Moving From TDM to Multiservice ATM

Increase Wide-Area Network Performance While Reducing Total Cost of Ownership

In the past, a time-division multiplexed (TDM) WAN network provided all of the voice and data capabilities a business could possibly need. Times have changed. The Internet has generated an explosion of data traffic. Business productivity applications have become highly complex and mission-critical. Information technology (IT) management costs are skyrocketing while IT budgets are not.

The future promises more of the same—increasing demand for network services; deployment of IP-based intranet and extranet applications; integrated data, voice, and video; and guaranteed quality of service (QoS). Continually adding TDM equipment, software, and IT staff just to keep pace with today's demands is not a strategic solution. Instead, more and more businesses are turning to multiservice ATM.

As today's market standard, multiservice ATM technology enables businesses to consolidate data, voice, and video traffic over a single integrated network infrastructure, significantly reducing equipment and management costs. Multiservice ATM networks can reduce the total cost of ownership of a WAN backbone by 30 to 50 percent, compared to TDM networks. And only ATM allows companies to preserve investments in legacy applications and lay a foundation for integrated IP-based applications such as packet voice, integrated call centers, inter-Web business-to-business services, secure extranet supply-chain management, Web hosting, and electronic commerce—all with the lowest achievable total cost of ownership.

Cisco Systems provides ATM networking solutions for companies that plan to transition TDM networks to flexible, cost-effective multiservice ATM networks. Using the Cisco IGX™ 8400 series wide-area switches, many of the world's leading businesses have slashed recurring bandwidth costs, gained functionality and performance, and positioned themselves to effectively deliver emerging IP-based applications. This report explains how.

A Network Traffic Explosion Drives New Networking Strategies

A company's network has become its most important asset. By delivering business-critical applications, providing enterprise-wide communication, and building links to strategic partners, customers, and suppliers, today's network is carrying more traffic than ever before. According to the Gartner Group, WAN traffic volume will grow between 300 and 600 percent by 2002. (See Figure 1.)

The advent of the Internet has changed the world of networking. The Gartner Group predicts that by 2003, the Internet will become the predominate mechanism for conducting business, whether it is business-to-business or business-to-consumer. The Internet's pervasiveness necessitates a radical change from traditional networking strategies. High volumes of bursty IP traffic are flooding corporate networks and are wreaking havoc with the best-laid plans for bandwidth management. Effectively managing new traffic mixes and a high percentage of IP traffic has become a priority for many IT managers because companies' competitive advantages will increasingly rely on IP-based Internet, intranet, and electronic commerce capabilities. When legacy data, video, and voice are added to a growing base of IP applications, the result is a recipe for high recurring bandwidth costs.

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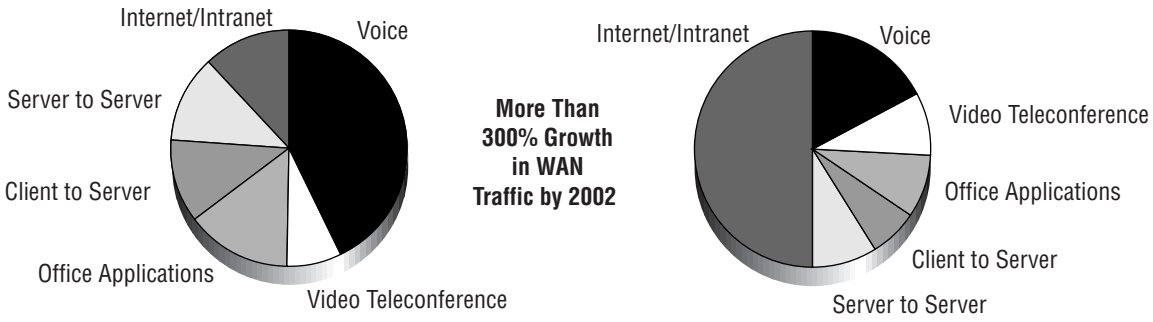
Figure 1 IP Explosion Causes Exponential Growth in WAN Traffic



According to The Gartner Group, the growth in mission-critical and IP-based applications will generate a 300-600% increase in WAN traffic by the year 2002. It is expected that network operation costs associated with this growth will increase between 200-300%.

Multiple Networks Increase Cost and Complexity

In the past, different traffic types were carried by different networks. Many network infrastructures were built to support specific applications—voice, Systems Network Architecture (SNA), X.25, and IP—and these networks were often established and maintained by different departments. As a result, many companies ended up with separate, standalone systems including:

- Legacy data applications that run on separate leased lines or modem links
- X.25 networks
- TDM networks for data or voice
- Router networks for WAN data using public Frame Relay or leased lines
- Voice over public networks

As networks grew and became more complex, managing them required greater expertise and more human resources. Two significant developments have made multiple, separate infrastructures less attractive for most companies. First, increasing competition in the global marketplace is driving widespread corporate cost reduction while, at the same time, demanding more from the company's network and networked applications. The cost of managing separate voice and data networks has rapidly increased while IT budgets have remained static or even decreased. In fact, recent studies by IDC show that most companies are budgeting less than a 10-percent increase per year for IT network expenditures.

