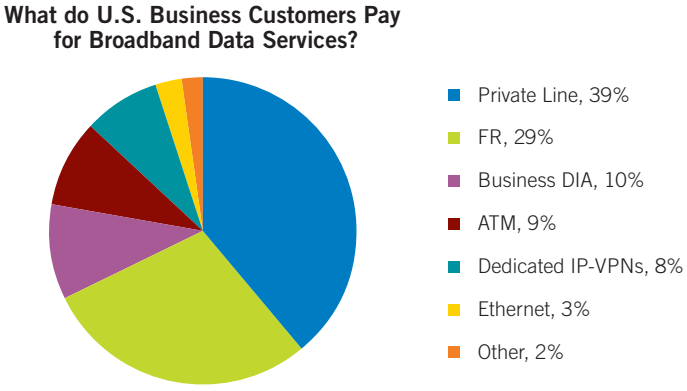
Multiservice Edge Platforms Pave a Smooth Migration Path to Next-Generation Networks

The competitive pressures of today's marketplace pose 3 major challenges for service providers. They must continue to provide slow-growing but profitable existing services — Asynchronous Transfer Mode (ATM), Frame Relay (FR) and private line — to an enormous installed user base. At the same time, they want to position themselves as providers new rapid-growth services, such as Ethernet and Internet Protocol Virtual Private Networks (IP-VPN). Equally important, they need to reduce the costs of providing both types of service to compete effectively in the marketplace. To tackle all 3 challenges successfully, service providers are looking for ways to evolve their ATM networks to next-generation IP infrastructures based on Multiprotocol Label Switching (MPLS).

The opportunities in both the existing and new service segments are significant. Although deployment of new ATM and FR services are not growing as quickly as before — given their lack of scalability and cost relative to IP/Ethernet — they continue to grow and will generate significant revenues in the future. According to Vertical Systems Group, business data services revenues in the United States totaled $31 billion in 2005. Of that, traditional business services accounted for 87%, or nearly $27 billion (see Figure 1).



Source: Vertical Systems Group ENS Research Program

Figure 1. U.S. business data service revenue in 2005

Although private-line, FR and ATM services collectively make up the largest portion of U.S. business data services, Ethernet and IP-VPNs are the fastest-growing segments. The Compound Annual Growth Rate (CAGR) of Ethernet services worldwide between 2005 and 2010 will be 32.5%, according to The Gartner Group. CAGR for IP-VPNs is expected to be 18.3% (see Figure 2). Service providers should consider that capturing opportunities in the existing and new-service segments while reducing costs requires them to evolve their networks to infrastructures designed to achieve both objectives.

Multiple Overlay Networks Create Multiple Problems

The greatest obstacle to the low-cost delivery of both legacy ATM/FR and new IP/MPLS services while reducing costs is service providers' current overlay network architecture. To deliver a full suite of voice and data services, they had to build — or have acquired — separate Time Division Multiplexing (TDM), ATM/FR, IP, and Ethernet networks (see Figure 3). Although this overlay network architecture enables them to deliver a broad range of services, it does increase operational and management complexities. In addition, this overlay network architecture severely limits provider's ability to offer services cost-effectively across those networks to their customers.

Adding to those difficulties is the fact that current multiservice switch support for service providers is dwindling. These embedded network platforms also do not offer a graceful migration path to next-generation IP and MPLS capabilities. Furthermore, ATM networks simply do not have the capacity and scalability that service providers need to accommodate growing demand for new, bandwidth-intensive applications, such as IP Television (IPTV) and Video on Demand (VoD). Consequently, trying to keep up with the increasing traffic volumes and bandwidth requirements means service providers must spend more money to increase network capacity beyond OC-192/STM-64 (the maximum ATM speed) — not just on their core networks but their access and edge infrastructures as well.

