White Paper

# Leveraging MPLS to Enable Deterministic Services in the Cable Core

## Building a “BGP-Free” Core Network to Enhance Performance and Operational Efficiency for Cable Operators

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## Executive Summary

Cable operators are competing with incumbent carriers to deliver both residential and commercial services. This requires an efficient core backbone that is agnostic to routing protocols and provides fast throughput to support regional metro networks. By building an MPLS core that provides high-performance transport for diverse services, cable operators can more effectively compete with carriers that already have the infrastructure in place to offer services nationwide. MPLS-enabled networks also allow Multiple System Operators (MSOs) to minimize the use of state-based routing protocols to develop a faster, more reliable and deterministic infrastructure that is easier to manage and operate, and which enables the efficient delivery of next-generation services.

## Introduction

The cable industry has seen a great deal of consolidation in the past ten to twenty years, resulting in large MSOs that are essentially independent regional operating companies connected over a common backbone network. Regional infrastructure varies greatly, yet cable operators are increasingly challenged to deliver high-performance services nationwide—at a time when major phone companies already have nationwide service infrastructures in place.

By building a MultiProtocol Label Switching (MPLS) core network and enabling diverse services to efficiently traverse that core network, cable operators can not only streamline the operations and administration of their network, but can also enable regional networks to more effectively utilize the core network to support such emerging services as:

- Layer 2 Virtual Private Networks (VPNs)
- Layer 3 VPNs
- Virtual Private LAN Service (VPLS)
- Point-to-multipoint commercial services

Juniper Networks offers an end-to-end MPLS core network solution that allows cable operators to enhance network performance and operational efficiency, and to dramatically minimize the number of Border Gateway Protocol (BGP) routes broadcast across the network.

## Taking Advantage of MPLS

MPLS is a data-carrying mechanism that emulates some properties of a circuit-switched network over a packet-switched network. It operates at an Open Systems Interconnecton (OSI) model layer that is generally considered to lie between traditional definitions of Layer 2 (data link layer) and Layer 3 (network layer), and it is often referred to as a "Layer 2.5" protocol. It was designed to provide a unified data-carrying service for both circuit-based clients and packet-switching clients. It can be used to carry many different kinds of traffic, including IP packets, native Asynchronous Transfer Mode (ATM), SONET, and Ethernet frames.

MPLS works by appending packets with an MPLS header containing one or more labels. These MPLS labeled packets are switched after a Label Lookup/Switch instead of a lookup into the IP table. The exit points of an MPLS network are called Label Edge Routers (LERs). Routers that perform routing based only on Label Switching are called Label Switch Routers (LSRs). Devices that function as ingress and/or egress routers to MPLS core networks are often referred to as Provider Edge (PE) routers. In order to give MPLS networks the deterministic capabilities inherent in private networks, operators can concurrently rely on the Resource Reservation Protocol (RSVP).

RSVP-Traffic Engineering (RSVP-TE) is an extension to RSVP that supports the reservation of resources across the network. Applications running on IP end systems can use RSVP to indicate to other nodes the nature (bandwidth, jitter, maximum burst, and so forth) of the packet streams they want to receive. RSVP is a network-layer protocol designed to reserve resources across a network, and it provides receiver-initiated setup of resource reservations for multicast or unicast data flows with scaling and robustness.

RSVP can be used to request or deliver specific Quality of Service (QoS) levels for application data streams or flows. RSVP defines how applications place reservations and how they can relinquish the reserved resources once the need for them has ended. RSVP is not itself a routing protocol and was designed to interoperate with current and future routing protocols. Cable operators can rely on MPLS and RSVP to build a traffic-engineered backbone network that efficiently serves regional networks, simplifies backbone operations and management, and allows regional networks to create transparent services that traverse the core. For example, an enterprise customer based in California can be offered VPN services to connect with remote locations throughout the East Coast.

MPLS combines the best of both Layer 3 IP routing and Layer 2 switching. While routers require network-level intelligence to determine where to send traffic, switches only send data to the next hop, and so are inherently simpler, faster, and less costly. MPLS relies on traditional IP routing protocols to advertise and establish the network topology, but MPLS also predetermines the path data takes across a network and encodes that information into a label that the network's routers understand. This is a connection-oriented approach and it establishes a clean separation of protocols. Since route planning occurs ahead of time and at the edge of the network, very little overhead is placed on the MPLS-labeled data that travels across the core of the network. This contrasts sharply with networks that rely on Layer 3 protocols like BGP for route determination across the network.