The second factor affecting corporate networking decisions is a severe shortage of qualified IT professionals. According to the U.S. Commerce Department, the IT industry will need to hire more than 1.3 million workers to meet demands over the next eight years in the U.S. alone.

A study by the Information Technology Association of America estimates that 346,000 high-tech jobs in the United States are unfilled. Studies conducted by Coopers and Lybrand, Deloitte & Touche, and Price Waterhouse reached similar conclusions; more than half of today's CEOs surveyed said that they did not have enough skilled IT workers to staff their operations. This tremendous shortage means that corporate IT managers must find ways to make network management, maintenance, and upgrades simpler and less resource-intensive.

New World Applications Require New Standards

To maintain a competitive advantage, businesses increasingly rely on new technologies and applications to achieve objectives such as reducing product cycle time, streamlining processes, increasing productivity, and launching e-business opportunities. Crucial to a company's agility and success, today's new business applications require nonstop performance and guaranteed QoS. (See Table 1.) Corporations can lose millions of dollars in just one hour if a mission-critical application becomes unavailable or does not run correctly, quickly, or completely.

Table 1 Network Availability: The High Cost of Downtime

Business	Average Cost Per Hour
Brokerage Operations	$6.4 million
Credit Card Authorization	$2.6 million
Pay-per-View TV	$150,000
Home Shopping TV	$113,000
Catalog Sales	$90,000
Airline Reservations	$89,500
Tele-Ticket Sales	$69,000
Package Shipping	$28,000
ATM Fees	$14,000

Source: Contingency Planning Research

Today's indispensable enterprise applications include:

- Legacy applications, such as SNA/SDLC
- Client/server applications such as SAP, Baan, Citrix, PeopleSoft, and others
- Groupware (Lotus Notes)
- Internet/intranet/extranet applications
- Multimedia e-mail (including images, presentation slides, and documents)
- Leased-line alternatives such as cost-effective public ATM services

In addition, broadband network connectivity will soon be a "must" for those businesses that need to provide worldwide employees, customers, partners, and suppliers with access to business-critical applications, multimedia tools, integrated call center capabilities, and video services. Soon, the prerequisite business requirement will be a network that delivers nonstop availability with the appropriate QoS for every business application.

The Limitations of TDM Networks

Until recently, TDM networking technology has successfully delivered on its promise for data, voice, and video networking. However, as application needs change, as IP traffic becomes a higher percentage of overall network traffic, and as the need for bandwidth continues to increase, TDM networks are not able to deliver the required scalability or traffic management capabilities.

A New Mix of Network Traffic Aggravates Bandwidth Efficiency

As end-user applications have become more complex, the network traffic they generate has also increased. Today's IP/LAN traffic is characterized as "bursty"—demanding bandwidth in spurts and frequently demanding more than has been assigned to the connection designated to carry it. IP traffic, in particular, is known for its unpredictable behavior over a network. With bursty LAN traffic and an increasing percentage of IP traffic being carried over wide-area networks, bandwidth management has become a nightmare for IT managers.

Each TDM network connection dedicates a specific amount of bandwidth to a specific application. Therefore, each circuit is "nailed up"—making it available for the specified transmissions only. This scenario works for applications that require constant packet throughput, such as voice or SNA/SDLC. With an increasing percentage of bursty IP/LAN traffic in the network traffic mix, however, the TDM approach leads to increased inefficiencies. To ensure acceptable QoS for bursty and high-priority traffic over a TDM network, IT managers must often purchase extra bandwidth and equipment. As a result, they must continually invest money to maintain the same level of performance. When traffic is not bursting or there is no traffic over the connection, bandwidth sits idle because it cannot be reassigned to other applications that could benefit from it. In general, the higher the peak-to-average traffic ratio, the greater is the efficiency gained from statistical multiplexing, that is, ATM.

Limited Scalability Increases Costs while Hindering Growth

To accommodate growing traffic volumes and high-priority applications, IT managers must continually optimize bandwidth to maintain performance and service levels with a TDM network. This scenario can require constant tearing down and rebuilding of circuits, because each circuit is dedicated for specific traffic types and volumes. It might also require adding new equipment and software—a requirement that is costly and also adds to network management costs.

TDM networks cannot be trunked over a public ATM service, and therefore cannot scale application speeds to OC-3/STM-1. The only alternative businesses have is to spend substantial amounts of money to interconnect locations via leased lines. Although access to new applications is important, many businesses cannot justify the high cost of leased lines to all locations or smaller branches. They choose to limit network growth and flexibility instead.

