native Ethernet switch environments). In addition, Juniper’s Metro Fabric provides multihomed connectivity between customer premises equipment (CPE) and access nodes, as well as between access nodes and aggregation nodes, creating a true loop-free, resilient network.

Juniper Networks® Junos® Continuity and unified in-service software upgrade (unified ISSU) features eliminate the downtime risks associated with implementing new hardware or

upgrading operating systems. A plug-in package that provides the drivers and support files needed to bring hardware online, Junos Continuity eliminates OS upgrades and system reboots when adding new hardware. Unified ISSU reduces the risks associated with OS changes by enabling upgrades between two different Juniper Networks Junos operating system releases (major or minor) with no control plane disruption and minimal traffic disruption on the forwarding plane.

### Simplified Operations

To address the challenge of provisioning and performing daily operational tasks, Junos OS includes embedded scripting tools and APIs that automate routine and repetitive tasks, allowing easy integration with virtually any operator’s backend management tools. This helps you gain greater traffic visibility through customer microservices built on standards-based YANG models. Junos Telemetry Interface (JTI) provides greater visibility for gathering, aggregating, and streaming real-time network data and events throughout the metro network. JTI helps identify, isolate, and resolve issues with minimal human interaction, while a Zero Touch Provisioning (ZTP) feature dramatically reduces the complexity of extending MPLS in the access layer. This accelerates new box deployments, improving operational efficiency and lowering OpEx. Programmable interfaces such as terminal interface processor (TIP), OpenConfig, and OpenROADM Multi-Source Agreement (MSA) increase the programmability of the transport layer.