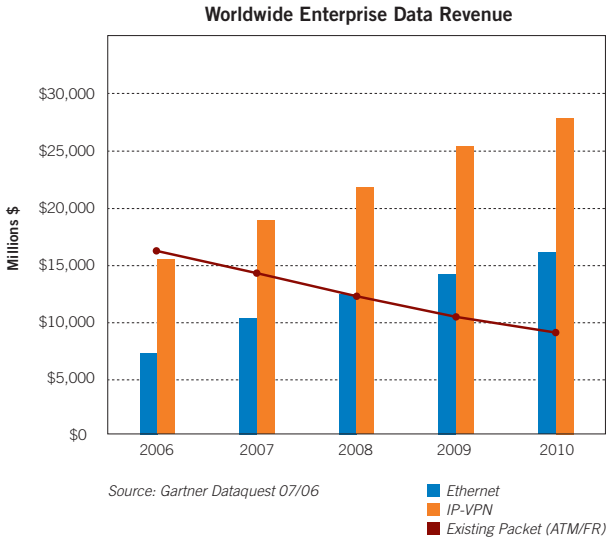


Figure 2. Trends in North American business data service revenues

To eliminate these problems and strengthen their ability to compete in the marketplace, service providers need a cost-effective strategy for migrating legacy services to the next-generation network (see Figure 4). Specifically, they are looking for ways to consolidate their multiple networks into a single IP/MPLS-based platform. The architecture must support both legacy and new protocols, reduce CapEx/OpEx, scale readily to accommodate network and service growth, and feature the capacity to handle bandwidth-intensive applications readily and cost-effectively.

Choosing the Right Network Convergence Strategy

For most service providers, the ideal strategy is to evolve the existing infrastructure to a converged Layer-2/Layer-3 network based on MPLS. Such a network combines the security and Quality of Service (QoS) associated with the connection-oriented ATM, the scalability and flexibility of connectionless pure-IP networks and the traffic-engineering capabilities inherent with MPLS. How do they get there without disrupting their operations, budgets and customers?

Leading service providers have discovered they can make a seamless transition from today's Layer-2 network architecture to a converged MPLS-based IP infrastructure by deploying a Multiservice Edge (MSE) platform. An MSE platform with purpose-built service interworking capability among ATM/FR, IP/MPLS and carrier Ethernet will pave the smoothest possible migration path to a converged MPLS-based IP network. By deploying these advanced platforms, service providers can provide ATM-like connection-oriented services with guaranteed QoS for mission-critical traffic, high levels of security and per-circuit/flow provisioning and visibility.

At the same time, service providers can support connectionless transport, such as any-to-any connectivity and scalability, along with MPLS traffic-engineering capabilities. As a result, service providers can offer guaranteed QoS over an MPLS network for any type of access traffic, create customized services with verifiable Service Level Agreements (SLA), differentiate themselves in a competitive marketplace and generate additional revenue streams.

A Solution that Combines the Best of Both Worlds

Because most equipment vendors have focused their products on either ATM or IP, service providers want to avoid the difficulty and expense of trying to evolve those products to meet changing market conditions. Instead, they are turning to multiservice edge platforms that combine the best of both the ATM and IP worlds. This requires equipment with purpose-built service interworking among ATM/FR and IP/MPLS that is designed to pave the smoothest-possible migration path to a converged MPLS-based IP network.

By deploying these advanced platforms, service providers obtain ATM's connection-oriented strengths, including guaranteed QoS for mission-critical traffic, high levels of security and per-circuit/flow provisioning and visibility. At the same time, they get IP's connectionless transport, any-to-any connectivity and scalability, along with MPLS traffic-engineering capabilities. As a result, service providers can offer guaranteed QoS over an MPLS network for any type of access traffic, create customized services with verifiable Service Level Agreements (SLA), differentiate themselves in a competitive marketplace and generate additional revenue streams.