## Building a "BGP-Free" Core Network?

BGP has played a valuable role in cable networks, but it has limitations that operators need to address. BGP works by maintaining a table of IP networks or prefixes which designate network reachability among Autonomous Systems (ASs). BGP allows network platforms to make routing decisions based on path, network policies, and/or rulesets.

In the simplest arrangement, all routers within a single AS that are participating in BGP routing must be configured in a full mesh, and each router must be configured as a peer to every other router. This causes massive scaling problems since the number of required connections grows dramatically with the number of routers involved. BGP requires Layer 3 routing throughout, which imposes overhead on both core and access routers.

Cable operators, therefore, face the challenge of managing the performance impacts of potentially hundreds-of-thousands of BGP routes. One of the largest problems faced by BGP comes from the growth of the routing table. If the global routing table grows to the point where some older, less capable routers cannot cope with the memory requirements or the CPU load of maintaining the table, these routers will cease to be effective gateways. Larger routing tables take longer to stabilize after network upgrades or topology changes, potentially leaving network service unreliable or even unavailable in the interim.

While industry reports of potential "BGP-free" networks sound promising, the reality is that BGP is still a valuable protocol that is essential for peering arrangements between providers. While cable operators will need to continue to support BGP, they can dramatically reduce the number of BGP routes that core routers and PE routers need to support by building an MPLS core network and relying on RSVP for all traffic flows.

Instead of forcing routers to store and manage hundreds-of-thousands of BGP routes, operators can efficiently switch traffic in the MPLS core and deploy hierarchical, service-based route reflectors to reduce the number of connections required in an AS. A single router (or two for redundancy) can serve as a route reflector and other routers in the AS only need to be configured as peers to them. For example, an operator offering Layer 2 or Layer 3 VPN services can rely on route reflectors to direct traffic as needed without the need to distribute BGP routing tables to each router.

## The Juniper Networks MPLS Core

Juniper offers a proven MPLS core solution that allows MSOs to efficiently deliver transport services utilizing an agnostic MPLS-RSVP core. Juniper's MPLS implementation allows cable operators the ability to collapse existing Layer 2 and Layer 3 services while enabling national service delivery. Cable operators can deliver deterministic services and support performance-sensitive applications such as transporting video across the core to regional networks or meeting the QoS requirements for virtual private LAN services. Using this solution, MSOs can build a core MPLS network and provide a more efficient backbone for supporting regional networks. There are many advantages to utilizing a traffic engineered RSVP backbone based on Juniper technology:

- A single converged network can support new and existing services, and it can create an effective migration path to an all IP-based infrastructure.
- Network performance is significantly improved because less information on network state needs to be transmitted. The network becomes more deterministic and routers do not need to maintain vast numbers of BGP routing tables.
- Regional or metropolitan networks can create and provision new services while taking advantage of a protocol-agnostic backbone.
- Cable operators benefit from increased service velocity and the ability to swiftly add new enhanced data, voice, and video services. Any service supported by RSVP can be swiftly added without massive efforts in configuring network equipment.
- DiffServ-aware traffic engineering can also be implemented based on application information so that cable operators can provide QoS guarantees based on traffic requirements, and charge premium prices in exchange for guaranteed service levels.
- MPLS is less taxing on existing hardware because all that is required is a label lookup instead of the need to rely on more complicated IP routing protocols.
- Operators can leverage MPLS resiliency to decrease failover times.
- Management of devices becomes simpler because the RSVP core does not need to be changed to enable services. Services are enabled on the PE routers and passed transparently through the RSVP backbone.
- MPLS simplifies the configuration of core routers, reducing potential for errors and streamlining Operations, Administration, Management and Provisioning (OAM&P).
- The MPLS core masks network complexity from customers by reducing the visibility of hop counts.
- Flexible service delivery is enabled by providing a way to transport legacy protocols like frame-relay and Asynchronous Transfer Mode (ATM).
- Management and administration of the core network is simplified due to a clean separation of administrative domains and the fact that routing protocols are enabled between PE routers and not on the RSVP core routers.
- Increased scalability is enabled by relying on hierarchical route reflectors for each type of service.
- More effective use of bandwidth is enabled via traffic engineering.
- Increased network resiliency is achieved by utilizing self-healing MPLS protocols like Fast Re-Route to provide link and node protection.