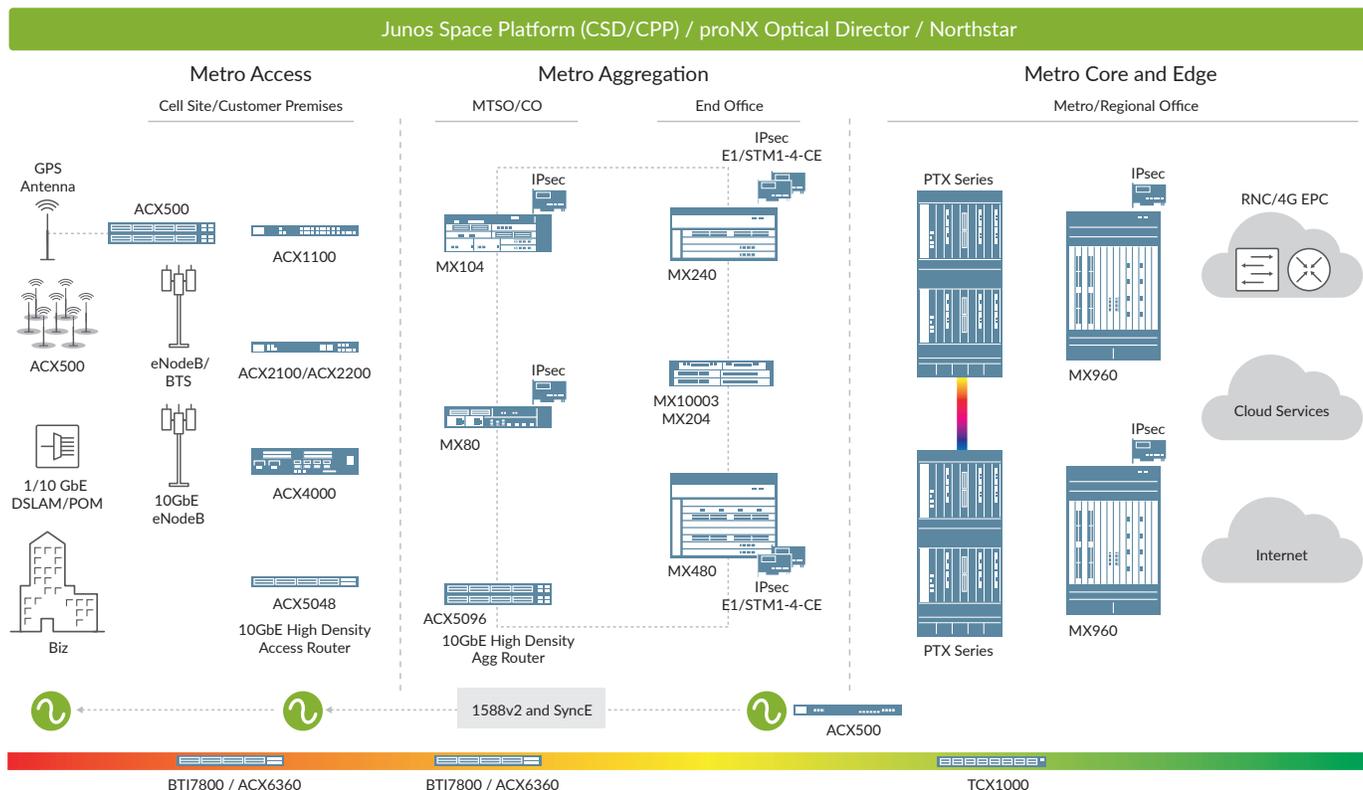


Figure 1: Juniper Networks Metro Fabric product portfolio

Table 1: Industry Definitions of Metro Services

Standard		Services		
MEF	E-LINE	E-LAN	E-Tree	E-Access/E-Transit
IETF	Virtual private wire service (VPWS)	Virtual private LAN service (VPLS)	Achieved with VPLS and specific flooding rules	Achieved with VPLS, VPWS, and VLAN translation
Junos OS CLI	L2 circuit (targeted LDP signaling pseudowires) L2VPN (BGP)	H-VPLS VPLS EVPN	H-VPLS VPLS EVPN	L2 Circuit VPLS Flexible-vlan-tagging

**Service Flexibility**

Juniper’s Metro Fabric allows users to deliver fully compliant Metro Ethernet Forum (MEF CE 2.0) services such as E-Line, E-LAN, E-Tree, and E-Access/E-Transit. Table 1 shows how Junos OS-specific terms and features map to MEF and IETF standards. What’s more, Juniper’s Metro Fabric, designed with an open framework, delivers the flexibility to provide not only L2 but also L3 services of all kinds, allowing operators to evolve the metro architecture on their own terms.

**Security**

Security is integrated and pervasive in Juniper’s Metro Fabric. Security is critical in use cases like mobile backhaul, where IPsec-based secure gateways provide robust traffic encryption. For DCI, Juniper’s Open Cloud Interconnect offers EVPN and Virtual Extensible LAN (VXLAN) with Media Access Control Security (MACsec) for highly scalable, low power, coherent dense wavelength-division multiplexing (DWDM). As more and more services get distributed to the network edge, security will become increasingly vital. Unified security policies across physical and virtual infrastructure will deliver end-to-end visibility, real-time threat intelligence and mitigation, and advanced threat protection of any workload.

**Solution Components**

Juniper’s Metro Fabric consists of the following components.

**ACX Series Routers in the Access Layer**

In the access layer, Juniper Networks ACX500 and ACX4000 Universal Metro Routers serve as MEF CE 2.0-compliant, cost-optimized access nodes loaded with the full features of MPLS routers and Metro Ethernet switches. With ACX Series routers, users can configure IPv4, bridging, or L2 circuit cross-connect (CCC) traffic families on the same physical port. Leveraging a mobile backhaul cell site router feature set, ACX Series routers act as a true universal access node, interconnecting customer sites that are still using legacy services. ACX Series platforms let you migrate those services and backhaul them over Ethernet.

**ACX Series Routers in the Metro Aggregation Segment**

Juniper Networks ACX5000 Universal Metro Routers incorporate the full ACX Series feature set while opening new horizons for metro area network (MAN) operators. The ACX5000 line of routers provides high-bandwidth business

services or mobile backhaul metro services with strict service-level agreements (SLAs) and minimum provisioning efforts at a highly attractive price per port and with a flexible license-based feature set. The ACX5000 line is perfect for ongoing access network transformations, as well as for migrating from 1GbE to 10GbE in the access and aggregation layers.

**Packet Optical Transport Platform in the Metro Access and Aggregation Segment**

Juniper Networks BT17800 line of Packet Optical Transport Platforms supports large-scale 10 Gbps, 100 Gbps, and 200 Gbps wavelength capacities in a programmable platform. Featuring a rich set of optical capabilities, including coherent modules with integrated reconfigurable optical add/drop multiplexers (ROADMs), the BT17800 line helps service providers increase network capacity, reduce space, power, and cooling costs, improve network utilization, and simplify the deployment of next-generation services.