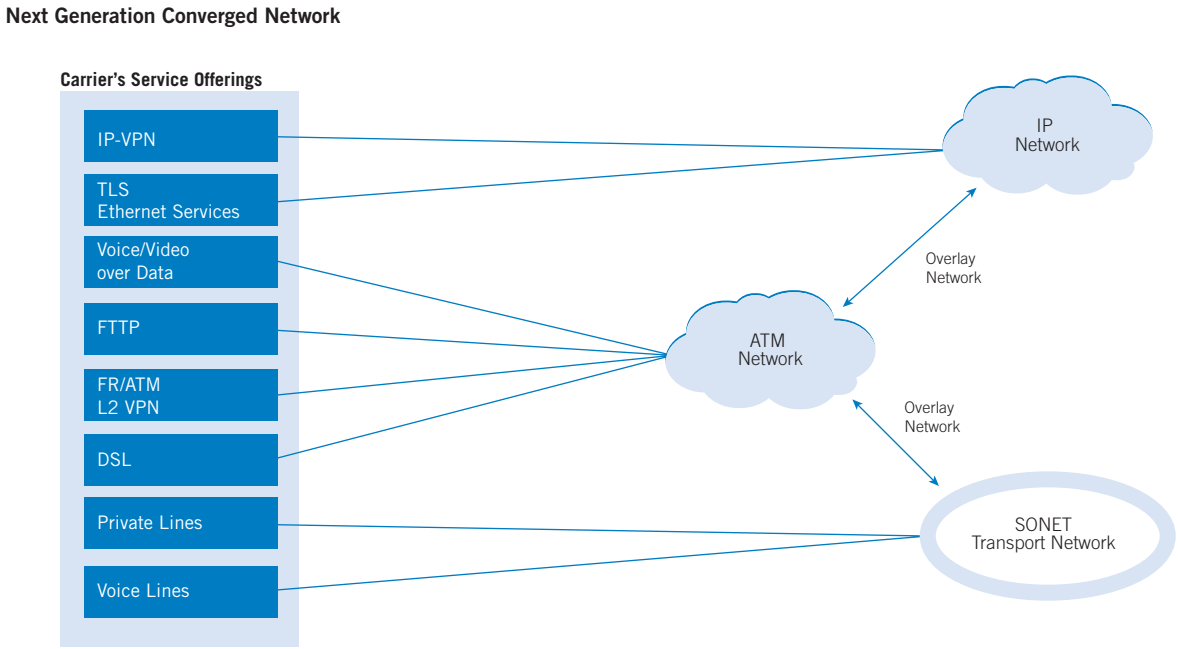


Figure 3. Today's service provider network

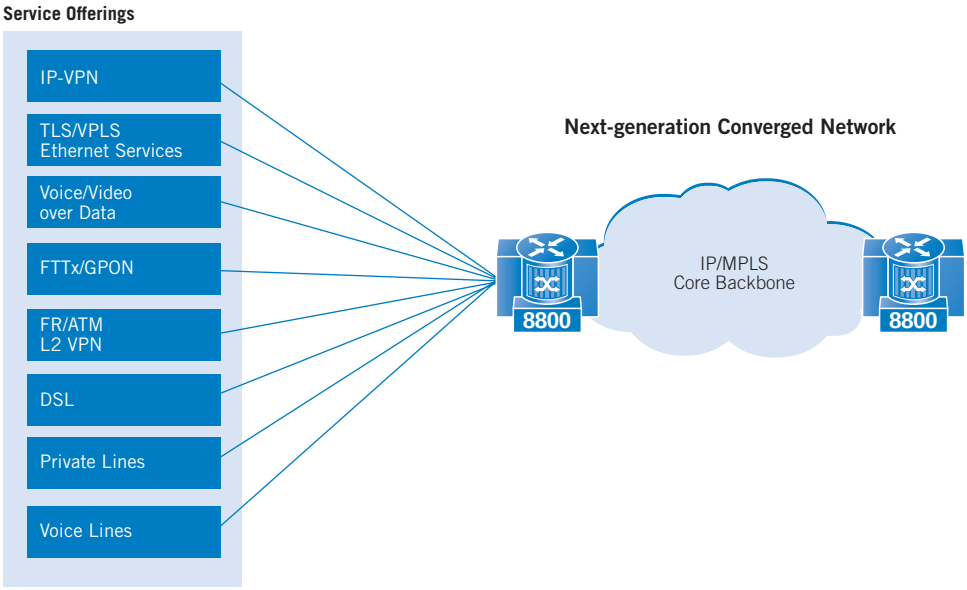


Figure 4. Multiservice Converged Network Architecture

Advantages of ATM-to-MPLS Control Plane Interworking

Depending on their existing customer base and service mix, as well as their individual business strategies, service providers have 2 basic options when it comes to an ATM-to-MPLS migration strategy. They can establish a separate MPLS core network and use MPLS-based IP VPNs or pseudowire technology defined by IETF to migrate ATM/FR services to the MPLS core. Alternatively, they can connect their existing ATM/FR networks to an MPLS core and use ATM-to-MPLS control plane interworking to tunnel ATM Private Network to Network (PNNI) signaling and routing information through the MPLS core.

MPLS-based IP VPN services are easier to connect new sites to than are existing traditional meshes: The service provider simply configures the endpoints for the new connection. In contrast, traditional services required 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 example, many customers cannot or will not share their IP routing information for customer-specific routes with their service provider — a requirement when implementing MPLS-based IP VPNs.

These customers can be migrated onto an IP/MPLS core if the service provider constructs Layer 2 VPNs based on pseudowire technology. 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 their 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. Operators manually provision and map one pseudowire connection for each ATM or FR circuit.

