Challenge
As mobile operators deploy 4G/LTE radio access and packet core to support smart devices, legacy mobile backhaul has become a barrier. Clearly mobile service providers need an evolved mobile backhaul to deliver the rich broadband experiences that Internet users have come to expect.

Solution
Juniper’s evolved mobile backhaul solution creates an access network between cell sites and mobile packet core. It offers single control, forwarding and management plane from cell-site to packet core, field-proven high precision timing for both frequency and phase synchronization, and the industry’s first open platform.

Benefits
- Operational intelligence and traffic steering for efficient mobile data traffic management, improving AMPU (average margin per user) and quality of experience
- Designed for any generation radio access and any size cell
- Open platform providing unlimited possibilities in cell site consolidation, analytics, and management bringing increased innovation and maximum capital leverage of mobile assets.

To compete effectively, mobile service providers (MSPs) need to evolve their offerings from current best-effort mobile broadband service to mobile Internet experiences that can be differentiated for application and subscriber. The key requirement is to simultaneously run real-time and non real-time, person to person, and client/server, MSP-hosted and over-the-top (OTT) applications. To fulfill this, providers are deploying the Evolved Packet System (EPS) specified by the Third-Generation Partnership Project (3GPP) as depicted in figure 1. This eliminates the centralized radio network controller to flatten the network and separates the Control plane from the User plane to allow for deployment flexibility. Consequently, Cell-sites require full-mesh connectivity with neighboring cell-sites and user and control plane nodes deployed at any location in aggregation and backbone transport network.

Figure 1: 3GPP Architecture evolution from 3G to 4G/LTE Evolved Packet System (EPS).

The Challenge
The prevailing approach of upgrading mobile backhaul from time-division multiplexing (TDM) to Ethernet switching is preventing MSPs from unleashing the benefits of an evolved radio access and packet core. The main problem is that it is executed on top of the transport bearer consisting of several disparate control and forwarding mechanisms from cell site to the data center (e.g., IP/MPLS in the backbone, and Ethernet switching with TDM/ATM pseudowires in the access and aggregation layers). Such legacy mobile backhaul upgrades are further challenged by the emerging solutions for handling ever growing mobile signaling and data traffic, which include:
- Converged fixed and mobile networks to keep the low value bits on the lower cost network
- Small cells (microcell, picocell, public femtocell) piggybacked over macrocell backhaul or other available access networks
- Low value traffic breakout as early as possible in the backhaul network to save precious resources
- Sharing the radio access network with multiple MSPs
- Transporting baseband radio signals from remote radio heads to centralized baseband processing locations

The overriding goal for MSPs is to design a transport network between cell site and data center that not only unleashes the EPS benefits, but also enables efficient mobile traffic management across multiple accesses.

**The Juniper Networks Evolved Mobile Backhaul Solution**

Meeting these challenges without sacrificing the MSP’s profit margin requires decoupling EPS User and Control plane from the transport bearer, automated service provisioning, and unified network management. To this end, Juniper Networks evolved traditional mobile backhaul across the following three dimensions:

1. Internetworking cell sites with packet core nodes using MPLS based common control and forwarding across the access, aggregation, and backbone transport.
   - Each cell site requires a minimum of six connections with several EPS gateways, each deployed at various levels in pre-aggregation, aggregation, and backbone parts of the mobile transport as depicted in fig. 2. For load sharing and resiliency, these EPS gateways are pooled, which further increases the required connections by the pool size. As a mobile network typically consists of several thousand cell sites in each service region, MPLS-based mobile transport provides scale to support all required connections from cell sites in a service region.

- MPLS-TE (traffic engineering) and hierarchical quality of service (QoS) provide for guaranteed bit rate and best-effort simultaneously, providing aggregated maximum bit rate per subscribers with call-admission control.
- Allows for smooth 2G and 3G backhaul migration to the evolved packet core as it supports TDM, ATM, and High-Speed Data Link Control (HSDL) pseudowires over MPLS or MPLS transport profile (MPS-TP).
- Supports low latency and lossless inter-cell site connectivity (X-2 interface) among tens of neighboring 4G/Long Term Evolution cell sites required for seamless mobility and LTE-Advanced features (aka coordinated multipoint, dynamic inter-cell interference coordination).
- Emerging ring, mesh, and point-to-multipoint (P2MP) transport links over fiber and microwave are efficiently leveraged by a Layer 3 network.
- Cell sites may have to support many more inter-cell sites and EPS gateway connections when small cells are piggybacked over cell site transport.
- Flexible placement of EPS gateways (S-GW, ePDG and SaMOG) as MPLS service nodes (SNs) enable optimal traffic management by routing selective IP flows at SNs located at metro-pop or peering point, while breaking out local IP access flows at the small cell as depicted in Figure 3. Due to Layer 3 routing selective traffic can be directly routed to bypass the MTSO (for example, Internet traffic from small cell or Wi-Fi access).