IT departments needing to provide worldwide clients with access to business-critical applications, multimedia tools, integrated call center capabilities, and video services will require broadband connectivity. TDM architecture is not designed for broadband services, and without the ability to take advantage of public ATM or broadband services, a company will find itself stymied in its ability to grow. Businesses planning to deploy new applications—and take advantage of new opportunities—are migrating to broadband connectivity.

Performance at the Expense of Bandwidth

TDM networks can deliver high levels of QoS, but at the expense of bandwidth. Therefore, to deliver an increasing volume of business-critical traffic with the required QoS, more must be spent on equipment, software, and bandwidth to maintain performance levels. Financially this is not an attractive option, as application and user demand for bandwidth and high QoS is projected to continue skyrocketing. At the same time, already-strapped IT resources are hard pressed to take on the burden of managing more infrastructure.

Y2K Compliance Critical for Survival

In the process of upgrading business applications for Y2K compliance, many businesses are finding that existing networking devices or software are not Y2K-compliant. In addition, the complex business-critical applications that many companies are now deploying require traffic prioritization and bandwidth management that TDM simply cannot provide. Today, many enterprises are upgrading to a technology that not only supports existing legacy applications, but also future-proofs the corporate WAN backbone and provides the advanced networking capabilities that will be required for vital business tools.

The Advantages of Multiservice ATM Networks

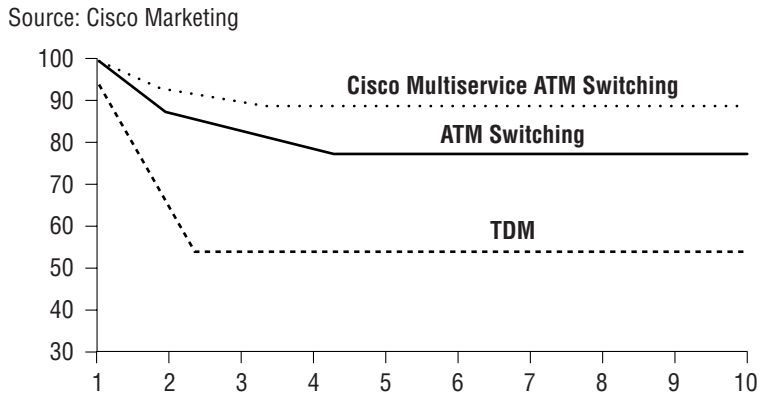
Multiservice ATM technology has become the market standard for meeting today's wide-area networking needs. The reasons are many—cost savings, better bandwidth management, the ability to guarantee QoS, and the ability to carry existing legacy applications while laying the foundation for emerging IP and multimedia applications. Companies that wish to ensure the most flexibility for the future are finding that ATM allows them to guarantee the high performance they need today while future-proofing the network against obsolescence.

Superior Bandwidth Management

While TDM provides dedicated bandwidth to specific applications, multiservice ATM dynamically allocates available bandwidth to any application that needs it. This management technique is called statistical multiplexing, and it ensures that bandwidth is used as efficiently as possible while still guaranteeing high levels of QoS.

The optimal ATM solution also includes technologies such as silence suppression for voice and repetitive pattern suppression for circuit data. These techniques enable a multiservice ATM network to conserve even more bandwidth. With this type of network, IT managers can gain up to 95 percent—or better—efficiency. ATM maximizes expensive bandwidth utilization so that managers do not have to continually invest in bandwidth as traffic volumes increase. (See Figure 2.)

Figure 2 Optimized Bandwidth Management with ATM



ATM networks have twice as efficient bandwidth utilization as TDM networks. TDM networks require room for error on trunks to handle bursts of traffic. As a result, TDM's trunk utilization is poor. ATM, on the other hand, achieves extremely high utilization rates from closed-loop network bandwidth management. Cisco's multiservice switching closed-loop management system continuously monitors ATM trunk utilization and adjusts the rate of each ATM connection to avoid trunk congestion and to make maximum use of network resources. Therefore, there is no need to leave room for error on trunks, and bandwidth is utilized to near 100%.

Consolidation of Multiple Networks and Lower Costs

Beating the cost/complexity challenge of managing and maintaining separate networks can be achieved by consolidating separate infrastructures and applications onto a single multiservice ATM backbone. Businesses that have consolidated legacy applications, IP traffic, high-speed data, voice and video traffic onto a multiservice ATM infrastructure have eliminated the costs associated with multiple, standalone networks.

A multiservice ATM network can also reduce recurring bandwidth costs. Vendors who provide multiservice ATM backbones with statistical multiplexing and other bandwidth-saving techniques can help companies slash bandwidth requirements significantly. By consolidating multiple networks onto a single backbone and integrating with the existing routed LAN infrastructure, a multiservice ATM network reduces recurring bandwidth requirements, reduces network complexity, and significantly lowers a company's total cost of ownership for the wide-area network infrastructure.

Guaranteed Performance and QoS

Mission-critical applications require available bandwidth and traffic prioritization. For these reasons, multiservice ATM has become the network technology of choice to guarantee QoS and reliability while maximizing bandwidth utilization.