While the pseudowire solution works well for operators with relatively few ATM/FR connections on an MPLS core, operators who wish to simplify their provisioning with dynamic connection setup, or those who want to link multiple regional ATM networks over an MPLS core, need a more scalable approach. Many are looking for something like the dynamic signaling and routing mechanism they have used for years on their ATM/FR networks, for example, the ATM PNNI or other vendor-specific protocols.

For service providers seeking to connect multiple ATM networks via an MPLS core and who want the same dynamic-provisioning capabilities available with their legacy ATM/FR networks, the scalable, ATM-to-MPLS control-plane interworking option is the preferred strategy. This ATM-to-MPLS control plane interworking migration strategy effectively:

- Decouples the ATM and MPLS control planes, allowing them to operate separately — and thus enabling service providers to continue supporting legacy services with no disruptions/changes for their 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
- Leverages 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 a graceful ATM-to-MPLS migration by permitting site-by-site or node-by-node 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.

Preserving the dynamic provisioning capabilities of ATM enables service providers to connect multiple ATM networks over an MPLS core. It also minimizes the impact of the ATM-to-MPLS migration on traditional ATM and FR networks, equipment and operating procedures, thus avoiding service disruptions and enabling service providers to protect their embedded ATM investments.

A Pay-as-You-Grow Migration to Ethernet

With support for any-to-any network and service interworking at Layer 2, the most advanced multiservice edge 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 their growth rates, are still the primary revenue streams for service providers.

Certainly Ethernet is attracting more and more customers because of its speed, cost-effectiveness, scalability, and simplicity and bandwidth- on-demand flexibility. However, the volumes — and the margins — of Ethernet service are not yet comparable to those of legacy services. Consequently, service providers must carefully time their transition to Ethernet. It is vital to protect legacy-service revenues, while gradually adding Ethernet services until 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 advanced multiservice edge platforms enable service providers to address their customers' budgetary constraints as well. Making it possible for both ATM/FR to co-exist in the network, these platforms ensure the smoothest possible migration to Ethernet by providing true access-network convergence. They 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 the Preferred Migration Strategy

As mentioned earlier, the key to executing a graceful ATM-to-MPLS migration strategy is to deploy a purpose-built multiservice edge platform, one that enables the provider to cap its ATM investments and move forward gradually, on a pay-as-you-grow basis, with its IP and Ethernet investments.

The most advanced multiservice edge platforms today offer a wide array of standards-based signaling and routing support, including full IP, ATM, FR and MPLS control planes, as well as pseudowire service interface — all on a single chassis. In fact, platforms such as the Tellabs® 8800 Multiservice Router (MSR) Series, now provide standardized ATM/MPLS control-plane interworking for true service interworking at line rates. Based on pseudowire architecture, support for ATM signaling/ routing protocols and MPLS/IP routing protocols, these platforms effectively create a virtual trunk to tunnel that information through the MPLS core.

From the service provider's perspective, however, the change brought about by ATM-to-MPLS control-plane interworking is readily apparent. The multiservice edge platform can gracefully enable the convergence of ATM, FR and Ethernet/IP networks into a single infrastructure, producing significant savings in both CapEx and OpEx. With the MPLS core connecting their ATM/FR networks, service providers can continue to support all of their legacy services, extend the reach of their operations and comply with strict SLA requirements for all service types. Some versions of that platform, for example, the Tellabs 8800 MSR series, provide maximum flexibility during the transition. The Tellabs 8800 MSR series can function not only as a multiservice switch but also as IP/MPLS edge router and/or carrier-class Ethernet switch and router.

The Tellabs 8800 MSR series also supports "hard QoS," or ATM-like QoS for IP and Ethernet services. They feature customized Application-Specific Integrated Circuit (ASIC) technology to optimize performance and traffic management. By delivering per-flow queuing with connection admission control, these platforms ensure end-to-end, ATM-like hard QoS across different service types. These include IP and Ethernet, which traditionally have been best-effort services. As a result, service providers can offer guaranteed SLAs across legacy and new services, thereby differentiating themselves in an increasingly competitive market. The bottom line: Service providers can transition cost-effectively from legacy services to Ethernet and IP service, protect their current revenue streams and add new ones on a pay-as-you-grow basis. Similarly, their customers can transition from ATM/FR to Ethernet access at their own, cost-controlled pace, protecting their embedded equipment investments and with confidence that they have secure, scalable communications capabilities.