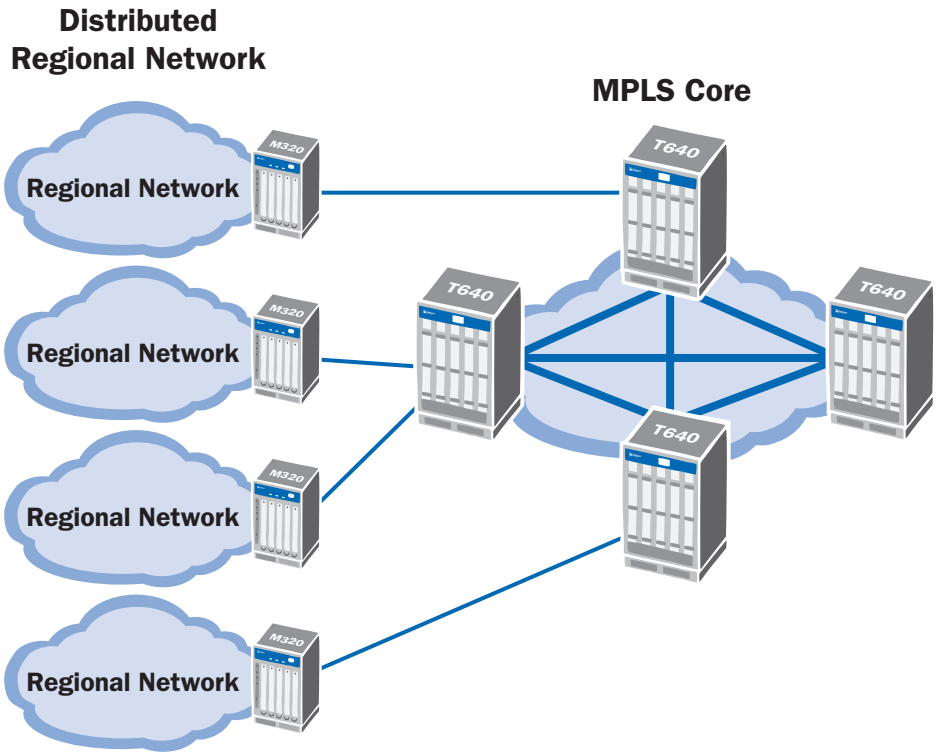


Figure 1. The Juniper MPLS Core Network.

## MPLS Solution for Cable Operators

The Juniper MPLS core solution for cable operators employs Juniper T-series routers in the core and M-series routers in the regional network with JUNOS™—the industry's most proven and trusted network operating system—operating from the edge to the core across all Juniper routing platforms. All Juniper T-series and M-series platforms share a common architecture that separates routing, forwarding, and service functions in order to protect and scale each of these critical elements. Implementing an end-to-end Juniper network means that cable operators can leverage a single JUNOS software release in the peering centers, regional data centers, and core networks to greatly simplify overall network operations. It also means that operators can draw from a common pool of interchangeable physical network interface cards to simplify maintenance and reduce sparing costs. Deploying Juniper T-series and M-series routers not only translates into more efficient network operation, but it also helps cable operators generate new revenues by accelerating the deployment of new services.

Juniper Networks T-series routers free MSOs from the traditional trade-off between rich services and performance by offering sophisticated processing capability on a true multiservice platform. The scale and density of T-Series core routers allow service providers to increase capacity without adding additional systems to the network. The TX Matrix allows incremental expansion to a 2.5 Tbps system. Future-proof architecture scales comfortably to well beyond this capacity as provider needs progress. High Availability (HA) and continuous operation is critical in core routing, where loss of a single routing node can remove service for a wide geographical area, and there is no single point of failure in T-Series routers.

Building core Next-Generation Networks (NGNs) with T-series routers offers a "pay-as-you-grow" path to accommodating exponential bandwidth growth and seamlessly integrating with the optical transport networks that connect metropolitan areas. Alternative solutions require forklift upgrades and modifications to the transport network. The data plane in T-series routers is based on a complex of programmable application-specific integrated circuits (ASICs) that provide high security and granular traffic control while handling potentially hundreds-of-thousands of filtering operations at the highest line rates. Highly granular QoS, advanced filter-based forwarding and flow-based monitoring are critical in core routing. Juniper's programmable ASICs deliver a comprehensive hardware-based system for packet processing. To ensure a nonblocking forwarding path, all channels between the ASICs are oversized, dedicated paths. Furthermore, Juniper forwarding engines implement the industry's most sophisticated, predictable, and granular policies.