Figure 2: Common MPLS control and forwarding from cell site to packet core.
2. Optimal synchronization that delivers frequency, phase, and time of day.
As multi-generational radio access technologies (GSM, UMTS LTE-TDD, LTE-FDD) are present at the same cell sites, both frequency and phase (with time of day) synchronization will be required at such cell sites to provide seamless intra- and inter-radio access handovers, radio interference avoidance, and improved spectral efficiency with upcoming LTE-Advanced features (e.g., coordinated multipoint transmission and dynamic intercell interference coordination).

3. Open network platforms for ecosystem integration across cell site, access, aggregation, and packet core.
Dynamic customer demands coupled with rapidly evolving technology make meeting marketing needs in a timely manner, cost effectively, difficult for service providers. The near term evolution of mobile backhaul emphasizes capacity enhancements and architectural optimizations as the foundation for enabling the next generation of mobility services, with longer term innovations being built on this platform through open network programmability.

Features and Benefits
Industry’s most comprehensive and widely deployed MPLS service portfolio:
- Juniper’s end-to-end MPLS solution, as depicted in fig. 4, is offered on Juniper Networks® ACX Series Universal Access Routers and MX Series 3D Universal Edge Routers, all running a single Juniper Networks Junos® operating system.
- Juniper’s solution enables industry-leading wire-rate support for multicast VPLS and VPN, and it delivers route convergence within 24 seconds for 1 million routes.
- Multilayer resiliency is enabled by offering path, link, node, element, and protocol level reliability through nonstop active routing (NSR), unified in-service software upgrade (unified I55U), Virtual Chassis technology, service mirroring, multichassis link aggregation group (LAG) and L2/L3 redundancy.
- Operation, Administration, and Maintenance (OAM) detection-based local repair delivers the required sub-50 ms restoration.
- Further, enhanced local repair capabilities for service continuity are provided with features such as MPLS fast reroute, loop-free alternate (LFA), fast Bidirectional Forwarding Detection (BFD), L2/L3 service mirroring, L2 active/active access, and multihoming.

Field-proven, best-in-class timing for frequency and phase synchronization:
- Juniper Networks mobile backhaul evolution supports comprehensive timing and synchronization options, including Synchronous Ethernet (SyncE), IEEE 1588-2008 (PTP), T1/E1, and BITS.
- It exceeds the International Telecommunication Union (ITU) standard G.8261 requirements for stringent jitter and wander. Juniper’s timing has the best performance in the industry with phase accuracy of sub-ms, and frequency accuracy of less than 1 part per billion (ppb).
- It is highly scalable, interoperable and already deployed in many networks.
- In the event that a timing source is lost, Juniper’s solution offers frequency holdover time of more than 24 hrs.
- Juniper Networks Junos Space supports configuration and provisioning of synchronization interfaces such as IEEE1588-2008 (PTP) and SyncE. This application allows creation and management of timing domains that comprise Precision Time Protocol (PTP) grandmasters and clients, and it also provides performance and fault monitoring capabilities with probes to test clock accuracy.

Figure 3: Single MPLS enables intelligent mobile traffic management across fixed and mobile networks.
Junos OS for rapid hardware and software integration, manageability, applications, and rapid innovation:

• Juniper’s evolved mobile backhaul solution offers unmatched open APIs for integration of new services, analytics, manageability functions, automation, and orchestration.
• It incorporates Juniper Networks Junos SDK, enabling software applications and hardware components to be embedded in the network by running on top of Junos OS. As an example, Juniper’s partner Nokia Siemens Networks leverages the dynamic adaptability of its liquid radio technology by Junos application that collects real-time traffic information from access and aggregation nodes and based on that triggers policy enforcement from Junos Space.
• With support for open hardware integration, operators can further reduce power and space requirements by seamlessly consolidating other network elements such as microwave IDUs (InDoor Unit).

