From ATM to IP/Ethernet: Three Strategies for Cost-Effective Network Convergence

In This White Paper, You Will:

- Learn how multiservice edge platforms enable service providers to protect ATM and legacy revenue while efficiently expanding new revenue-generating, packet-based wireless and wireline services.
- Uncover tips for implementing a migration strategy through multiservice edge platforms, including guidelines for selecting the best platform and partner.

The Current Challenge and Coming Opportunity

The State of Telecom

The breadth of competition in today's telecom marketplace poses major challenges for service providers and mobile operators. They want to continue to provide profitable existing services — Asynchronous Transfer Mode (ATM), Frame Relay (FR) and private line — to an enormous installed base of users. At the same time, they need to position themselves to deliver new rapid-growth services, such as Ethernet and Internet Protocol Virtual Private Networks (IP-VPN).

But, there is good news. The transition to IP/Ethernet can be accomplished without wholesale capping of end-customer ATM services, having to build a parallel IP/Ethernet network and force customer migrations, or even service-affecting downtime.

The answer is a Multiservice Edge (MSE) platform that combines the best of both ATM and IP worlds. Such an MSE from Tellabs is purpose-built with service interworking between ATM/FR and IP/Multiprotocol Label Switching (MPLS), designed to pave the smoothest-possible migration path to a converged network.

With a strategic transition plan and MSE platform, service providers can get ahead of growing customer bandwidth demand for advanced packet-based wireless and wireline services. The right strategy enables them to scale existing businesses, add next-generation services on a pay-as-you-grow basis and reduce capital and operating expenses — with minimal disruption to customers and networks.

The Potential of IP/Ethernet

Although ATM/FR services continue to be a profitable way to serve customers, demand for Ethernet and IP-VPNs is where the market is headed. Worldwide revenues for IP-VPN will jump 42 percent between 2008 and 2014, while Ethernet is expected to more than double in that time frame, according to estimates from Ovum (see Figure 1).

In addition, ATM networks simply do not have the capacity and scalability needed to accommodate growing demand for new, bandwidth-intensive applications, particularly the growth of mobile broadband in addition to IP Television (IPTV) and Video on Demand (VoD). Consequently, to keep up with increasing traffic volumes and bandwidth requirements, service providers must invest more to increase network capacity beyond OC-192/STM-64 (the maximum ATM speed) — not just for core networks, but for access and edge infrastructures as well.

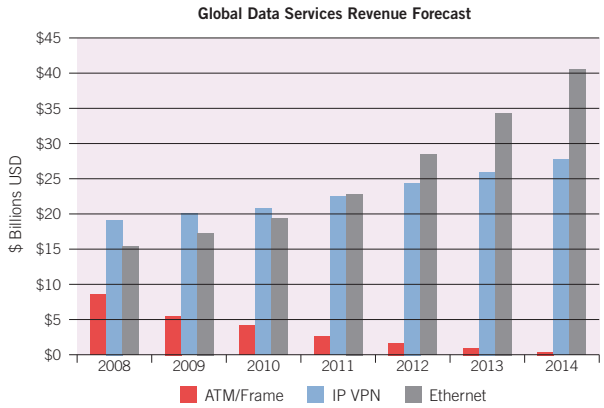

Figure 1. Source: *Ovum, Forecast: Enterprise Ethernet services, IP VPN forecast pack,* October 2009

To seize opportunities in existing and new service segments *and* simultaneously drive down capital and operating expenses, service providers must evolve networks to infrastructures designed to achieve both objectives. MSE platforms address those needs.

Waning ATM Switch Support — Further Reason to Migrate

Changes in the dynamics of the ATM switch market have caused particular concerns regarding ATM switch support. With the recent bankruptcy of Nortel, the future of its Passport series of ATM switches and support of Passport products is in question. Some service providers have reported limited response to recent calls for assistance with Passport-based networks. The status of already expensive service contracts and ongoing availability of replacement parts from the manufacturer causes concern among some service providers, since critical customer services are running on a network where future support is questionable and growth is limited.

Additionally, other ATM vendors have scrapped plans to further support ATM switch development. Cisco stopped development on its IGX 8400 and BPX 8600 ATM platforms, and Ericsson has ceased developments for the Ericsson AXD series. This means that significant amounts of critical customer traffic are currently running on ATM switches that have no enhancements, no further development and no migration path to Ethernet service support.

