Challenge
Mobile carriers seek new, high-speed data services to improve ARPU and customer retention while decreasing costs. As bandwidth demand grows, providers need a high-performance and service-aware backhaul solution that protects their investment while providing flexibility to quickly add next-generation technologies.

Solution
Juniper’s solution cost-effectively supports a full range of transport types, enabling a flexible architecture that allows for the coexistence of multigenerational networks. This includes products for the cell site, metro transport network, and aggregation site—all managed by a comprehensive management solution.

Benefits
- Nonstop service delivery, extensive traffic management, and end-to-end MPLS provide a high-performance transport.
- Cost optimized transport, streamlined operations, and monetization of service intelligence deliver lower total cost of ownership (TCO).
- Graceful migration, feature rich clocking, and open interfaces provide deployment flexibility.

Consumers are demanding more mobile services—especially bandwidth-hungry, media rich, and interactive services. Service providers are already seeing rapid growth in data services, and this trend will continue to accelerate. New value-added services such as video chat, interactive real-time gaming, mobile VPNs, and video streaming offer operators new ways to attract and hold subscribers and grow revenues. Realizing this potential, however, requires upgrading the mobile infrastructure, especially mobile backhaul.

At the same time, carriers are looking for ways to reduce operating expense (OpEx) and capital expense (CapEx) in order to compensate for declining average revenue per user (ARPU), increasing competition, and the transition to new technologies. While they need to roll out new IP-based services in order to survive and thrive, carriers still must provide and protect legacy non-IP services, since these services will continue to produce a significant share of their revenue for many years to come.

The Challenge
To achieve their goals, mobile operators must upgrade legacy backhaul networks that do not provide the flexibility or scalability to cost-effectively support multiple services on the same network. Ease of provisioning, planning, and network management is also vital to reducing OpEx and ensuring rapid new service creation and delivery. Additionally, evolving business models in the overall telecom industry are driving operators to closely integrate...
their networks with content and application providers, in order to generate new revenue streams and differentiate themselves from competitors. To do this, operators require a means of separating and securing traffic and maintaining strict service-level agreements (SLAs). Next-generation mobile backhaul solutions must address all of these concerns.

Limitations of the existing mobile backhaul solutions include:

**Cost:** For mobile backhaul today, operators typically use copper or microwave time-division multiplexing (TDM) links, often leased from other service providers. Unlike infrastructure costs, leased line expenses are ongoing, draining profits and impacting competitiveness. Any cost savings realized in backhaul go straight to the bottom line.

**Scalability:** A typical cell site requires two or three leased T1/E1 lines, representing 4 to 6 Mbps of bandwidth. New data intensive mobile services could double this requirement—and more. Adding this much capacity via TDM lines is time-consuming and economically prohibitive. Carriers need the ability to add capacity on demand to respond to changing customer needs.

**Flexibility:** As mobile networks evolve from 2G to 3G and beyond, cell sites must support multiple transport technologies such as TDM, ATM, and IP/Ethernet. Carriers have substantial investments in second-generation (2G) technology, so a “rip out and replace strategy” is not feasible. The next generation of backhaul components must support multiple coexistent technologies at the cell site.

**Efficiency:** Because each T1/E1 line is dedicated, excess capacity cannot easily be shared. The current method of providing backhaul capacity invariably involves a substantial amount of unused—and expensive—bandwidth in the mobile backhaul.

The Juniper Networks Mobile Backhaul Solution

Juniper Networks mobile backhaul solution is an integrated solution that delivers high-performance transport and deployment flexibility at lower total cost of ownership.

The solution delivers high-performance transport using end-to-end MPLS. The resiliency of IP/MPLS, combined with the reliability and stability of Juniper’s hardware and software, maximizes service availability to meet stringent SLA requirements. Extensive quality-of-service (QoS) and traffic engineering (TE) capabilities with best-in-class multicast delivery over MPLS VPNs deliver premium quality of experience for lower network resource utilization. Intelligence of the Juniper Networks® MX Series 3D Universal Edge Routers located closer to the subscriber allow for decentralized and distributed modes of operation.

