The massive demand for bandwidth and pervasive connectivity from both residential and business users is driving service providers of all types to look for innovative ways to increase network and service capacity in cost-efficient ways, while at the same time enabling new and more sophisticated applications. As part of this trend, carriers have expanded the adoption of carrier Ethernet from its emergence in carrier Ethernet networks to several other areas of the network for transport, aggregation, and Ethernet-based services. Challenges of early generations of deployment included the lack of carrier-class attributes such as service continuity, high scalability, flexible bandwidth control, and cohosted value-added services. Today’s advanced offerings address these stringent requirements and enable service providers to further leverage carrier Ethernet as the technology of choice for a wide range of progressive applications.

Carrier Ethernet is being adopted by virtually all service provider types for aggregation, transport, Ethernet-based services, or a combination of these applications. According to IDC, the carrier Ethernet market is expected to grow to almost $9.1 billion by 2014. This is up from $5.2 billion in 2009 and represents a five-year compound annual growth rate of more than 11.7 percent.
The Challenge

With accelerating momentum in the carrier Ethernet market, a new set of requirements has emerged to extend industry adoption from opportunistic deployment to full-scale implementation. While earlier deployments focused primarily on cost optimization, recent emphasis on such areas as network-wide operational consistency, increased service richness, and inter-domain service continuity has become critical as the popularity of carrier Ethernet applications grows.

Significant demands are being placed on service provider networks to support next-generation applications and services such as IPTV, video on demand (VOD), VoIP, mobile video conferencing, real-time gaming, and others. In addition to increased capacity requirements, service provider networks also must be able to deliver high quality applications to customers. Networks of all types—whether operated by wireline, wireless, cable, or content service providers—are being pressed to evolve so that they can not only support these applications cost-effectively, but also deliver superior quality of experience to subscribers.

Ethernet can easily meet many service provider requirements (speed, cost-effectiveness, and ease of use), but traditionally has not provided the reliability, scalability, resiliency, and functional richness service providers need to support emerging applications and services. In fact, service providers have often found that many earlier generation Ethernet products failed to deliver the features their networks needed. This has led to slower than expected adoption of Ethernet in service provider networks.

Traditional Ethernet solutions also lack many crucial capabilities that are essential to supporting existing and future network demands:

- Ability to scale cost-effectively
- Increased deployment flexibility
- Ability to support all Ethernet-based services
- Efficient space utilization and power consumption
- Decreased network and operational complexity
- Enhanced network resiliency
- Reduced time to market for new services
- Extensive quality-of-service (QoS) and traffic management capabilities
- Faster roll-out of new services

Only solutions that address all of these challenges can truly be considered carrier-class or carrier Ethernet solutions.

The Juniper Networks Carrier Ethernet Services Solution

Juniper Networks carrier Ethernet services solution delivers a future-ready infrastructure network that is optimized for the next wave of growth. At the heart of the solution are Juniper Networks® MX Series 3D Universal Edge Routers delivering unmatched 3D scale across bandwidth, subscribers, and services as validated by EANTC. The flagship MX Series’ unparalleled modularity, combined with the feature richness of Juniper Networks Junos operating system, allows service providers to choose a deployment model that fits their architecture. The same MX Series platform can not only be deployed as a IP/IPv6 edge router, virtual private LAN service provider edge router (VPLS-PE), MPLS label-switching router (LSR), L2 switch, or L3 router, but it can also cater to a variety of mobile, cable, and other media rich edge applications.

And, the openness of Junos OS and Juniper Networks Junos Space enable third-party development, fostering faster innovation and reduced time to market for value-added applications such as video monitoring, voice monitoring, and content caching.

Significant OpEx savings come with the exceptional operational efficiencies of Juniper’s hardware (power, cooling, space) combined with the operational effectiveness of Junos OS. Junos Space, the open and extensible management platform for the solution, consists of innovative tools such as Junos Space Network Activate, Junos Space Service Now, and Junos Space Route Insight that streamline operations, further reducing operating expenses.

