

Executive Summary

Network-based applications such as Voice over IP (VoIP), cloud, collaboration services and video applications of all kinds are driving the need for high-speed, high-quality and reliable networks that exceed the capabilities of the services many businesses are using today. Bandwidth requirements are forcing growing businesses to rethink their networking solutions. For example, we estimate that mid-sized business sites will require 25 Mbps to 85 Mbps of bandwidth over the next three years. TDM-based access networks in use today are poorly positioned to meet these emerging network service needs. They do not scale easily to meet higher bandwidth requirements, and quality guarantees and resiliency features must be added via a switching or routing overlay.

Ethernet services scale from 1 Mbps to 10 Gbps and beyond and have built-in quality and resiliency features that are compliant with industry-standard Carrier Ethernet specifications. When combined with an Ethernet LAN, Ethernet services provide an end-to-end Native Ethernet solution. This makes Ethernet services easier to install, operate and maintain than TDM-based access service alternatives.

For typical mid-sized businesses, ACG Research compared the monthly recurring costs of Ethernet versus TDM access for point-to-point, point-to-multipoint, and multipoint-to-multipoint network configurations. We found that Ethernet services have 56 percent to 71 percent lower costs than TDM-based alternatives. In addition, Ethernet services provide a complete end-to-end solution, while a switching or routing overlay must be added to the TDM access service to create a complete solution.

An analysis of scaling economics of Ethernet and TDM/SONET access services shows that Ethernet solutions are available at many bandwidth speeds with gradually increasing prices. In contrast, TDM bandwidth speeds are limited with steep price steps as speed increases. The TDM scaling behavior creates bandwidth barriers to increasing network capacity that can be overcome by switching to Ethernet services.

Key Takeaways

Ethernet services provide industry-standard solutions to meet the emerging network requirements faced by mid-sized businesses. Compared to TDM solutions, end-to-end Native Ethernet solutions offer significant savings in monthly recurring charges:

- 71% lower for point-to-point private line
- 56% lower for point-to-multipoint configurations
- 63% lower for multipoint-to-multipoint configurations

Why Mid-Sized Businesses Are Moving to Ethernet Access Services

There is a growing need for high-speed, high-quality, reliable network services such as Carrier Ethernet to support bandwidth-intensive applications that exceed the limitations of T1 and other TDM-based last-mile services.

Limitations of TDM Services Versus Ethernet

The inherent limitations of TDM make it a poor choice for today's service requirements.

Lack of Scalability

TDM access services do not easily scale up to meet higher bandwidth requirements. Three TDM technologies are used to provide access: T1, DS3 and SONET (see sidebar). When additional bandwidth is needed another circuit must be added. Also, upgrades from T1 to DS3, or DS3 to SONET, require end-to-end redesign and replacement of ports and the local loop. This requires new hardware, protocols and service-management procedures and makes bandwidth upgrades a costly and lengthy process. Quality guarantees and resiliency features must be added using legacy technologies such as Frame Relay and ATM, or newer services such as MPLS.

In contrast, most Ethernet bandwidth upgrades are made via a remote command to the existing hardware. Ethernet service scales affordably from thousands to billions of bits per second and has quality and resiliency features built into the Metro Ethernet Forum (MEF) industry-standard Carrier Ethernet specification.

Higher Maintenance Expense

TDM access services are difficult to manage and maintain. They are slowly being phased out by the telecom industry, and there are a limited number of IT professionals with knowledge of TDM. In addition, service deployment requires integration of multiple service providers and systems vendors.

Ethernet services are simpler to deploy, operate and maintain than TDM access services. With Ethernet, all network requirements are met by a single service and thus avoid the complexity of TDM-based service overlays². Ethernet technology is also used universally by IT

Despite Limitations, TDM Still Widely Used

T1 technology, the most common form of TDM, was introduced in 1962. Used to carry 24 digital voice channels between analog telephone switches, T1 became the dominant transport technology in the Public Switched Telephone Network (PSTN). Today, for lack of a better alternative¹, TDM circuits are still the mainstay for many businesses' last-mile access to switched voice, Internet and carrier-managed data services. These include Multiprotocol Label Switching (MPLS) networks, which enable private IP routing functions and managed router services.