Juniper’s solution is based on Ethernet and MPLS/MPLS-TP technologies, which have proven to be up to 5 times more cost-effective than TDM technologies. The optimal system characteristics of the Juniper Networks BX7000 Multi-Access Gateway and MX Series platforms (size, power, space, ruggedness) significantly reduce operational expenses in the long term, reducing the cost per bit delivered. Streamlined operations, enabled by zero touch deployment, Juniper Networks Junos® Space Service Now, and an extensive Operation, Administration, and Maintenance (OAM) toolkit, reduce the OpEx associated with deploying and managing the network. The service awareness and feature richness of the solution enable further monetization of the network investment by converging more services (residential and business services, wholesale of mobile backhaul) onto the same infrastructure, maximizing the value per bit delivered.

Modular system design and comprehensive support for various mobile technologies (2G, 3G, and 4G) enable graceful migration to Long Term Evolution (LTE). A wide range of clocking options (1588, SyncE, BITS, T1/E1) provides choice in how timing and synchronization services are delivered in the network. High performance and standard compliance of the clocking solution helps in meeting the stringent timing requirements demanded by mobile networks. Openness of the platforms, as well as of the management platform, allows customization and integration with best-in-class third-party tools.
Features and Benefits
Juniper Networks mobile backhaul solution delivers high-performance transport and deployment flexibility at lower total cost of ownership.

High Performance Transport
MPLS End-to-End—Highest Performance from Access to Core
Traditionally, Layer 2 technologies have been used in the access network (cell site router to the hub site), and Layer 2 or IP/MPLS is used from the hub sites and the aggregation site. Use of multiple technologies increases operating expenses because it requires staff with wider technical knowledge. It also degrades performance of the end-to-end network because traffic has to cross the technological boundaries.

Juniper’s mobile backhaul solution is built with end-to-end MPLS, a proven and familiar technology for most mobile operators. End-to-end label switching with MPLS/MPLS-TP delivers the highest performance at lower operating cost. Juniper Networks pioneered the deployment of MPLS in highly demanding carrier networks, and Juniper’s proven, production hardened hardware platforms and software have been powering the core of the Internet worldwide for more than a decade.

2009 Snapshot: MX960 3D Comparison Chart

Nonstop Service Delivery—No Dropped Calls
Traditional mobile backhaul was built using circuit-switched TDM networks that were extremely reliable and resilient. As the industry has moved to packet-based networks for mobile backhaul, reliability and resiliency have become crucial to ensure service continuity. Service downtime can result in major financial and brand image losses for operators.

Juniper’s mobile backhaul solution delivers highly reliable transport service. The ruggedized design of BX7000 (Network Equipment Building System Level 3 compliant), wide temperature ranges, and unique passive cooling (no fans) minimize failures and maximize service availability. Software features such as MPLS/IP fast reroute, line protection and Automatic Protection Switching (APS), Ethernet ring protection, nonstop active routing (NSR), unified in-service software upgrade (unified ISSU), and inter-chassis redundancy all maximize service availability through failure and maintenance events.

Extensive Traffic Engineering—Prioritize What’s Most Important
The variety of IP services running on mobile devices such as smart phones has increased dramatically in the last decade. Different services demand different quality of service characteristics such as delay, jitter, throughput, etc. For example, minimizing delay is crucial for real-time gaming, and maximizing throughput is important for the download of large files such as photos or videos. The need for extensive QoS and traffic engineering capabilities has never been more important for the mobile backhaul networks to deliver superior quality of experience to their mobile subscribers, while at the same time optimizing the use of network resources.

The MX Series routers’ industry-leading queuing density supports hierarchical QoS and TE per subscriber, per VLAN, per VLAN set, per application, and per service session to ensure that service providers have the tools necessary for satisfying highest levels SLAs, and for maximizing revenue by offering highest levels of differentiated services.

Optimized and reliable multicast forwarding, enabled by point-to-multipoint (P2MP) label-switched paths (LSPs) and next-generation multicast VPNs (NGMVPN) featured in Juniper Networks Junos operating system, deliver IPTV and multiparty video chats using up to ten times lower network bandwidth, delivering highest value per bit and premium quality of experience to subscribers. Multicast replication on the MX Series is performed on the Packet Forwarding Engines (PFEs), keeping the switch fabric simple and as scalable as possible. This allows the MX Series to deliver five times higher multicast forwarding performance than the competition.