Extensive and scalable support for standards-based MPLS and Ethernet Operation, Administration, and Maintenance (OAM) tools on the platforms also allow for the highest degree of network and service monitoring and management integration with third-party, best-in-class management tools. MX Series universal edge design allows for the same platforms to be used to provide residential, business, mobile services, and retail and wholesale services, delivering significantly lower TCO compared to the competition.

Industry-leading hierarchical QoS (HQoS) along with Traffic Engineering (TE) and management capabilities arm the service provider with extremely fine-grained controls for delivering a superior quality of experience to subscribers. Juniper’s flagship carrier-grade Junos OS has been rated #1 in reliability, software stability, and operational effectiveness by service providers worldwide. These differentiators maximize service continuity to subscribers. The industry’s first implementation of point-to-multipoint label-switched paths (P2MP LSPs) and next-generation multicast virtual private network (NG MVPN) allow the service provider to deliver multicast content such as IPTV using up to one-tenth the network resources compared to competition.

The solution transforms a carrier Ethernet network into a strategic asset that can be used as an innovation engine for value creation and monetization. And, the feature richness of Junos OS allows the service provider to deploy composite innovative services faster (e.g., mobile telepresence, location-based services, and service delivery platforms).
Features and Benefits

Performance without compromises, deployment flexibility, and an open ecosystem ensure that the network is ready to handle demands for bandwidth and services for the next decade.

Operational efficiencies of the platforms and streamlined network operations minimize CapEx and OpEx, while a converged network for multiple services maximizes the revenue per platform. Service continuity, superior traffic management capabilities, and faster service velocity deliver unmatched quality of experience to subscribers.

Future Readiness

A future-ready carrier Ethernet network will require high performance with a variety of services enabled, headroom in processing and network capacity to handle the unprecedented growth, deployment flexibility to accommodate the emerging deployment models, and openness for faster and distributed innovation. The carrier Ethernet solution from Juniper Networks delivers across all of these dimensions to make a carrier Ethernet network ready to handle growth for the next decade.

Solution Components

Juniper Networks carrier Ethernet services solution is built around the MX Series. These routers are purpose-built to deliver high-performance, scalable, and reliable carrier Ethernet and are available in a variety of form factors and capacity. At the lowest end of the spectrum is the Juniper Networks MX80 3D Universal Edge Router that is optimum for the access and aggregation layer in the carrier Ethernet network. The MX240 and MX480 3D Universal Edge Routers are the mid-range routers built for the aggregation and edge network. The MX960 3D Universal Edge Router is the highest end of the MX Series and delivers the industry’s highest capacity and port density. MX960 is best suited for the high-end aggregation and/or edge of the carrier Ethernet network, providing a multitude of services.

All MX Series routers are built on the unique 3D technology that delivers scale in three dimensions—bandwidth, subscribers, and services. MX Series routers are powered by the industry-leading Junos operating system, which has been rated #1 for its reliability and software stability by 81 service providers in a survey conducted by Heavy Reading.

Junos Space, the management platform for Juniper’s carrier Ethernet solution, consists of effective tools such as Network Activate, Service Now, Route Insight, and QoS Design—all proven to streamline network operations and reduce operating expenses significantly. Junos Space is an open and extensible platform that allows third-party developers to create innovative applications using open application programming interfaces (APIs), providing flexibility and faster time to market for service providers.

<table>
<thead>
<tr>
<th>EANTC Validation Highlights</th>
<th>Density and Scale</th>
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<tr>
<td>Throughput and performance</td>
<td>• 1.44 Tbit/s (unidirectional) throughput in 1/6 rack size</td>
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<tr>
<td></td>
<td>• 240 Gbit/s (unidirectional) IPv4 and IPv6 forwarding on a single line card</td>
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<td></td>
<td>• 2.4 million IPv4 and 2.4 million IPv6 prefixes</td>
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**Unicast Routing Performance**