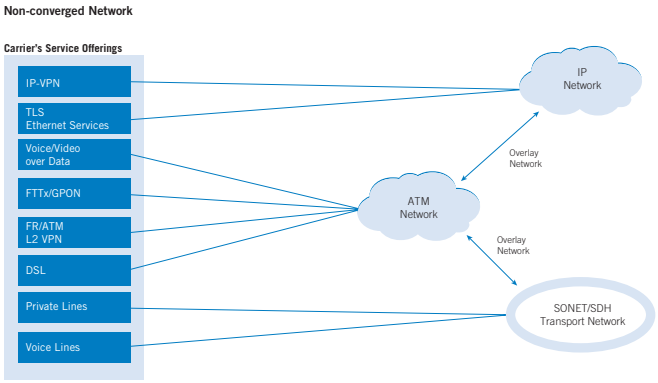

Figure 2. Service providers' overlay networks assembled to offer multiple types of services

Multiple Overlay Networks Create Multiple Problems

To deliver a full suite of voice and data services, over the past several years service providers have acquired or been forced to build separate Time Division Multiplexing (TDM), ATM/FR, IP and Ethernet networks (see Figure 2). Although this overlay network architecture enables delivery of a broad range of services, it increases operational and management complexities. Ultimately, it's an expensive network architecture from which to grow revenues for new bandwidth-intensive services, or to maintain existing services.

Network Convergence Strategy: Three Approaches

Depending on the existing customer base and service mix, as well as individual business strategies, service providers have three basic options when it comes to an ATM-to-MPLS migration strategy. They can migrate to an IP/MPLS core using:

1. ATM/FR service migration
2. ATM/FR data tunneling over MPLS
3. Converged IP/MPLS network supporting native ATM/FR control and data planes

1. ATM/FR Service Migration

Service providers can use IP enabled ATM or FR to migrate legacy services to MPLS-based services like IP-VPN or Ethernet, for example. The Layer 3 MPLS-based IP-VPN approach has one major advantage over legacy Layer 2 ATM and FR VPN services: ease of connecting new IP/Ethernet-based customer sites. The service provider simply configures the endpoints for the new connection and the network dynamically provisions the circuit. In contrast, traditional Layer 2 VPN services requires operators to painstakingly configure a large number of Permanent Virtual Circuits (PVC) to point to the new customer site.

While MPLS-based IP-VPNs can deliver cost-competitive, scalable and flexible services, using them to migrate ATM/FR services to MPLS is not the best option for all end-customers. For one, many customers cannot and will not share their IP routing information for customer-specific routes with their service provider — a requirement when implementing MPLS-based IP-VPNs. This is often the case for route-sensitive customers like government agencies or financial institutions. Secondly, the service provider will need to maintain the existing ATM network and the IP/MPLS network in parallel for some time as this transition from ATM to IP/MPLS takes place. Finally, all of a given customer's endpoints connected and communicating using a common service need to be migrated simultaneously in a flash cut, adding planning complexity and inflexibility.

Advantages:

- Ease of connecting new IP/Ethernet-based customer sites

Disadvantages:

- Requires supporting parallel ATM and IP/MPLS networks throughout a potentially long migration
- Migration to IP/MPLS network requires operationally complex customer-by-customer service cutover
- Potential revenue loss from customers that do not want to migrate away from ATM/FR
- MPLS-based services like IP and Ethernet lack the end-to-end OAM, QoS and security of ATM networks

2. ATM/FR Data Tunneling Over MPLS

Service providers that do not want to share their customer specific IP routes can be migrated to an IP/MPLS core if the service provider constructs pseudowire-based Layer 2 VPNs. pseudowires combine MPLS forwarding and IP routing to emulate ATM and FR services and to transport the user traffic of these Layer 2 services between enterprise endpoints through the MPLS core.

The pseudowire solution enables legacy services, such as ATM and FR, to traverse new high-speed packet networks while maintaining original attributes. However, the downside of the pseudowire migration strategy, especially for larger service providers, is that pseudowires lack dynamic setup or signaling of ATM/FR connections over MPLS, limiting large-scale deployments. Service providers must manually provision and map a pseudowire connection for each ATM or FR circuit connecting various customer sites, which could amount to a large number of point-to-point pseudowires.

As the number of customer sites grow, the number of pseudowires needed to provision is going to grow by orders of magnitude. In addition, like the IP-VPN approach, all of a given customer's endpoints connected and communicating using a common service need to be migrated simultaneously in a flash cut, adding planning complexity and inflexibility.