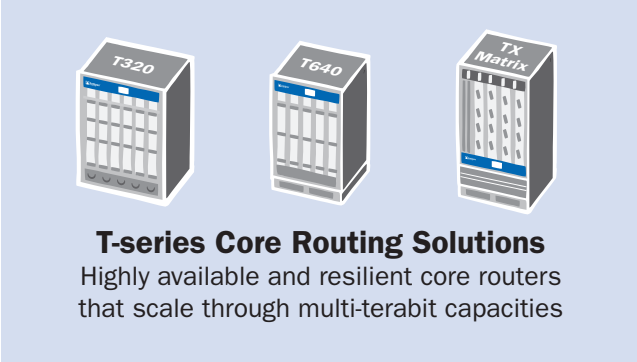


**Figure 2. Juniper T-series Routers.**

On the control plane is the JUNOS operating system, which operates from the edge to the core across all Juniper routing platforms. In addition to being the industry's most proven and trusted network operating system, JUNOS is integrated with Juniper's Session and Resource Control (SRC) portfolio for policy-driven control of network resources. Each JUNOS process runs in protected memory to guard against system crashes and to ensure that applications do not interfere with each other. JUNOS provides the greatest breadth of features and most stable network operating system in the industry.

Each release of JUNOS runs consistently across all Juniper Networks routing platforms and feature sets. JUNOS was conceived and implemented as a modular design. Advanced features include point-to-multipoint (P2MP) MPLS, MPLS VPN, IPv6 PE, and many more unique features in core routers.

Juniper Networks M-series multiservice edge routing portfolio can be deployed in regional data centers to provide access to T-series routers in the MPLS core. The M-series uniquely combines best-in-class IP/MPLS capabilities with unmatched reliability, stability, security, and service richness. These multiservice edge routing platforms allow cable operators to consolidate multiple networks onto a single IP/MPLS infrastructure while simultaneously generating new revenues with leading-edge services. The M-series multiservice edge routing systems use a hardware-based approach combined with the highly scalable, secure, and reliable JUNOS software, which enables multiple services without compromise on a single IP/MPLS platform.

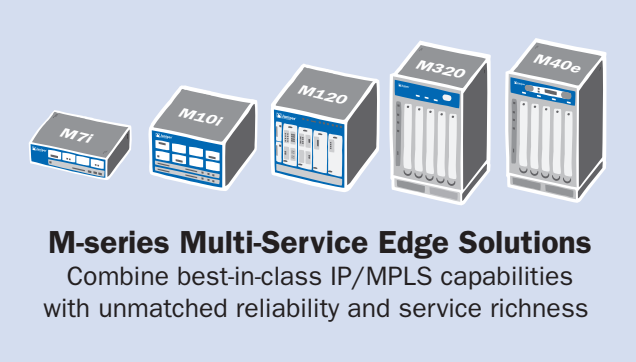


**Figure 3. Juniper M-series Routers.**

Deployed predominantly at the edge of regional networks, the IP/MPLS M-series multiservice edge routing family is capable of supporting current and emerging Layer 2 and Layer 3 services. From a Layer 2 perspective, the J-FASE (Juniper Frame and ATM Service Emulation) toolkit, combined with M-series multiservice edge routing performance, enables accurate emulation of ATM and Frame Relay services over MPLS. The same multiservice edge routing platform supports rich Ethernet services, enabling providers to capture revenue from this emerging service. Layer 2.5 interworking VPNs are available to smoothly migrate customers from ATM/Frame Relay to Ethernet services, as demand dictates.

The same IP/MPLS M-series multiservice edge routing platform also delivers rich Layer 3 services, including the industry's most scalable and comprehensive Layer 3 VPN portfolio, granular per logical interface QoS, hardware-based IPv6, multicast, Network Address Translation (NAT), stateful firewall, and IPSec encryption. New revenues are generated faster and more cost-effectively when Session and Resource Control portfolio solutions leverage these rich features. The M-series multiservice edge routing platform provides:

- Rich packet processing, supporting any Layer 2 or Layer 3 services to any customer on a single platform
- Services scaled with proven stability in the world's largest networks
- Low operational costs and consistent services, with a single JUNOS image across all platforms
- Rapid time to revenue with the Session and Resource Control portfolio

## Simplifying Operations and Enabling High-Performance Services

Cable operators can build MPLS core networks to successfully compete with incumbent carriers and increase service velocity. The integration of T-series routers in the core and M-Series multiservice edge routers in the regional networks allows operators to deliver more deterministic, predictable, and reliable services. Instead of flooding the network with BGP routing tables, MSOs can simplify operations and build core networks that can support high-performance commercial and residential services with measurable and guaranteed QoS levels.

## About Juniper Networks

Juniper Networks, Inc. is the leader in high-performance networking. Juniper offers a high-performance network infrastructure that creates a responsive and trusted environment for accelerating the deployment of services and applications over a single network. This fuels high-performance businesses. Additional information can be found at www.juniper.net.