TDM services are offered as T1 (1.5 Mbps) or DS3 (45 Mbps) leased lines. Several T1 lines can be grouped together or bonded to provide bandwidth between the T1 and DS3 speeds. When more than 45 Mbps is needed, SONET leased lines such as OC-3 (155 Mbps) are used within the same TDM technology class.

¹ Vertical Systems Group estimated that total U.S. TDM bandwidth equaled Ethernet bandwidth in 2011. Though adoption of Ethernet services is rapid, it will be many years before Ethernet lines exceed the number of T1 lines. See "U.S. Ethernet Bandwidth Surpasses Legacy Bandwidth," Vertical Systems Group press release, July 26, 2011.

² Overlays are needed because TDM itself is a Layer 1 (physical layer) technology. To provide a complete network service, TDM must be combined with Layer 2 protocols such as Frame Relay, ATM or Ethernet; or Layer 3 protocols such as IP/MPLS.

professionals. Finally, Carrier Ethernet service certification ensures that Ethernet service offerings conform to standards and that a service provider's offerings interoperate.

Network Applications and Bandwidth Projections Today

Network-based applications are gaining wide acceptance, making them critical to business success³. These applications require Service Level Agreements (SLAs) that meet high-speed, low-latency, guaranteed response times, as well as high availability and resiliency. Driving this growth are applications such as cloud and collaboration services, Machine-to-Machine applications, video streaming and conferencing, Voice over IP (VoIP) and a host of vertical solutions such as medical imaging, records digitization and distance learning.

Bandwidth requirements associated with these applications vary. WebEx with video, Cisco TelePresence, Skype HD video, and video streaming are the most bandwidth intensive and are growing due to lower equipment costs and high adoption rates by users. In contrast, applications such as voice and business process software (for example, CRM, ERP) consume negligible bandwidth but require guaranteed performance. Other applications including email and calendar programs are essential but require neither significant bandwidth nor guaranteed performance.

The total bandwidth requirement for branch or remote sites with 15 to 20 employees ranges from 20 Mbps to 30 Mbps, while headquarters locations with up to 100 employees require 50 Mbps to 85 Mbps.

In the following sections Ethernet and TDM access service prices are compared. Three case studies illustrate typical mid-sized business networking scenarios and the cost advantages of Ethernet over TDM services.

Ethernet Versus TDM Price Comparisons

Figure 1 compares the monthly recurring charge for Ethernet versus TDM access services. Monthly recurring charges mount in stair-step fashion as bandwidth increases. TDM charges increase in steps of 1.5 Mbps as additional T1 circuits are bonded together. Once seven T1s are bonded together, the monthly charge is equivalent to a DS3 45 Mbps circuit. When the bandwidth requirement exceeds 45 Mbps, the next available service is a SONET OC-3 155 Mbps circuit with a monthly charge of \$10,000. These steep monthly charge steps for TDM/SONET access services create obvious economic barriers to increasing bandwidth.

Carrier Ethernet Defined

The MEF defines Carrier Ethernet as a ubiquitous, standardized, carrier-class service and network defined by five attributes that distinguish Carrier Ethernet from familiar LAN-based Ethernet.

1. Standardized services: E-Line, EVPLS, E-LAN.
2. Scalability: Used by millions; bandwidth from 1 Mbps to 10 Gbps and beyond.
3. Reliability: Network detects fault and recovers without impacting users.
4. QoS: SLAs with end-to-end performance guarantees.
5. Service management: Carrier-class operations, administration and maintenance.

³ In a 2012 survey by Forrester Research, 58 percent of SMBs and 65 percent of enterprises indicated that, because of the increased use of software, infrastructure or business processes as a service offering, they will "invest in additional network bandwidth to provide access."