• Line-rate forwarding for (64 through 1,518 bytes) on 71 10GbE ports
• 3,300 maximum outgoing interfaces on a single line card
• 60,000 multicast groups on each of the 11 10GbE ports
• 660,000 total receiver groups on a single line card

**Multicast Performance**

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• 3,300 maximum outgoing interfaces on a single line card
• 60,000 multicast groups on each of the 11 10GbE ports
• 660,000 total receiver groups on a single line card

**Service scalability**

• Line-rate performance for 6,000 L3VPNs with 2.4 million unicast VPN routes on a single line card
• Line rate performance for 6,000 VPLS with 240,000 MAC addresses on a single line card

**Power consumption**

• 25.34 watts per 10GbE with line rate traffic
• 3.88 watts per gigabit of throughput

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Deployment Flexibility—Choose a Deployment Model That Fits Your Architecture

In today’s fast changing world where network architectures are continuously evolving and new service delivery models are constantly emerging, service providers require unprecedented flexibility in network platforms to adjust to their changing future.

MX Series 3D Universal Edge Routers are powered by Modular Port Concentrators (MPCs) that give service providers flexibility as to how their MX Series routers are deployed and what functions the routers perform in the network. The universal edge architecture, therefore, allows the same platform to be deployed as a VPLS-PE, L3-PE, MPLS LSR, L2 switch, L3 router, firewall, VPN concentrator, or a NAT device. At the heart of the MPCs is Juniper’s fourth generation purpose-built silicon Trio chipset, which is the industry’s first chipset based on Network Instruction Set Processor (NISP) technology. NISP technology combines the performance of application-specific integrated circuit (ASICs) to deliver highest performance at scale, with the flexibility of Network Processors (NPs) to deliver faster feature velocity.

Standard-based protocols implemented in Junos OS allow greater interoperability and choice (for example, LDP and RSVP, Rosen and NG MVPN, VPLS-BGP and VPLS-LDP, inter-AS VPLS). A robust and rich feature set, combined with multi-dimensional scale, not only allows flexible access and network topologies including rings, partial/full mesh, and hub and spoke, but also enables flexible topological service placement with different degrees of centralization or distribution per residential, business, wholesale and mobile backhaul service type. The same MX Series 3D technology is used for the multi-terabit edge platform (MX960) and the scaled down access/aggregation platform (MX80), clearly demonstrating 3D technology elasticity.

The modularity and flexibility of Juniper’s hardware platforms and the feature richness and scalability of Junos OS allow service providers to fully control the service delivery points based on operational and economical matrices, rather than on the capabilities and limitations of the platforms.

Open Ecosystem—Fast, Flexible Innovation for Differentiation

Demanding subscribers and stiff competition are putting significant pressure on service providers to innovate faster than ever before in order to survive and differentiate themselves. Service providers today cannot afford to lock their future into a single networking platform vendor.

MX Series routers are powered by the open Junos Platform, which provides a Software Developer Kit (SDK) that allows third parties such as customers, OEM partners, and independent software vendors to develop innovative applications integrated with Junos OS. The open Junos Space management platform also enables third parties to develop innovative management applications such as Route Insight using rich APIs. The openness of Junos OS and Junos Space, combined with an ecosystem of partners, eliminates vendor lock-in and enables open, faster innovation and value creation.

Transformed, Sustainable Economics

Exponential growth in bandwidth, subscribers, and services, flat or declining average revenue per user (ARPU), over-the-top delivery, specialized platforms, increased network complexity, and higher cost of management are just some of the things that are threatening the profitability of today’s service provider. To survive these pressures and to create value, service providers need a network that will transform the economics of networking and will empower them with sustainably profitable services. The following three benefits of Juniper’s carrier Ethernet services solution enable this transformation.

Converged Services—Increase Revenue per Platform

Traditional carrier Ethernet products are only able to perform Layer 2 switching. Service providers deploying these L2 devices often find themselves needing additional functionality such as MPLS, VPLS, or L3 functionality for deploying other services. Deploying and managing multiple networks to provide residential, business, and mobile services increase network complexity, CapEx, and OpEx.