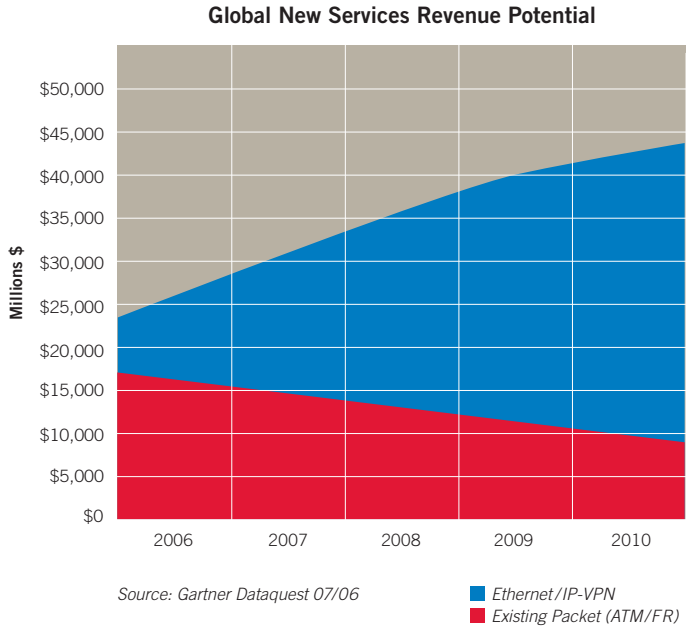


Figure 5. New service revenue potential

In summary, advanced platforms such as the Tellabs 8800 MSR series support:

- A full suite of control plane protocols for native ATM, FR, IP, MPLS and Ethernet, as well as all the 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 and IS-IS) required for high-availability applications. Even if the control plane fails, the data-forwarding plane continues to process and forward packets. 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.

Real Benefits

To protect legacy ATM, FR and private-line revenues and, at the same time, position themselves to offer new broadband services, providers need a proven strategy to migrate their networks. Basically, such a strategy must enable them to scale their existing businesses, add next-generation services on a pay-as-you-grow basis (see Figure 5) and reduce their CapEx/OpEx (see Figure 6) — with minimal disruption to their customers and their networks.

The Tellabs 8800 MSR series was designed to create a seamless migration from ATM to MPLS and to enable true multiservice convergence to the common IP/MPLS network on a single platform. The key benefits that the Tellabs 8800 MSR series deliver include:

- Investment protection — extending the useful lives of legacy networks by scaling capacity to keep pace with customer demands and by broadening providers' service portfolios
- 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 services such as Ethernet and IP
- Superior traffic management — using customized ASIC technology to provide SLA bandwidth management on a per-flow and per-service basis
- Creating new revenue streams — using enhanced SLAs and superior MPLS traffic engineering to deliver high-growth Ethernet services, while also supporting legacy ATM and FR services
- OpEx reduction — reducing truck rolls, spares inventory and operational costs via any-service, any-channel, any-port functionality
- CapEx reduction — collapsing multiple core-service networks into a consolidated infrastructure that reduces the number of network elements

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

CapEx/OpEx Cost Comparison
Single Converged Multiservice Network vs. Separate Overlay Networks

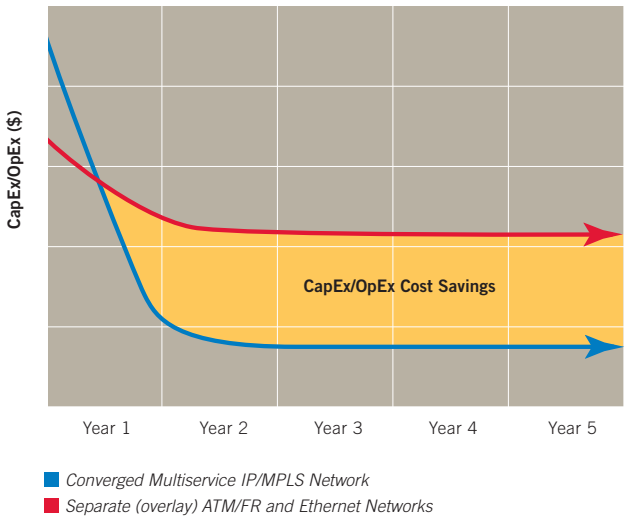


Figure 6. Converged multiservice versus multiple technology overlay network 5-year cost outlook

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