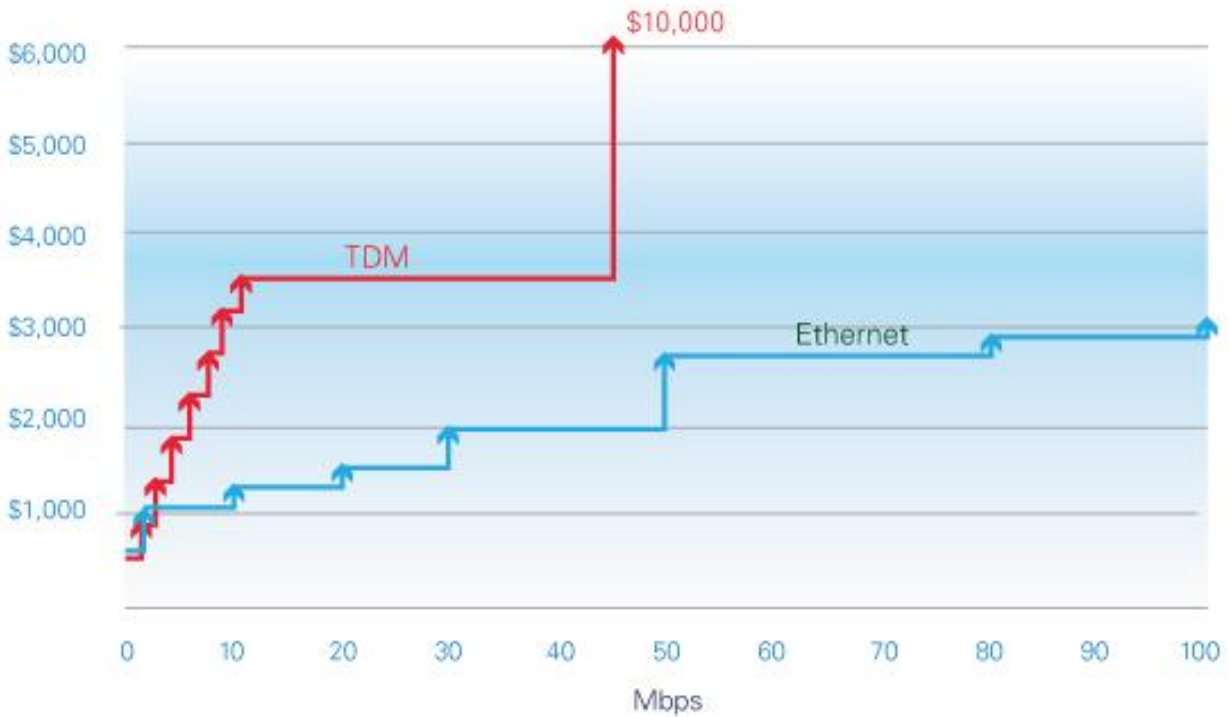


Figure 1. Ethernet vs. TDM Monthly Recurring Charges⁴

In contrast, Ethernet service monthly charges inch up gradually as bandwidth increases. Ethernet bandwidth is much less expensive than TDM/SONET in the 25 Mbps to 85 Mbps bandwidth range that mid-sized businesses will need over the next several years, offering savings of 50% or more.

The monthly charges shown in Figure 1 include the cost of the ports, the local loop, and the cost to operate and maintain the network. Ethernet technology enjoys cost advantages over TDM in all cost categories. First, an Ethernet port capable of operating up to 1,000 Mbps costs about the same as one T1 TDM (1.5 Mbps) port. DS3 and SONET ports cost 10 to 100 times more, respectively. This is due, in large part, to Ethernet's simpler design and statistical multiplexing that uses bandwidth much more efficiently than does TDM or Sonet. In addition to lower port costs, local loop charges and equipment fees may be reduced as well. Finally, Ethernet technology is very simple to operate and maintain because it is a connectionless protocol. TDM, on the other hand, must be engineered, operated and maintained for each TDM channel and each network link from end to end. This costs two to three times more than operating and maintaining Ethernet facilities.

For the Figure 1 pricing comparison, we are only showing the TDM access layer pricing versus Ethernet. Ethernet, however, provides a complete end-to-end solution, while TDM private line access provides only the transport function. Additional costly features such as quality of service (QoS) and switching must be added as needed via service overlays on top of the TDM access service.

⁴ The monthly recurring charges were developed by ACG Research using median prices for Ethernet and TDM services used by a U.S. master agent that develops Ethernet and TDM service solutions for U.S. businesses.