A multiservice ATM network improves network performance by efficiently using and sharing network resources. Techniques such as cell switching and sophisticated queuing techniques enable IT managers to guarantee QoS for a wide range of applications. This embedded intelligence provides better control over QoS while maximizing bandwidth utilization.

ATM equipment that supports various classes of service enables IT managers to distinguish between types of traffic and handle each application uniquely. Application performance can be matched to users' needs and expectations while reducing costs and allowing for growth. Current service choices include:

- Constant bit rate (CBR)—dedicated bandwidth for consistent delivery
- Available bit rate (ABR)—ideal service class for TCP/IP, APPN, IPX/SPX, and LAN-to-LAN connections
- Variable bit rate (VBR)—comes in two flavors, as VBR real-time (VBR-RT) for efficient voice and video transmission, and VBR non-real-time (VBR-NRT), which is like ABR without guaranteed delivery rates
- Unspecified bit rate (UBR)—the lowest QoS guarantee for data that is not time-critical (best-effort service)

As a result, multiservice ATM networks significantly reduce application delay that users experience, fairly allocate bandwidth to users based on their needs, increase network reliability by decreasing discarded data, and accurately predict data patterns that increase overall performance.

> After evaluating several TDM-based systems, the advantages of a cell-based [ATM] system in terms of investment protection, scalability, and performance became obvious.
>
> —*Deutsche Post AG*

Seamless Integration and Painless Migration

Whether motivated by today's new networking needs, Y2K compliance, or both, companies are migrating to multiservice ATM infrastructures so that the network can deliver the projected performance benchmarks and prioritize traffic types within powerful enterprise-wide applications. For these reasons, companies look for a vendor who can seamlessly integrate multiservice ATM technology with existing TDM environments. The new multiservice ATM solution must be able to simultaneously support TDM classes of service and legacy interfaces (X.25, circuit data, and voice), as well as native Frame Relay or ATM. This scenario would enable a business to retain its investment in existing applications. As business needs change and the network grows, the superior scalability of ATM ensures the ability to easily add applications, users, and technologies.

TDM-to-ATM Migration: Reducing Risk

Migrating a network from a TDM to a multiservice ATM infrastructure can be achieved gradually, minimizing—or eliminating—risk to existing applications and network services.

The Migration Process

The goal of the migration process is to replace the TDM infrastructure without affecting service levels, and to migrate applications at the users own pace. One way to migrate the TDM network infrastructure is as follows:

1. ATM equipment is gradually brought on line over parallel trunks. This step verifies operation of the new ATM equipment.
2. ATM equipment gradually receives all TDM trunks as inputs. This step eliminates the numerous old trunks and places all traffic over ATM.
3. Applications are gradually removed from the TDM equipment and placed directly onto the multiservice ATM platform. Sometimes this removal is accomplished by migrating voice traffic, adding router and Frame Relay connections, moving data traffic, and finally video traffic—one at a time to ensure uninterrupted service.

Of course, applications and the specific migration plan will vary from company to company. Businesses undertaking a TDM migration should work with a vendor that has a significant amount of experience in helping customers migrate networks. Not only must the vendor be intimately familiar with the equipment being upgraded, it must also have a thorough understanding of the business' applications, business objectives, and operations capabilities. Only the most experienced vendor can provide the level of assistance required.

Plan for Migration Assistance

Many of today's IT organizations are already stretched to the limit or lack the specialized resources required for a rapid, trouble-free network implementation project. Companies planning a TDM-to-ATM migration should partner with the vendor that provides:

- A comprehensive suite of services that address all phases of the deployment and network life cycle—network design, implementation, cutover, production, expansion, and optimization
- Project management and engineering expertise
- Technical expertise for every aspect of the migration process
- Support capabilities for every worldwide location where the company's network is deployed

Assistance from an experienced vendor ensures rapid transparent deployment, eliminates resource drain, ensures maximum bandwidth savings, and enables the organization to reduce implementation costs.

Cisco Provides the Industry's Leading Multiservice ATM Solutions

Enterprise IT professionals increasingly face the challenge of delivering high-quality data, voice, video, and multimedia services throughout the enterprise while keeping costs under control. Today's next-generation multiservice ATM solutions from Cisco Systems connect all enterprise locations while integrating with existing routers and access devices to safely and cost-effectively support business-critical applications.

> Cisco guaranteed us a 40-percent reduction in transmission costs, and we actually achieved a 54-percent reduction.
>
> *—Fleet Financial Group*

Cisco IGX 8400 series wide-area switches provide a powerful multiservice backbone that enables businesses to consolidate data, voice, fax, and video traffic onto a single network. Integrated IP and ATM capabilities future-proof the enterprise network, supporting today's Frame Relay, SNA, leased-line, and Internet applications while providing a foundation for emerging IP-based applications such as virtual private networks (VPNs), intranets and extranets, voice over IP, video over IP, Web hosting, and electronic commerce. The IGX 8400 switches fully integrate with other Cisco LAN or branch office equipment (that is, customer premises equipment, or CPE) for an efficient, cost-effective end-to-end networking solution. As the leader in ATM, Frame Relay, traffic management, and QoS, Cisco provides today's businesses with the intelligent multiservice networks required to meet the demands of the new networking world.