The Juniper Networks ACX6360 Universal Metro Router provides a bridge between the secure packet optical transport layer and the IP/MPLS networking layer by giving operators the ability to seamlessly collapse both layers into a single platform. The ACX6360 converges a full IP/MPLS stack with secure packet optical transport in a space- and power-optimized platform designed for breakthrough capacity and deployments in DCI, metro, and Remote-Phy locations—both today and in the future. The ACX6360 implements secure transport based on IEEE 802.1AE/802.1X industry-compliant 256AES MACsec encryption while supporting modern automation and telemetry tools via Junos OS to meet cloud-grade routing principles.

**MX Series Routers in the Metro Aggregation and Core Segments**

Juniper Networks MX Series 5G Universal Routing Platforms are used in the aggregation and core segments, giving carriers best-in-class performance and functional flexibility. Leveraging a Layer 2 service head-end termination function, MX Series routers can collapse the MAN edge function with service edge functions in the same routing node. A metro network based on Juniper platforms performs equally well, providing connectivity services of any kind—L2 or L3—with service touchpoints placed anywhere in the MAN or network cloud.

### PTX Series Routers in the Core Segment

In geographically separated MANs, early adopters of 100GbE may opt to leverage Juniper Networks PTX Series Packet Transport Routers, which provide a core function enhanced by router-integrated 100GbE optical transponders. These transponders provide the ability to establish long-haul, back-to-back connectivity that can span hundreds of kilometers without signal amplification.

### Programmable Photonic Layer

The Juniper Networks TCX1000 Programmable ROADM is an integral part of Juniper's Programmable Photonic Layer open line system. Forming a colorless, directionless, flex grid-ready ROADM, it scales up to 25.6 Tbps per line for long-term growth investment across all metro use cases.

### Junos Space Platform

Juniper Networks Junos Space® Network Management Platform provides comprehensive management with broad fault, configuration, accounting, performance, and security management (FCAPS) capabilities for both device- and service-level management. For device management, the Junos Space platform supports Network Configuration Protocol (NETCONF), CLI, and SNMP v1/v2/v3. Its northbound APIs support easy integration with existing network management systems and operations/business support systems (OSS/BSS). Running on the Junos Space Management Platform, Junos Space Connectivity Services Director (CSD) ensures effortless, end-to-end service provisioning of carrier Ethernet (E-Line, E-LAN, E-Tree, E-Access/E-Transit), VPLS, L3VPN, and MPLS using a simple interface to design, validate, and manage these services. Another Junos Space application, Cross Provisioning Platform (CPP), helps service providers provision E-Line, L2/L3 VPN services, and VPLS between Juniper and third-party devices, while the Connectivity Services Director tool provides the operational team with full life-cycle management over connectivity services.

### proNX Optical Director

The Juniper Networks proNX Optical Director software platform enables full management of and control over Juniper Programmable Photonic Layer open-line system elements, as well as Juniper's coherent DWDM transponder-based solutions such as the Juniper Networks BTI Series Packet Optical Platforms and integrated DWDM transponders on MX Series and PTX Series routers. The proNX Optical Director enables you to more easily and reliably deploy, scale, and integrate applications and services.

### NorthStar Controller

Juniper Networks NorthStar Controller is a flexible traffic engineering solution that delivers granular visibility into and control over IP/MPLS and optical layer flows. It streamlines capacity planning, enables proactive monitoring, and lets service providers dynamically route traffic and balance loads based on administratively defined policies.

### Use Cases

Juniper's Metro Fabric delivers significant, real-world benefits in the following use cases.

#### L2 Business Access

For service providers providing Layer 2 business access services to corporate clients and other service providers, VPLS offers a unified method for providing end-to-end service connectivity or connecting access segments running different protocols. Juniper has implemented multiple features into its metro fabric that make this type of "stitching" extremely reliable, ensuring interoperability between different flavors of Spanning Tree Protocol (STP) or Ethernet Ring Protection (G.8032v1/v2).