The universal edge design of MX Series routers allows the same platforms to be used to provide residential (high-speed Internet, IPTV, VoIP), business (E-Line, E-lAN, E-Tree), mobile services (backhaul), and retail and wholesale services, resulting in 60% lower TCO to competition. Feature-rich support for clocking (SyncE, 1588v2) and support for legacy interfaces enable the business case for selling mobile backhaul or clocking as a service. Service richness, ample processing/bandwidth headroom, flexible service assembly and delivery prevent forklift upgrades and proliferation of specialized appliances. Convergence of all services to the same network minimizes the total cost of ownership (TCO) by reducing CapEx and OpEx and by increasing revenue per platform.
Operational Efficiencies—Reduce the Cost Per Bit Delivered

With energy costs soaring and concerns about the global environment growing, service providers need to do their part to conserve energy. The advanced hardware design and silicon of MX Series routers require less power, cooling, and space for supporting higher bandwidth, services, and subscribers than the competition, helping to reduce operating expenses and environmental impact.

A significant component of operational cost is consumed in managing configurations and the operating systems on the platforms. The automation capabilities of Junos OS and its uniform operating environment (one Junos operating system across platforms) increase operational efficiency, while reducing OpEx. Robust service and network management, rated #1 by 81 service providers in a Heavy Reading Survey, deliver efficient service provisioning and management, which helps in reducing OpEx even further.

Streamlined Network Operations—Reduce the Cost of Managing the Network

Operating expenses make up a significant percentage of total network costs—up to 75% in some networks. To help alleviate some of these cost concerns, Juniper has developed the industry’s first MPLS plug-and-play capabilities as a feature of Junos OS. MPLS plug-and-play is designed to automate certain time-consuming tasks. This significantly lowers operating costs by dramatically reducing the complexities involved in setting up and maintaining the network. Extensive standardized OAM tools available on the platform such as MPLS ping, BFD, Y.1731, LSP stats, 802.3ah loopback, 802.1ag linktrace streamline fault monitoring and performance measurements for enforcing service-level agreements (SLAs).

The Junos Space comprehensive Fault, Configuration, Accounting, Performance, Security (FCAPS) toolkit further simplifies network/service deployment and management tasks. The Network Activate application provisions VPNs up to 10 times faster than manual configuration. The Service Now application reduces MTTR up to 30 times by transmitting the details of the network to a Juniper support site even before the customer calls. Route Insight provides remarkable visibility into the network and also allows the simulation of network changes before they are committed.

Superior Quality of Experience

With increased competition and decreased subscriber tolerance for bad experiences, quality of experience, a subjective measurement of a subscriber’s satisfaction with the service provider, has become a critical differentiator in retaining and increasing a subscriber base. Juniper’s carrier Ethernet services solution empowers service providers to deliver superior quality of experience to their subscribers with service continuity, extensive traffic engineering tools, and faster service velocity.

Service Continuity—Minimize Subscriber Outages

In the presence of strict SLAs, downtime in service can result in significant financial losses. Service downtime for the subscriber can also have a negative impact on the brand and cause a permanent loss of business.

Reliability and software stability ensures that the network is up all of the time. Comprehensive link, node, path, service-level resiliency provided by IP/MPLS fast reroute (sub-50 ms failover), nonstop routing (NSR), best-in-class unified in-service software upgrade (unified ISSU), Virtual Chassis, MC-LAG, Ethernet ring protection (G.8032), multihoming, and pseudowire redundancy features in Junos OS, combined with the redundancy built into Juniper hardware, further maximize service availability in the network.

The modular operating system architecture of Junos OS provides security and reliability through microkernel and protected memory for processes. This architecture ensures that the entire platform does not restart because of a minor fault in one process, further ensuring the highest levels of service continuity.