Lowest Total Cost of Ownership
Cost Optimized Transport—Lower Cost Per Bit Delivered
With the bandwidth requirements growing exponentially, cost per bit delivered through the mobile backhaul network is an important metric. However, the cost per bit delivered should not be calculated simply using the CapEx of network equipment and the forwarding capacity of the network. The operational expenses, which tend to be much larger than capital expenses and include the cost of deploying and managing the network, the cost of power and space usage, the cost of detecting and fixing faults, and the cost of network downtime, should be an integral part of cost per bit calculations.

Juniper Networks’ cost-optimized transport delivers lower cost per bit. The solution is built on Ethernet, which is 3-5 times more cost-effective than T1/E1 according to ABI Research and Yankee Group. The advanced system architecture of Juniper’s network platforms is designed to reduce operational expenses. BX7000, the cell site router, allows passive cooling (no fans) and supports the widest range of temperatures for extreme environments (-40 to -70 C), minimizing failures and costly truck rolls. MX Series platforms deliver the same capacity with 90% less power consumption compared to two other leading vendors over five years, resulting in significant OpEx savings and the lowest carbon footprint (power, pollution, environmental impact).
BX7000 uses 2-3 times less IP bandwidth for emulating a T1, based on empirical data. Such forwarding efficiencies result in more network capacity for the same capital investment. Ethernet aggregation on the MX Series results in 47% lower total cost of ownership according to a study by Network Strategy Partners.

Streamlined Operations—Reduce the Cost of Deploying and Managing the Network

The cell site routers are deployed in thousands of geographically distributed locations. The cost of deploying, configuring, and managing cell site routers is a critical component of the overall operational cost of the mobile backhaul network. Other important components of the operational cost include fault management, performance monitoring, configuration, and system software management.

Juniper Networks Junos Space is an integral part of Juniper’s mobile backhaul solution. Junos Space is an open and extensible management platform that comes with applications such as Junos Space Network Activate, Junos Space QoS Design, Junos Space Route Insight, and Service Now—all designed to streamline the operations of mobile backhaul networks. Junos Space consists of a comprehensive set of interconnected components such as powerful device instrumentation (NETCONF/XML, SNMP, and CLI), rapid deployment support, and complete remote management that includes remote software upgrade, service provisioning, monitoring, and diagnostics tools.

Junos Space supports transport (generic routing encapsulation, MPLS, traffic engineering) and service provisioning of pseudowires. It also offers monitoring and diagnostics of provisioned services, device configuration management, and remote software upgrade. The solution comes integrated with the industry’s best fault management tool (IBM NetCool) and performance monitoring tool (Computer Associates eHealth), which allow seamless integration into the existing operations support and business support systems (OSS/BSS). Extensive support for standardized Ethernet/IP/MPLS OAM tools such as LSP ping, Bidirectional Forwarding Detection (BFD) protocol, Y.1731, LSP stats, 802.3ah loopback, and 802.1ag linktrace also reduce the operational cost.

Juniper’s unique Service Now application transmits important diagnostics information to Juniper support before a customer calls, reducing the meantime to recovery (MTTR) 30 times based on customer surveys. Automation capabilities of Junos OS and its uniform operating environment (one Junos operating system across platforms) increases operational efficiency, while reducing OpEx.

Monetization of Service Intelligence—Increase the Value Per Bit Delivered

While minimizing CapEx and OpEx is important to service providers, maximizing the revenue generated per network platform is even more important to stay competitive and profitable. Service providers, therefore, should choose intelligent and flexible platforms that can transform a mobile backhaul network from a cost center into a strategic asset that maximizes the value per bit delivered.

Juniper Networks mobile backhaul solution is built upon its flagship MX Series platforms and Junos OS software that deliver unparalleled flexibility and intelligence. The MX Series universal edge architecture allows the same platform to be used to provide residential, business, and mobile services, resulting in 3-4 times more revenue per router, according to a study by Network Strategy Partners. The MX Series supports best-in-class subscriber management, QoS, and multicast capabilities that allow convergence of residential services (high-speed Internet, voice over IP, IPTV, and video on demand) onto the same network. Comprehensive, scalable, MEF-certified support for L2 and L3 VPNs allows convergence of business services (E-Line, E-LAN, and E-Tree) onto the same network. Using specialized appliances for each service, on the other hand, results in platform proliferation, which adds complexity and cost to the network.