#### L3 Business Access and Direct Internet Access

The ACX500, ACX1000 line, and ACX2000 line of Universal Metro Routers can be deployed as network interface devices (NIDs) to provide L2/L3 business access, Direct Internet Access (DIA) connectivity, and IP services such as IP VPN. Juniper's Metro Fabric features robust Operation, Administration, and Maintenance (OAM), as well as SLA control capabilities. Combined with automation and ZTP, the solution supports seamless migration from 1GbE to 10GbE, supported by 100GbE metro aggregation.

#### Mobile Backhaul and Fronthaul

In addition to MEF CE 2.0 compliance supporting both Ethernet and IP/MPLS, Juniper's Metro Fabric provides high capacity and scalability, complete timing and synchronization, integrated security, and SLA tools that differentiate mobile backhaul and fronthaul services. Additionally, the ACX500 delivers a last-mile deployment solution for small cell-as-a-service offerings. Exponential bandwidth growth and preparation for 5G is driving 10GbE at the access and 100GbE at the pre-aggregation layers.

#### Residential Aggregation

Metro Ethernet networks aggregate Ethernet links from service provider broadband access nodes—DSL access multiplexers (DSLAMs), Ethernet Access Devices (EADs), cable modem termination systems (CMTS), etc.—or, in some cases, directly from residential CPE, delivering traffic to the broadband network gateway (BNG). Juniper's Metro Fabric supports

multicast traffic delivery, which triple-play service providers can use to backhaul IPTV/OTT services. Specifically, the ACX5000 line is perfect for a converged fiber to the home, building, premise, node, or curb, and GPON metro aggregation solutions. Residential traffic growth is forcing metro networks to look at cost-effective models to scale the aggregation to 100GbE.

### Ethernet Cloud Exchange

Ethernet Cloud Exchange is a relatively new network-neutral service that improves quality and removes the cost and complexity of interconnecting the L2 Ethernet networks of carriers, operators, and service providers. High capacity, high port density, and low power consumption—in combination with a rich MEF and IP feature set—all make the ACX5000 line an effective metro aggregation platform for Ethernet Exchange service providers. Scalable architectures for spine and leaf in the data center allow high-capacity direct connections to multiple clouds. To support the dynamic requirements in the Ethernet Cloud Exchange, YANG/NETCONF enables service provider tools to automate across the development life cycle, so new services can be launched quickly and cost-effectively.

### Cable Distributed Access Architecture

Consumer consumption of 4K video, business services, and streaming content continues to drive bandwidth growth. Distributed Access Architecture (DAA) helps cable networks evolve into virtualized network functions, decentralizing the control and user planes. The head-end will evolve towards more high-capacity fiber-based Ethernet links, and this will improve cost efficiencies to support bandwidth growth. Juniper's Metro Fabric will drive a fiber-deep architecture to enable multigigabit broadband by adopting the Remote MAC-PHY and a transition towards digital optics. The benefits of IP convergence include better returns on capital expenditures and lower operational costs through automation.

## Summary—Scalable, Resilient, and Flexible Metro Fabric for Future Business Growth

As demand for applications, services, and bandwidth continues to grow, service providers need to effectively scale network nodes to support higher capacities, improve operations through automation, and transform customer experiences by offering new, differentiated services to win in a very competitive marketplace. Juniper Networks addresses these challenges by offering a complete, integrated Metro Fabric that delivers high scalability, resiliency, operational efficiency, service flexibility, and security. This enables service providers to profitably serve multiple customers with differentiated services over a single infrastructure, increase profitability with a self-driving network focused on delivering simplicity, and deliver exceptional customer experiences built on a modernized metro network with edge compute.

### Next Steps

To learn more about how Juniper's Metro Fabric can help your company gain a competitive edge, contact your Juniper sales representative or visit [www.juniper.net/us/en/solutions/metro/](http://www.juniper.net/us/en/solutions/metro/).

## About Juniper Networks

Juniper Networks brings simplicity to networking with products, solutions and services that connect the world. Through engineering innovation, we remove the constraints and complexities of networking in the cloud era to solve the toughest challenges our customers and partners face daily. At Juniper Networks, we believe that the network is a resource for sharing knowledge and human advancement that changes the world. We are committed to imagining groundbreaking ways to deliver automated, scalable and secure networks to move at the speed of business.

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