> AvMed slashed its existing T1 lines by 50 percent and eliminated the need for the two additional T1s that had been projected. By deploying ATM switches and reducing its T1 links, AvMed saved approximately $750,000 the first year.
>
> *—AvMed Health Plan*

Optimized Bandwidth Management

The IGX 8400 switch ensures fair and cost-efficient bandwidth utilization using various techniques. Voice compression and voice activity detection (VAD) are used for voice; repetitive pattern suppression (RPS) is used for circuit data traffic; and ABR and ForeSight® licensed technology are used for ATM and Frame Relay traffic management. ABR is a standards-based ATM traffic management mechanism, and the ForeSight technology is Cisco's leading-edge implementation that mirrors ABR capabilities for Frame Relay traffic. ABR and ForeSight feature optimized real-time traffic performance and throughput, as well as minimize data loss.

Businesses using a multiservice ATM network based on the IGX 8400 switch have slashed leased-line costs by up to 50 percent by migrating from TDM infrastructures.

Consolidation over a Single, Robust Backbone

With interfaces for supporting ATM, Frame Relay, synchronous and asynchronous legacy data, TDM interconnect, Internet, video, and voice traffic, the IGX 8400 switch consolidates multiple traffic types over a single, reliable backbone.

> The IGX 8400 protected our investment in Frame Relay, X.25, HDLC, channelized T1, and ISDN technologies and gives us the ability to add new technologies, bandwidth, and sites to our network.
>
> *—U.S. Veteran's Administration Hospital*

Guaranteed Performance and QoS

The IGX 8400 switch cost-effectively increases application performance. A patented suite of intelligent traffic management features monitors and adjusts the cell rate of each connection so that congestion is avoided and application throughput is maximized. In many cases, enterprises can reduce the number of T1/E1 lines required for distributing applications while increasing the variety and quality of the services they deliver. Intelligent QoS management features of the IGX 8400 solution include:

- Automatic routing management
- Dynamic buffer management
- Advanced class-of-service management
- Optimized bandwidth management

The Highest Application Availability and End-User Satisfaction

Unforeseen downtime for a mission-critical application can result in a loss of millions of dollars. Originally designed for service providers, the IGX 8400 series switch offers carrier-class reliability. Redundant critical components and flexible routing paths ensure that vital business applications are always available.

> The IGX 8400 switch's advanced traffic management features and automatic rerouting functions have cut transport delay by 50 percent, greatly improving application performance. Fully redundant ATM switches and trunks ensure nonstop application availability from now on. Banco do Brasil experienced a double win—enhanced reliability and application availability as well as integrated data, voice, and video.
>
> *—Banco do Brasil*

Scalability for the Future

Business growth and new applications demand networking flexibility. The Cisco IGX 8400 series switch provides unmatched scalability, enabling businesses to cost-effectively support new IP-based applications, integrate tightly with LANs, extend networked services to branch locations and mobile users, and scale the network to accommodate growth.

Seamless Integration and Painless Migration

A rapid, successful implementation depends on planning, communication, and execution. Yet, with today's serious industry shortage of IT expertise, it's rare that a business has the luxury of in-house resources with deep expertise and years of migration experience. For these reasons, it makes sense to partner with a vendor that has years of experience in technology migration, deep technical and support expertise, and the resources available to ensure rapid implementation.

> WE'VE FOUND A SOLUTION [WITH CISCO] TO A COMMON PROBLEM FACING MANY COMPANIES TODAY: HOW TO SMOOTHLY TRANSITION FROM A PERFORMANCE-LIMITED TDM NETWORK TO A HIGH-SPEED, CELL-BASED NETWORK FOR ATM IMPLEMENTATION.
>
> *—British Post Office*

Cisco Professional Services provides the specialized assistance required to thoroughly plan a migration, minimize migration cycle time, reduce or eliminate risk to existing applications and operations, and speed return on investment of the new network. Cisco's years of networking experience ensure that TDM-to-ATM migrations backed by Cisco Professional Services deliver optimum uptime, optimum utility, and the longest life spans of any networking equipment in the industry. In addition, Cisco's support solutions integrate with a company's existing IT competencies to create a collaborative support solution.