Junos Space Network Management Platform
Junos Space network management platform with Network Activate is an integral part of Juniper’s Advanced Mobile Backhaul Solution portfolio.

• The Junos Space platform provides powerful device instrumentation (NETCONF/XML, SNMP, CLI), rapid deployment support, and complete remote management such as remote software upgrade, service provisioning, monitoring, and diagnostics tools.

• These basic administration capabilities are augmented by Network Activate, which consists of a comprehensive set of interconnected applications for service provisioning, path configuration, synchronization management, QoS configuration, and OAM Network Activate, together with other Junos Space applications, enables users to:
  - Automate the design, activation, and validation of the provisioning process for L2/L3 VPNs across MPLS and carrier Ethernet networks, enabling service providers to efficiently and cost-effectively manage deployments while reducing fallouts from misconfigured services.
  - Design, provision and activate RSVP signaled label-switched paths (LSPs), as well as static LSPs. LSPs can be configured as end-to-end, P2P, or P2MP LSPs.
  - Create QoS profiles and associate them to specific Ethernet services.
  - Perform management functions such as Ethernet Connectivity Fault Management (CFM), Ethernet link-level fault detection and management, and BFD.
  - Configure and provision synchronization interfaces such as IEEE1588v2-2008(PTP) and SyncE.
  - The Junos Space platform and applications are all accessible through a Representational State Transfer (REST)-based API from northbound systems. This enables operators to build native applications on their operations/business support systems (OSS/BSS), and tap into the rich functionality of the Junos Space platform and applications.

Figure 4: Juniper Networks evolved mobile backhaul solution.
Solution Components
MX Series 3D Universal Edge Routers
The MX Series is an Ethernet optimized, intelligent IP/MPLS converged edge platform. It contains several platforms—Juniper Networks MX960, MX480, MX240, MX80, MX40, MX10, and MX5 3D Universal Edge Routers, and it offers dynamic multilayered service creation with the Trio chipset for greater scale and performance. These systems will function from pre-aggregation to the edge of the network. The MX Series also includes service cards such as the Multiservices Dense Port Concentrator (MS-DPC) for advanced inline services, and the Modular Port Concentrator (MPC) for high-scale session and service. All of the features and benefits of MPLS described above are enabled by the MX Series router, increasing the reliability of the network and offering simplicity and scale with service continuity.

ACX Series Universal Access Routers
The ACX Series is a 60 Gbps platform with 10GbE uplinks providing the highest performance of any access router in the industry. It is an open access system with extensibility for services or hardware, and it features a standards-based programming interface that provides integration with existing services and tools. ACX Series supports Power over Ethernet (POE+) at 60 W, so there is no need for additional electrical cabling for microwave or other access interfaces. It is an environmentally hardened access router with passive cooling, and a minimum mean time between failures (MTBF) of 70,000 hours. ACX Series integrates timing synchronization with inputs and outputs for SyncE, IEEE1588-2008 (PTP), and GPS.

Summary—Juniper’s Evolved Mobile Access Unleashes 4G/LTE Benefits and Profits
Unlike legacy backhaul upgrades, Juniper’s evolved mobile access solution creates an access network between cell sites and mobile packet core. It provides single control and forwarding across cell sites, aggregation, and packet core for intelligent, dynamic, and scalable handling of traffic from any size any generation radio cell. It enables per-flow QoS, highest resiliency, and simplified OAM. It enables increased call quality, reduced dropped calls, and optimized spectrum utilization with its field-proven high precision timing for both frequency and phase synchronization. And, it is the industry’s first open cell site platform offering an SDK for rapid integration of hardware appliances and agile operations.

ACX Series Universal Access Routers and MX Series 3D Universal Edge Routers with single and open Junos OS provide industry’s highest performing IP/MPLS platforms across any access, aggregation and edge enabling rich mobile Internet experiences that help drive revenue and unleash 4G/LTE benefits and profits.

Next Steps
To learn more about Juniper Networks Mobile Access Solution, please visit http://www.int.jnpr.net/ipg/solutions/mobile-backhaul 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.