The pseudowire solution works well for operators with relatively few ATM/FR connections on an MPLS core. But, to simplify provisioning with dynamic connection setup, or to link multiple regional ATM networks over an MPLS core, a more scalable approach is required. Many service providers seek something like the dynamic signaling and routing mechanism they have used for years on ATM/FR networks, for example, ATM PNNI or other vendor-specific protocols.

Advantages:

- No sharing of IP routing information needed

Disadvantages:

- Requires intensive manual provisioning of a large number of point-to-point ATM or FR pseudowires to connect customer sites
- Requires supporting parallel ATM and IP/MPLS networks throughout a potentially long migration
- Migration to IP/MPLS network requires operationally complex customer-by-customer service cutover
- Limited to data plane tunneling only; no support of ATM control plane
- Lacks the end-to-end OAM, QoS and security of ATM networks

3. Converged IP/MPLS Network Supporting Native ATM/FR Control and Data Planes

A third option is to converge ATM, IP and Ethernet onto a single MPLS network supporting native ATM switching and PNNI. By preserving the dynamic provisioning capabilities of ATM, this migration scenario enables service providers to connect multiple ATM networks over IP/MPLS while enabling new IP and Ethernet services over one network.

A converged network also minimizes the impact on end user customers by allowing them to continue using their existing ATM service and CPE with no service disruption or changes to CPE. Additionally, unlike the previous approaches, customer endpoints can be migrated on a circuit-by-circuit basis versus having to migrate all connected customer endpoints simultaneously. This offers significant operational simplicity and flexibility as compared to the previous approaches.

Advantages:

- Does not require supporting parallel ATM and IP/MPLS networks throughout a potentially long migration
- Enables graceful and independent circuit-by-circuit migration versus simultaneously cutting all endpoints of a given customer to a parallel network
- Continues supporting existing native ATM/FR transparently; migration to IP/Ethernet when customer dictates
- Continue to support end-to-end ATM OAM capability and predictability of ATM/FR QoS

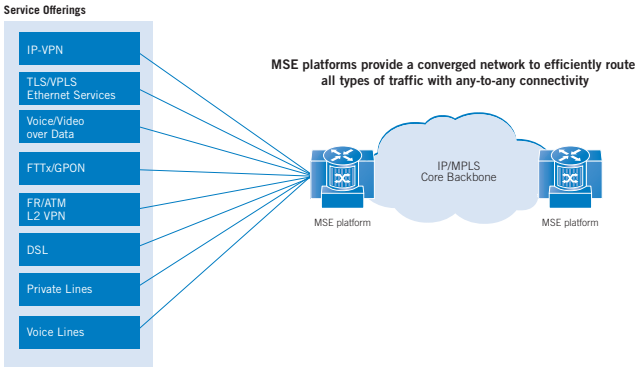

Figure 3. Multiservice converged network architecture

Additional PNNI-to-MPLS Interworking Benefits:

- Decouples the ATM and MPLS control planes, allowing them to operate separately — thus enabling continued support of legacy services with no disruptions/changes for end-users.
- Preserves the routing and signaling information in the ATM control plane, end-to-end across the MPLS core, which maintains ATM security because there is no need to exchange IP addressing or network topology with third-party vendors.
- Employs pseudowire technology for data-plane encapsulation, enabling service providers to retain Layer 2 operations and offer VPN-type security without exchanging routing information.
- Uses MPLS fast reroute in the MPLS core to restore the tunnel Label Switched Path (LSP) and ensure carrier-class reliability.
- Eliminates manually nailed-up ATM or FR pseudowires across the MPLS core. Dynamically establishes one ATM/FR pseudowire for each Switched Virtual Circuit (SVC) or Soft Permanent Virtual Connection (SPVC) across the MPLS core and dynamically maps signaled ATM QoS to the appropriate Experimental (EXP) bits of the MPLS Exp-inferred LSP (E-LSP) tunnel labels, thus preserving the hard, end-to-end QoS.
- Limits the need to pre-establish and manage large numbers of E-LSPs by aggregating ATM SVCs or SPVCs connected to the same remote network into the same E-LSP.
- Supports graceful ATM-to-MPLS migration by allowing site-by-site, node-by-node, or even circuit-by-circuit ATM/FR to MPLS migration. This can eliminate both downtime and the logistics nightmare of cutting hundreds or even thousands of sites to IP-VPNs or Ethernet networks simultaneously.