Figure 4: Streamlined operations through zero touch deployment

Juniper’s zero touch deployment allows BX7000 to configure itself out of the box—with no manual intervention—using the configuration available on the network, on local USB removable media, or on a combination of both. As a result, the BX7000 can be sent directly from the warehouse to the deployment site preconfigured. In addition, because the device knows how to find its proper configuration information and make it available on the network for remote management, no tech savvy personnel are needed at the deployment site. This enables rapid mass deployment of a large number of these devices at significantly lower cost.
Deployment Flexibility
Graceful Migration—Migrate to 4G While Supporting 2G and 3G
As mobile networks evolve from 2G to 3G to 4G and beyond, cell sites must support multiple transport technologies such as TDM, ATM, and IP/Ethernet. Carriers have substantial investments in 2G technology, so a “rip out and replace strategy” is not feasible most of the time. The next generation of backhaul components must support the multiple coexistent technologies at the cell site as well as at the aggregation site connecting to the base station controller (BSC), radio network controller (RNC), or the signaling gateway (SGW).

Juniper’s mobile backhaul solution supports the interfaces required for 2G and 3G cell sites, making it an easy addition to existing infrastructures. At the same time, the Juniper solution supports 4G technologies such as WiMax and LTE to future-proof investments in cell site installations. Juniper’s comprehensive solution allows mobile operators to use an end-to-end common IP/MPLS transport network that can support L2 or L3 backhaul as well as business and residential services. Modularity of the interface and timing cards on the BX7000 allow customization to fulfill diverse needs. The modularity of MX Series platforms enable “pay as you grow” models, allowing service providers to dial up the bandwidth as subscriber traffic increases.

Feature Rich Clocking—Use the Timing Solution that Fits the Architecture
In mobile access networks including those with 2G and 3G base stations, there are stringent timing requirements for handover as mobile stations move from one cell to another. Timing and synchronization are critical elements for maintaining good voice quality, reducing interference, and managing these call handovers. In a typical TDM network, the various entities are synchronized on a common primary reference source. As the industry moves to packet-based transport networks to distribute TDM services, the same level of synchronization is needed to avoid cutouts, lost handovers, and blocked or failed call setup.

Juniper Networks mobile backhaul solution supports comprehensive timing and synchronization options, including synchronous Ethernet, 1588v2, T1/E1, and BITS, providing deployment flexibility to the operator. Juniper’s cell site router can derive timing from multiple sources simultaneously to ensure that each mobile operator gets timing from its own clock source and maintains accurate clock recovery. Compliance with the International Telecommunication Union (ITU) standard G.8261 ensures that the solution meets the stringent jitter and wander requirements demanded by mobile networks. Modularity of the timing module in Juniper’s cell site router also saves cost if alternative timing sources are deployed.

Open Interfaces—Integrate with Existing Systems, Customize as Needed
Service providers already have carrier-grade OSS/BSS systems, and adding yet another vendor-specific management system to the mix makes things complex and costly. Closed management and networking systems lock service providers to the vendor and also make them dependent on the vendor for new features, customization, integration with other systems, and innovation.

Juniper Networks believes in openness that allows service providers to customize, integrate, and innovate. Junos OS, which powers Juniper’s network platforms, supports well published, open programmable interfaces that enable service providers and other third-party vendors to innovate on top of the Junos Platform. Innovation can range from simple scripts to collect some information that is not available via the management interfaces to extensive services such as video traffic monitoring, location-based services, and content caching.

Juniper’s management platform integrates best-in-class tools from industry-leading vendors such as IBM and Computer Associates to ensure that service providers are not locked into one vendor.

Solution Components
Juniper Networks BX7000 Multi-Access Gateway
Designed for the demanding environment of the cell site, the BX7000 interfaces to common uplinks including T1 and E1, DSL, and Ethernet. It reliably transports TDM, ATM, and packet traffic over IP/MPLS using pseudowire technology. BX7000 includes a replaceable interface module that supports higher density at the cell site while minimizing equipment diversity.