Cost Comparisons for Three Typical Network Configurations

Typical monthly recurring cost comparisons follow for Ethernet versus TDM-based services for three network configurations:

1. Point-to-point private line service: connects headquarters with 100 employees to a data center for LAN or Wide Area Network (WAN) extension, data backup and video applications.
2. Point-to-multipoint private line service: connects headquarters to several branch offices (15–20 employees per site). Also known as a hub-and-spoke configuration.
3. Multipoint-to-multipoint: operates like a LAN to interconnect healthcare affiliates and providers, school districts or municipal government offices (15–20 employees per site). Also referred to as Metro Area Network (MAN) or WAN service.

Point-to-Point

Point-to-point private line service provides a direct two-way connection between two sites. In Figure 2 a large headquarters site with 100 employees is connected to a data center. A site with 100 employees requires bandwidth of 85 to 120 Mbps; in this example the estimated bandwidth requirement is 100 Mbps.

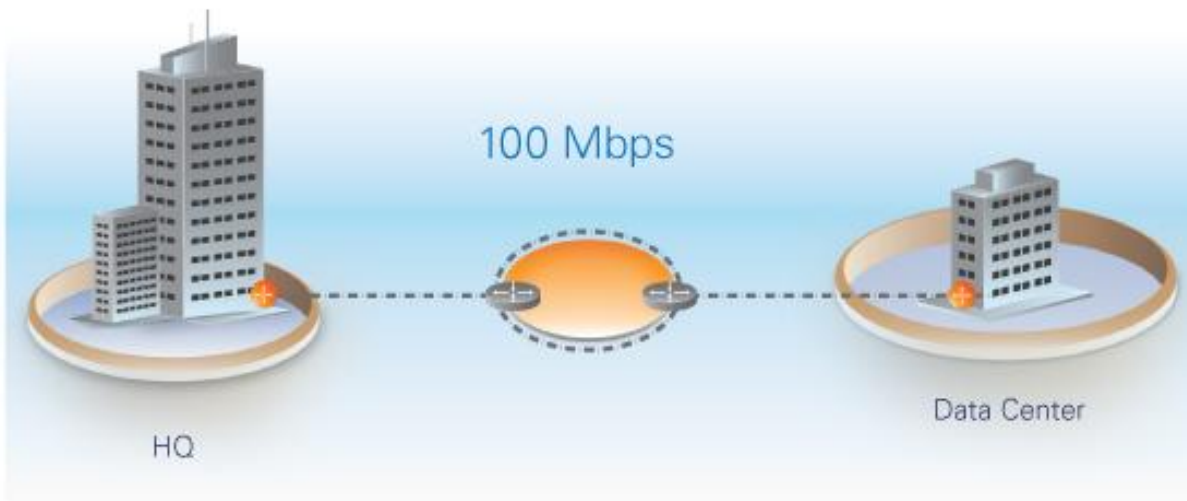


Figure 2. Point-to-Point Private Line Service

A 100 Mbps Ethernet Private Line (E-Line) service meets the 100 Mbps requirement using Ethernet, while a SONET OC-3 155 Mbps uses TDM. If slightly less bandwidth were required, then Ethernet service could be cut back to 80 Mbps using the same physical installation—but the next lower TDM data rate would be 45 Mbps using DS3 technology and a different physical installation.

Financial Impact: 71 Percent Savings with Ethernet

The monthly recurring cost of the E-Line service is \$2,900. Compared to \$10,000 for the OC-3 service, E-Line yields a 71 percent cost savings. These cost estimates use U.S. typical prices as shown in Figure 1. While Ethernet service prices are fairly uniform across the U.S., TDM prices can be much higher than those shown in Figure 1 in some geographic regions.

Qualitative Impact

E-Line service provides a uniform Ethernet environment within and between business establishments, making E-Line easier to install, operate and maintain than SONET service. E-Line services can, in addition, be rapidly scaled up or down as business conditions change, without the long planning cycles and truck rolls required for TDM/SONET services.

Point-to-Multipoint Service

In this example, a headquarters building acts as the hub with connections to four branch offices, as illustrated in Figure 3. Each branch office site has 15 to 20 employees, with estimated bandwidth requirements ranging from 20 Mbps to 30 Mbps.