Figures 4-6 represent the MPLS-based IP-VPN and pseudowire-based Layer 2 VPN approaches, which require parallel ATM and IP/MPLS networks and complex customer cutovers. These parallel networks require support throughout the transition away from ATM, which could take years.

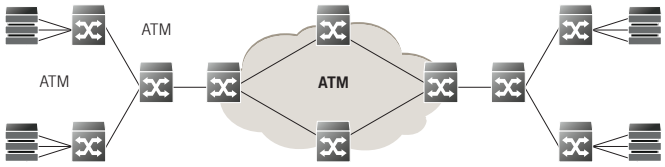

Figure 4. Original ATM Network

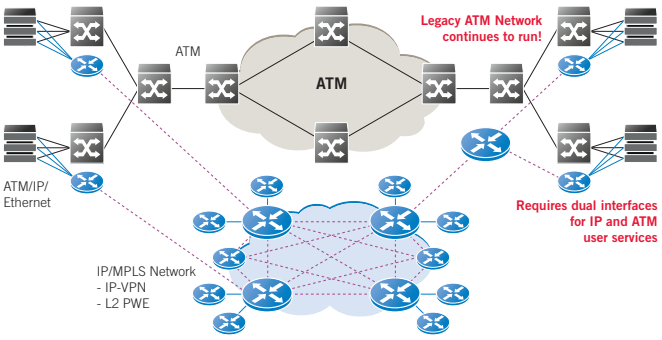

Figure 5. Parallel networks supporting ATM and IP/Ethernet/PWE

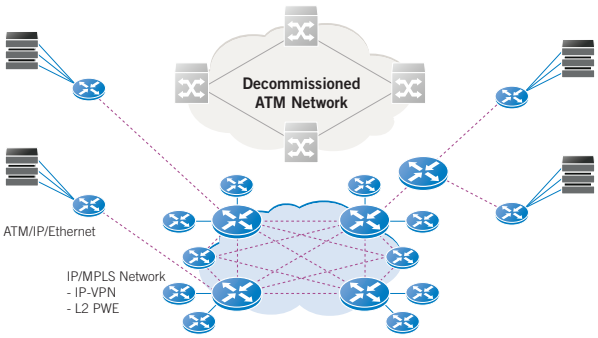

Figure 6. Flash-cut of customers to new IP/MPLS network; decommissioned legacy ATM network

Alternatively, the converged network approach enables service providers to connect existing ATM/FR services natively or via PNNI to an IP/MPLS network without supporting parallel ATM and IP/MPLS networks. See Figures 7-9.

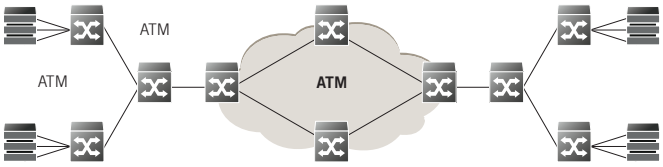

Figure 7. Original ATM Network

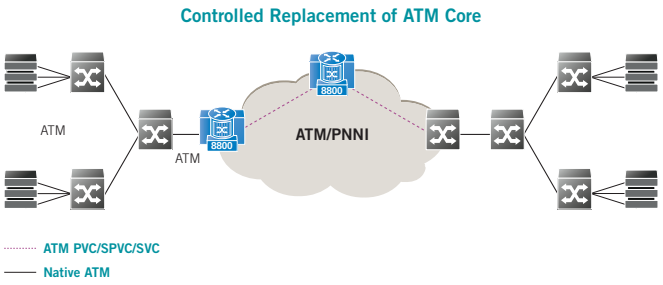

Figure 8. Tellabs® 8800 Multiservice Router Series (MSR) as native ATM switch supporting PNNI or native ATM switching

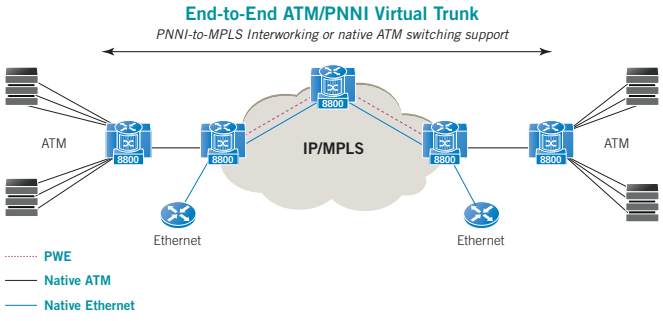

Figure 9. Tellabs® 8800 Multiservice Router Series (MSR) for native ATM, PNNI, IP and Ethernet services on a converged network.