Cisco Professional Services

The industry's most experienced support team offers:

- A single point of contact for the entire implementation project—A project or engineering manager who coordinates the many different types of expertise required for complex integrations
- A design review and verification, site surveys, remote technical support, hardware and software configuration, software or firmware revision or migration requirements, network connectivity, and network cutover
- Backing from more than 900 customer engineers and more than 300 Cisco Certified Internetworking Experts—The industry's most respected network accreditation
- More than 10,000 field engineers in over 120 countries
- Cisco Connection Online (CCO), Cisco's award-winning Web site, provides 24 x 7 registered user access, support tools, and immediate solutions 80 percent of the time
- A 4.6/5.0 customer satisfaction rating from Cisco customers
- Test labs at each Cisco Technical Assistance Center (TAC)
- Support in more than 140 languages
- Global support capabilities to ensure that installation and implementation projects anywhere in the world receive the attention of a team that understands the equipment and the intricacies of large-scale deployments

Business Case Cost-Saving Examples

The three examples that follow demonstrate the savings that each company achieved by using an ATM network. These examples cover a range of industries and network topologies in Europe, the United States, and throughout the world. Each example presents top-level financial results derived from models that simulate all required hardware and software at every node and link. The analyses use actual prices for ATM equipment, TDM equipment, current leased-line costs, and future expected costs. Additional ATM savings can be expected from reduced downtime, maintenance, and overhead. However, these savings are less predictable and are not included.

ATM delivers significant recurring leased-line savings, which offset the one-time equipment costs. In all three cases, the ATM equipment pays for itself within the first year. After five years, the percentage savings and net savings are substantial.

Example 1—U.S. Bank

This New York-based bank had a single TDM network that connected corporate headquarters to branch offices in seven United States cities, with the communication requirements specified in Table 2.

Table 2 Communication Requirements

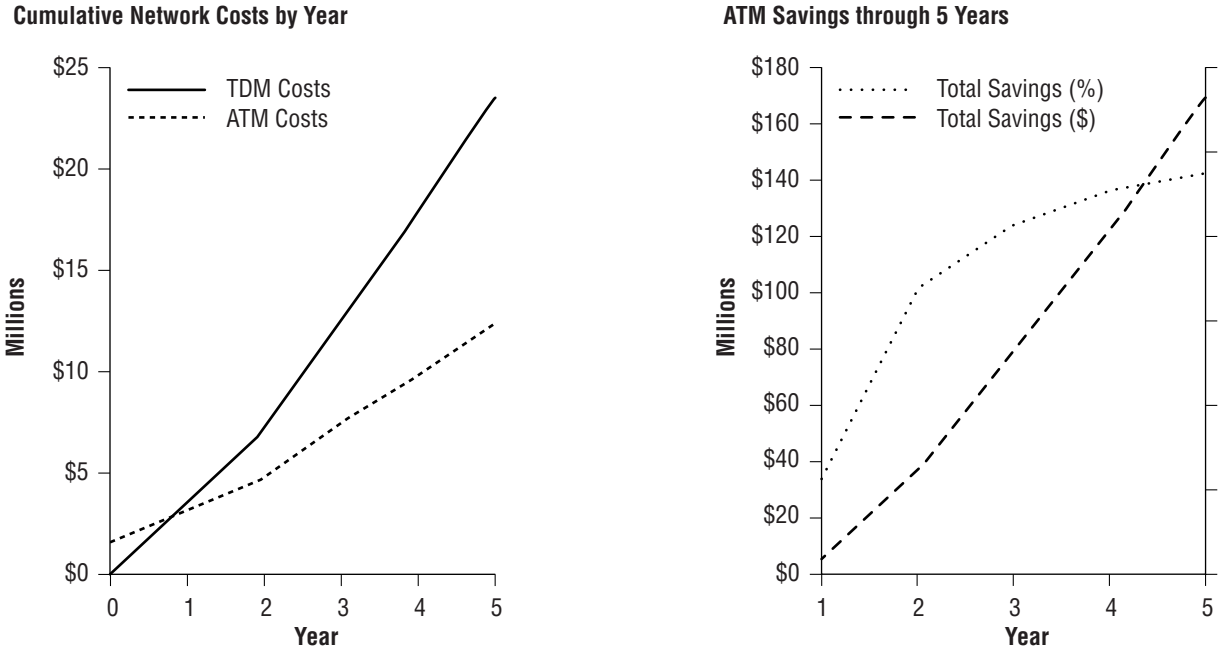
Location	Voice Lines	56K Data Lines	256K Frame Relay Lines	Current TDM Network (T1s)	ATM Network Solution (T1s)
Los Angeles	140	32	13	10	5
New York	202	50	16	14	6
San Francisco	140	34	14	9	4
Chicago	201	40	12	15	7
Cleveland	146	28	12	14	6
Atlanta	148	31	10	12	6
Dallas	146	19	8	10	4
Washington	167	20	7	8	4
Total	1290	254	92	46	21
Cost per Month				$267,844	$121,151

Figure 3 illustrates the optimized TDM network with 46 T1 lines and a lease cost of $267,844 per month. A network with the same requirements was redesigned and optimized with a Cisco multiservice ATM configuration. It requires only 21 T1 lines at a cost of $121,151—a savings of 55 percent.