Superior Traffic Engineering—Prioritize What’s Most Important

The variety of IP services running on a service provider’s network has increased dramatically in the last decade. Different services demand different QoS characteristics such as delay, jitter, throughput, etc. For example, minimizing delay is crucial for real-time gaming, while maximizing throughput is important for the download of big files such as photos or podcasts. Many service providers offer differentiated tiered services (e.g., silver, gold, platinum) to subscribers on the same network. Thus, it is critical for service providers to be able to prioritize traffic from a platinum subscriber over a silver and gold subscriber.

The industry-leading queuing density of the MX Series supports hierarchical QoS and TE per subscriber, per VLAN, per VLAN set, per application, and per service session. This provides service providers with the tools they need to satisfy highest level SLAs, and to maximize revenue by offering the highest levels of differentiated services.
Optimized and reliable multicast forwarding, enabled by the P2MP LSPs and NG MVPN features of Junos OS, delivers IPTV and multiparty video chats using up to 10 times lower network bandwidth, and delivering highest value per bit. Multicast replication on the MX Series is performed on the Packet Forwarding Engines (PFEs), keeping the switch fabric simple and allowing it to be as scalable as possible. This enables the MX Series to deliver 5 times higher multicast forwarding performance than the competition.

The MX Series also supports content caching and adaptive streaming capabilities using Juniper Networks Media Flow Solution. Media Flow can reduce cost, improve scalability, and enhance quality of experience for video and IPTV delivery.

**Faster Service Velocity—Deploy Innovative Services Faster**

Stiff competition and declining ARPU are putting significant pressure on service providers to innovate and deploy new revenue generating services faster. Time to market for these innovative services is becoming a critical differentiating factor. With new unpredictable services emerging every year, service providers need network platforms that are feature-rich and flexible enough to adjust to the emerging needs for innovative services and business models.

Juniper Networks carrier Ethernet services solution is built with MX Series platforms that are extremely flexible. The platforms are powered by Junos OS, Juniper’s flagship network operating system that has been powering the Internet for more than a decade. All Juniper products are powered by the same Junos OS, Juniper’s flagship network operating system that has been powering the Internet for more than a decade. All Juniper products are powered by the same Junos operating system. Juniper has been delivering new cutting-edge functionality by releasing a new Junos OS version every quarter consistently for the last 10 years. Predictable and reliable Junos OS releases ensure that service providers will receive the features they need when they need them. Junos OS also supports well published, open programmable interfaces that enable service providers and other third-party vendors to innovate on top of the Junos operating system.

This open and flexible innovation framework allows ecosystem partners to develop their own innovative services. Flexibility, service richness, and an open solution allow service providers to deploy composite and innovative services such as mobile telepresence, location-based services, multiparty video chats, mobile TV, and VOD faster to provide cutting-edge services to their subscribers.

**Summary—Juniper Solution Delivers Transformed Economics for Service Providers and Superior Quality of Experience for Subscribers**

The service provider network is a strategic asset, and network performance, reliability, and scalability are critical to its success. Next-generation applications and services are straining existing networks and driving the need to replace legacy technologies with Ethernet. Due to its cost-effectiveness, Ethernet is enjoying adoption within multiple service provider segments. However, traditional Ethernet lacks the reliability and resiliency that high-performance networks require.

Juniper Networks carrier Ethernet services is an end-to-end solution for deploying a future-ready and service-rich carrier Ethernet network that delivers superior quality of experience at the lowest TCO. The solution delivers an infrastructure network system that can be used for deploying and managing a multitude of applications and services such as metro transport, broadband aggregation, business services, mobile backhaul, video service delivery, and emerging new services, all on a single converged network powered by one platform family and one Junos OS. The feature richness and openness of Junos OS, and the unmatched 3D scale across bandwidth, subscribers, and services of the MX Series enable unprecedented service velocity and faster time to market for service providers creating composite innovative services.

**Next Steps**

To learn more about what Juniper Networks carrier Ethernet services solutions can do for your network, contact your Juniper Networks sales team or visit [www.juniper.net](http://www.juniper.net) for additional information.

**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](http://www.juniper.net).