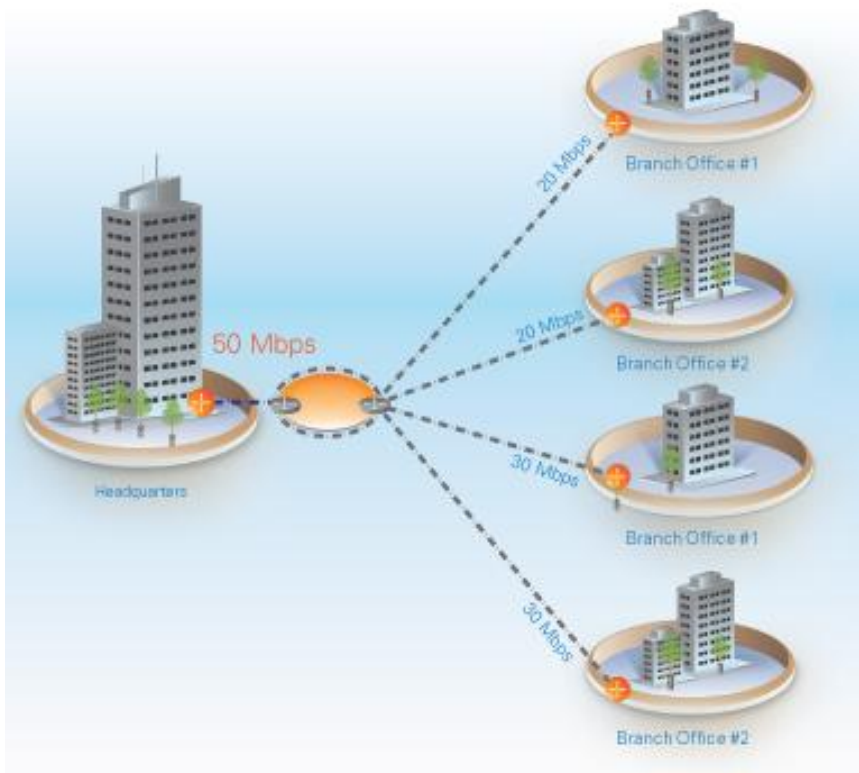


Figure 3. Point-to-Multipoint Service

An Ethernet Virtual Private Line (EVPL) service delivers the prescribed access bandwidth for each location, as well as switching and SLA guarantees that vary by the service provider's implementation approach. If, however, Layer 3 routing services are needed, EVPL and other Ethernet services can also be employed as an access layer for MPLS service.

The TDM solution uses TDM private lines to provide data transport. The analysis includes the cost of the TDM private lines; however, it excludes the cost of a switching or routing overlay service such as MPLS needed to complete the solution.

Financial Impact: 56 Percent Savings with Ethernet

The Ethernet solution has a \$4,600 monthly recurring charge as compared to \$10,500 for the TDM private line portion of the TDM solution, a 56 percent monthly cost savings. As in the previous example, the cost estimate was put together by working with a master agent that develops solutions for U.S. businesses.

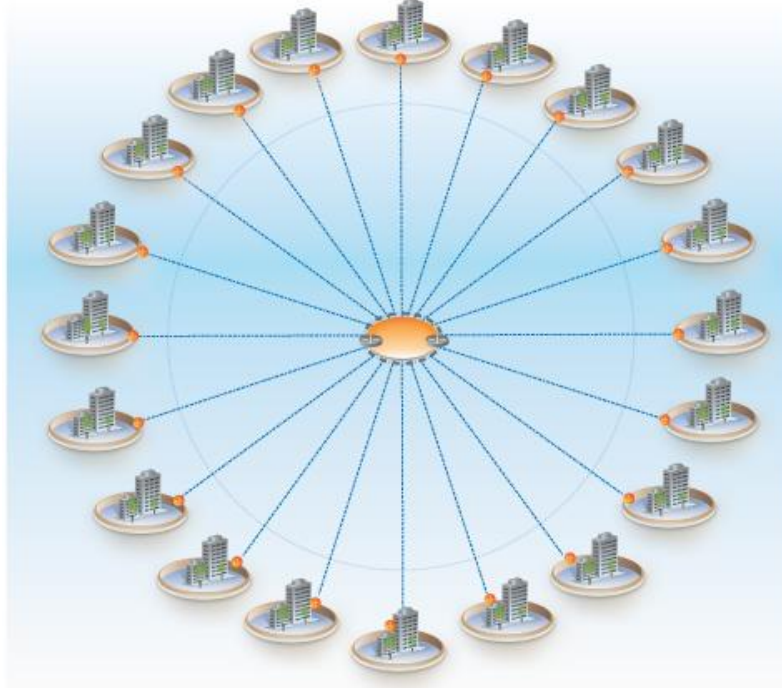
The high cost of TDM access compared to Ethernet is due to the poor scaling of TDM access services. Once TDM data rates exceed 10 Mbps, there are big jumps in cost and bandwidth to the next available data rate of 45 Mbps for DS3 service (see Figure 1).