The BX7000 supports a range of timing synchronization options, with future-proofing provided by a slot for field-replaceable timing modules. The BX7000 supports today’s technologies as well as emerging standards such as WiMAX and Third-Generation Partnership Project (3GPP) LTE.

By deploying the BX7000 Multi-Access Gateway, mobile operators can protect their existing investment in 2G and 3G cell sites while reaping the benefits of IP/MPLS-based transport. Services can be migrated gradually, for example, by offloading the high growth data transport as a first step.

Juniper Aggregation Site Gateway (M Series with Circuit Emulation PICs)
Juniper’s aggregation site gateway terminates pseudowires, sending TDM traffic to the base station controller, and ATM and IP traffic to the radio network controller. Based on Juniper Networks M Series Multiservice Edge Routers, the Juniper aggregation site gateway features two new circuit emulation PICs designed specifically for mobile backhaul applications: 12-port T1/E1 circuit emulation PIC and 4-port ChOC3/STM1 circuit emulation PIC.
MX Series 3D Universal Edge Routers for Metro Transport

Juniper Networks MX Series 3D Universal Edge Routers are ideal for IP/MPLS-based metro backhaul transport. They offer all of the benefits of IP/MPLS—fast reroute, resiliency, reliability, and OAM. The MX Series can implement both L2 and L3 VPNs.

While the Juniper mobile backhaul solution is fully interoperable with a wide range of metro aggregation architectures and components, there are a number of advantages to using MX Series 3D Universal Edge Routers, including:

- **Pseudowire-VPLS interworking:** The Juniper solution with MX Series platforms supports pseudowire interworking with virtual private LAN service (VPLS), in which an access pseudowire from the BX7000 Multi-Access Gateway is cross connected with a point-to-point VPLS instance in the metro backhaul network. This feature allows mobile operators to address a number of technical requirements, including multihoming, control plane scaling, and multicasting, as well as segmentation issues that can arise when backhaul components reside in different administrative domains.

- **Comprehensive network management:** Junos Space management platform, with applications such as Network Activate and QoS Design, allows network operators to manage the full end-to-end mobile backhaul network from a central location, as described below.

**Junos Space Management Platform**

Junos Space is Juniper’s open and extensible management platform for the operational management and administration of Juniper routers, including the BX7000, M Series, and MX Series. Junos Space is the platform for applications such as Network Activate, QoS Design, Route Insight, and Service Now that have been designed to address the demanding requirements of mobile backhaul.

Using Junos Space, network managers can provision services, manage device configurations, track inventory, diagnose faults, and monitor the backhaul infrastructure from a central location. Junos Space can push software upgrades to all components in the Juniper mobile backhaul solution, minimizing the need for costly site visits. As a result, Junos Space reduces operating costs and improves operational efficiency.

**Figure 5: Solution Components**

The Juniper Backhaul Solution includes:

- BX7000 Multi-Access Gateway
- M Series Aggregation Site Gateway with Circuit Emulation PICs
- MX Series for metro backhaul aggregation
- Junos Space for Management
Summary—High Performance Transport and Deployment Flexibility at Lower TCO

For more than a decade, Juniper Networks has been helping service providers evolve to secure, converged packet infrastructures. With its IP/MPLS-based mobile backhaul solution, Juniper is extending its advanced mobile solution portfolio.

Juniper Networks mobile backhaul solution is an integrated end-to-end solution that delivers high-performance transport using end-to-end MPLS and deployment flexibility at lower total cost of ownership. Cost-effectiveness of Ethernet/MPLS technologies, optimal system characteristics of Juniper platforms, and streamlined operations with comprehensive management tools result in reduced OpEx, while service awareness enables further monetization. Support for various mobile technologies (2G, 3G, 4G) and clocking options (1588, SyncE, BITS, T1/E1) enable graceful migration to LTE. The resiliency of IP/MPLS combined with the reliability of Juniper’s hardware and software maximizes service availability, while extensive QoS and TE capabilities deliver a premium quality of experience.

Next Steps

To learn more about Juniper Networks mobile backhaul solution, please visit www.juniper.net or contact your local Juniper Networks sales representative.

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.