This company projects that network needs will remain constant until year three, when a 25-percent bandwidth increase will be required for home banking services. The five-year financial projection of this company's network costs which covers both TDM and ATM scenarios, is shown in Figure 4.

Figure 3 TDM Network Before and After Cisco ATM Optimization

Figure 4 Financial Projection of Network Costs



The Bottom Line

This company's $1.5 million net investment is paid for within the first year, and it returns an additional 775 percent over the first five years—an average of 150 percent per year (see Table 3). Savings of total network costs average 48 percent per year over this period, a total savings of $11.3 million.

Table 3 TDM Versus ATM Cost Comparison[1]

Constant Dollars (000s)					
Old TDM Network	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
T1 Circuits	$3214	$3600	$5040	$5040	$5645
New TDM HW			$447		
Maintenance (entry level)	$161	$161	$181	$181	$181
Year Total	$3375	$3761	$5667	$5221	$5825
Running Total	$3375	$7136	$12,803	$18,024	$23,849
New ATM Network	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
T1 Circuits	$1454	$1628	$2280	$2280	$2553
New ATM HW	$1644		411		
Sell Old TDM HW	– $179				
Maintenance (entry level)	$74	$74	92	92	92
Year Total	$2993	$1702	$2783	$2372	$2646
Running Total	$2993	$4695	$7479	$9851	$12,496
Savings					
Yearly Savings	$382	$2058	$2884	$2849	$3180
Yearly Savings	11%	55%	51%	55%	55%
Total Savings	$382	$2440	$5325	$8173	$11,353
% Total Savings	11%	34%	42%	45%	48%
Summary					
Total Initial Investment =		$1644 + ($179) =	$1465		
5-year Return on Investment (ROI) =		$11,353 / $1465 =	775%		
Internal Rate of Return (IRR) =			140%		
Time to Break Even (months) =		$2993 / $3375 =	10.6		
Net Present Value (NPV) =			$6803		

Note: Company uses a hurdle rate of 15%

1. Leased line costs may vary in different environments; however, the cost-saving trend remains the same.

Example 2—European Manufacturer

The separate business units of this large European conglomerate were internally and externally networked with a large TDM network. Because of its large size, the company's bandwidth requirements were expected to grow at an annual rate of 15 percent. See Table 4 for data, voice, and Frame Relay requirements.

Table 4 Communication Requirements

Location	Voice Lines	56KData Lines	256K Frame Relay Lines	Current TDM Network (E1s)	ATM Network Solution (E1s)
Aach	21	0	20	9	7
Bad Bertrich	21	0	20	3	6
Geinsheim	22	0	19	7	4
Gersthofen	20	0	21	3	4
Glane-visbek	20	0	21	3	3
Hallstadt	20	0	21	4	2
Kaltenkirche	22	0	19	7	2
Karlshafen	20	0	21	6	2
Koln	20	0	21	9	3
Loitz	20	0	21	3	2
Narsdorf	22	0	19	3	2
Ottersleben	20	0	21	4	2
Wurmannsquic	20	0	21	3	3
Berlin	20	0	21	8	2
Frankfurt	22	0	19	4	3
Claydon	20	0	21	12	6
Cowley	20	0	21	9	7
Goole	20	0	21	6	8
Hamilton	22	0	19	6	2
Kincardine	20	0	21	4	3
Llangennith	20	0	21	3	2
Strichen	20	0	21	3	2
Crosne	22	0	19	5	4
Lougratte	20	0	21	3	2
Murat Sur Ve	20	0	21	4	4
Neant	20	0	21	4	2
St. Romans	22	0	19	4	2
Talmay	20	0	21	9	2
Asso	20	0	21	5	2
Correzzo	20	0	21	4	2
Monterosi	22	0	19	4	2
Morano Calab	20	0	21	3	2
Lodz	20	0	21	3	2
Sopot	20	0	21	3	2
Akkerwoude	22	0	19	12	5
Colijnsplaat	20	0	21	7	2
Den Hulst	20	0	21	3	3
Est	20	0	21	3	2
Limbricht	22	0	19	6	2
Wintelre	20	0	21	4	3
Hallesjo	20	0	21	3	2
Notteback	20	0	21	4	2
Total	862	0	860	106	63
Cost per Month				$3,022,207	$1,311,671

The optimal TDM network is shown in Figure 5, with 106 lines at a recurring lease cost of $3 million per month. A network with the same requirements was redesigned and optimized with a Cisco multiservice ATM network. This network required only 63 lines, at a monthly cost of $1.3 million—a savings of 56 percent.

The following five-year financial projection (see Figure 6) of this company's network costs clearly shows the savings that can be achieved with ATM.