Qualitative Impact

The EVPL service provides end-to-end Ethernet connectivity and SLA capabilities to all sites to guarantee the performance of critical business applications. In contrast, the TDM solution requires TDM private lines plus a switching or routing overlay that is more complex to deploy and administer.

Multipoint-to-Multipoint Service

Figure 4 shows 20 sites interconnected via any-to-any configuration with a requirement for 50 Mbps connection at the headquarters site and 20 to 30 Mbps at 19 satellite locations.



An Ethernet LAN (E-LAN) provides prescribed bandwidth of 20, 30 and 50 Mbps to users at any of the on-net offices in the same way that LAN connects users in a single building. The Ethernet service is a complete solution that includes connectivity, switching, SLA and resiliency mechanisms.

As in the point-to-multipoint example, the TDM solution consists of a package of TDM 45 Mbps access lines to each site, coupled with a required switching or routing overlay service.

Figure 4 – Multipoint-to-Multipoint Service

Financial Impact: 63 Percent Savings with Ethernet

The E-LAN solution costs \$13,000 per month versus \$35,000 per month for the TDM private line portion of the TDM solution, a 63 percent monthly savings. The cost estimate was prepared as if for an actual customer bid/proposal.

Qualitative Impact

The end-to-end Ethernet solution is backed by an SLA that guarantees service performance and quality across both the last mile and metro network. E-LAN simply extends the familiar Ethernet LAN solution across multiple sites, whereas the alternative TDM plus overlay solution requires IT staff to master new technologies and take on additional technology management responsibilities.

Ethernet Access: A Clear Advantage

The growing acceptance of network-based applications is driving the need for high-speed, high-quality, reliable networks that exceed the capabilities of the services many businesses are using today. In addition, the increasing strategic importance of network services requires that they be backed by SLAs.

Businesses are rethinking their data networking requirements and solutions in large part because of their increasing bandwidth needs. When considering cloud and collaboration services as well as video applications, we project the bandwidth requirement for a mid-sized business site will be 25 Mbps to 85 Mbps.

Today, TDM access services as a dedicated private line or in an MPLS/TDM configuration are poorly positioned to meet these emerging network service requirements. TDM does not easily scale up to meet higher bandwidth requirements, and quality guarantees and resiliency features must be added via an additional switching or routing mechanism. Ethernet services, on the other hand, scale from 1 Mbps to 10 Gbps and beyond, with built-in quality and resiliency features that are compliant with industry-standard Carrier Ethernet specifications.

In a comparison of Ethernet versus TDM-based services for three typical mid-sized business network configurations, the Ethernet solution had significantly lower monthly recurring charges:

1. Point-to-point private line: 71 percent lower monthly recurring charges with an Ethernet private line
2. Point-to-multipoint: 56 percent lower monthly recurring charges with an Ethernet virtual private line
3. Multipoint-to-multipoint: 63 percent lower monthly recurring charges with Ethernet LAN

In all cases the Ethernet solution featured end-to-end Native Ethernet connectivity, SLAs, and easier installation, operation and maintenance than the TDM-based alternative solution. In addition to cost and scaling, Ethernet services have many operational and quality advantages over TDM access. When it comes to providing network services for bandwidth-intensive applications, Ethernet is the clear winner.

About ACG Research

ACG Research is an analyst and consulting company that focuses in the networking and telecom space. Our best-in-class subject matter analysts have a combined 120+ years of experience and expertise in telecom segments that address both technology and business issues. We offer comprehensive, high-quality, end-to-end business consulting and syndicated research services. Copyright © 2013 ACG Research.

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