Validating Your Preferred Strategy

A Pay-as-you-grow Migration to Ethernet

With support for any-to-any network and service interworking at Layer 2, the most advanced MSE platforms also open a seamless and profitable migration path from ATM, FR and private line services to Carrier Ethernet. Those high-margin traditional services, while slowing in growth rates, are still important revenue streams for service providers.

Ethernet is attracting more and more customers because of its speed, cost effectiveness, scalability, simplicity and bandwidth-on-demand flexibility. However, the volumes — and sometimes profit margins — of Ethernet service are not yet comparable to those of legacy services. Consequently, service providers must carefully time the transition to Ethernet to protect legacy-service revenues, while gradually adding Ethernet services when demand and margins are strong enough to supplant those revenue streams.

Further, although customers want Ethernet service, they also want to protect existing investments in ATM and FR access equipment. In fact, many enterprise customers, particularly those using FR as their primary access technology, say that unless they have service interworking, they will not even consider migrating to Ethernet.

The powerful service interworking capabilities of MSE platforms enable service providers to address customers' budgetary constraints as well. Making it possible for both ATM/FR and Ethernet to co-exist in the network, these platforms ensure the smoothest possible migration to Ethernet by providing true access-network convergence. MSE platforms support E-Line, E-LAN, Ethernet over MPLS, Ethernet over ATM, Ethernet over FR and Ethernet over Synchronous Optical Network (SONET) for both Virtual Private LAN Service (VPLS) and Q-in-Q implementations in a multi-vendor environment.

Executing Your Preferred Migration Strategy

Selecting the right MSE platform is key to a successful ATM to MPLS migration. Equally important is working with the right partner to coordinate network architecture, design, planning, installation and integration of the technology transition. The goal is to determine how to best leverage existing ATM assets, when to cap ATM switches and to avoid unplanned traffic disruptions.

The preferred migration strategy is developed through a mix of counsel with extensive deployment experience armed with world-class tools and field-proven methodologies. When properly executed, the result is a network transition that meets the need of the service provider and its customers within specified time and cost constraints. This strategy enables service providers to scale as needed, add next-generation services to meet customer demand and reduce capital and operating expenses (see Figure 10).

By taking advantage of advanced MSE platforms, service providers can offer customers the best of legacy and next-generation communications and, in the process, boost their own competitive success well into the future.

Tellabs Full Service MSE Solution

Tellabs offers a combination of equipment and professional services to enable service providers to limit their risk exposure to future support for Passport/ATM switches while strategically migrating networks to IP/MPLS. Tellabs has modeling tools to help service providers assess the equipment and operational costs of their current networks and demonstrate the benefits of migrating to a new MSE solution.

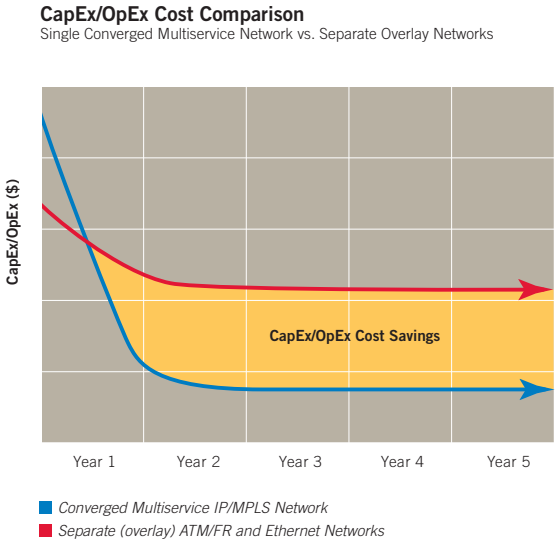

Figure 10. Cap and grow 5-year cost outlook

Tellabs® 8800 Multiservice Router (MSR) Series

The Tellabs 8800 MSR series provides a seamless migration from ATM to MPLS by enabling true multiservice convergence o a common IP/MPLS network on a single platform. Key benefits of the Tellabs 8800 MSR series include:

- Evolutionary migration of legacy networks — using standards-based software and hardware to interface with legacy equipment and protocols
- Enhanced SLAs — extending QoS contracts, historically available only with ATM circuits, to new, broadband data ervices such as Ethernet and IP
- Revenue protection — supporting existing ATM end-user revenues transparently to customers enables customer migration on their timetable
- Revenue creation — using enhanced SLAs and superior MPLS traffic engineering to deliver new high-growth Ethernet services, while also supporting legacy ATM and FR services
- Operating expense reduction — reducing truck rolls, spares inventory and operational costs via any channel, any port, any service functionality
- Capital expense reduction — collapsing multiple core-service networks into a consolidated infrastructure that reduces the number of network elements

- Superior traffic management — using customized ASIC technology to provide SLA bandwidth management on a per-flow and per-service basis
- Only vendor and product that supports PNNI on MSR.

The Tellabs 8800 MSR series is the only MSE platform that can natively support ATM switching and PNNI, critical to many service providers aiming to make a smooth, transparent and flexible transition to Ethernet. With ATM services at the customer UNI and MPLS in the core, service providers can support both ATM customers and Ethernet services simultaneously on the same chassis — even on the same line card. This enables the ultimate flexibility, enabling service providers and their customers to choose when the time is right to migrate away from ATM and onto Ethernet.

Tellabs® Global Services

Tellabs' ATM Migration Services address the challenges of network convergence by having our consulting team help you:

- Understand the migration project requirements
- Map out the design of the new network
- Acquire the necessary hardware and software
- Plan the migration
- Execute the migration
- Train your staff to operate the migrated network, design and implement extensions and troubleshoot any issues that may arise
- Program manage the project from start to finish.

Tellabs' ATM Migration Services provide a proven end-to-end process for the replacement of outdated ATM equipment currently in-service in carrier networks. Tellabs Global Services helps you mitigate the performance risks associated with outdated ATM equipment and reduces maintenance cost.

Our comprehensive services solution includes:

- Migration Services
- Program Management
- Transport Provisioning and Engineering
- Network Integration
- Deployment Services
- Training
- Support Services

An example of Tellabs' success in seamlessly managing the ATM Migration process is an ATM-to-MPLS migration executed for Telstra, Australia's leading telecommunications provider. Tellabs is simplifying Telstra's network topography by replacing 856 existing nodes with 220 Tellabs 8800 MSR series nodes — a 74.3% decrease in infrastructure that will contribute to Telstra's improved network efficiencies.

Checklist for MSE Platform Selection

- A full suite of protocols for native ATM, FR, IP, MPLS and Ethernet, as well as pseudowire encapsulation: ATM (SDU and cell mode), FR (port and Data Link Connection Identifier (DLCI) mode), Ethernet, Virtual LAN (VLAN), Point-to-Point Protocol (PPP) and High-level Data Link Control (HDLC), Structure Agnostic TDM over Packet (SAToP), etc.
- A full range of ATM switching, signaling and routing protocols, including ATM User Network Interface (UNI), ATM Inverse Multiplexing over ATM (IMA), Integrated Local Management Interface (ILMI), Interim Interswitch Signaling Protocol (IISP), ATM Inter-Network Interface (AINI), PNNI and hierarchical PNNI for scaling large networks, as well as ATM-to-MPLS control plane interworking
- Any channel, any port, any service, with channelized optical interfaces supporting native ATM/IMA, FR, packet over SONET, IP over ATM, IP over PPP or Multilink PPP (MLPPP) or HDLC, Ethernet over SONET or Synchronous Digital Hierarchy (SDH) (both based on X.86 and GFP standards), and SAToP, etc.
- MPLS network and service interworking, both bridged and routed, thus enabling service providers to offer FR, ATM and Ethernet services
- Carrier-class reliability:
  - Fast-reroute of less than 10 ms for thousands of LSPs
  - Graceful restart (OSPF, BGP, LDP and IS-IS) required for high-availability applications, with the data-forwarding plane continuing to process and forward packets even if the control plane, which is responsible for determining best paths, fails. With a large number of reroutes, graceful restart enhances network stabilization and reduces consumption of control-plane resources.
  - Guaranteed service availability, with packaged hardware/software upgrades and full redundancy in common equipment and software resiliency features, all of which translates into maximum service and network uptime.
  - Pseudowire redundancy, service assured upgrades and modular software architecture with memory and process protection.

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