Figure 5 TDM Network Before and After Cisco ATM Optimization

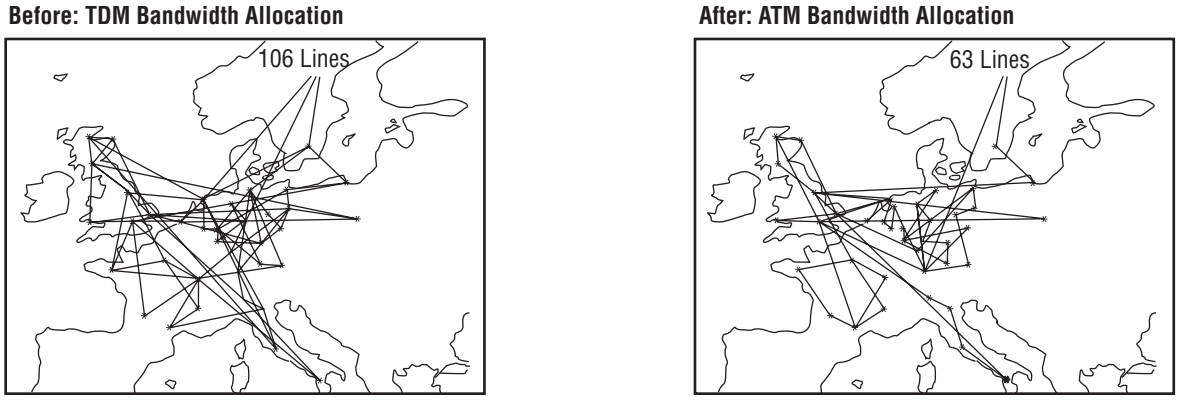
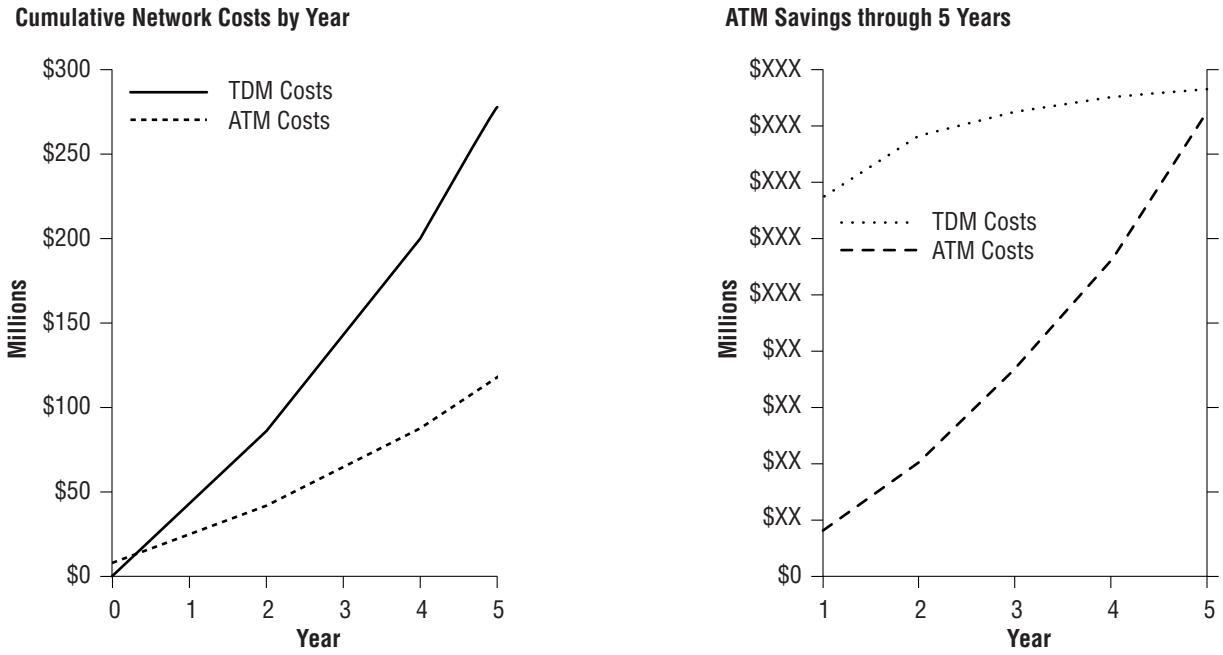


Figure 6 Financial Projection of Network Costs



The Bottom Line

This company's $4.3 million net initial ATM investment is more than paid for within the first year, and returns an additional 3000 percent over the first five years—an average of 200 percent per year (see Table 5). Savings of total network costs average 53 percent per year over the first five years, a total savings of $130 million.

Table 5 TDM Versus ATM Cost Comparison[2]

Constant Dollars (000s)					
Old TDM Network	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Leased Lines	$36,266	$41,706	$47,962	$55,157	$63,430
New TDM HW	$367	$422	$486	$558	$642
Maintenance (entry level)	$220	$239	$261	$286	$315
Year Total	$36,854	$42,368	$48,709	$56,001	$64,388
Running Total	$36,854	$79,222	$127,931	$183,933	$248,320
New ATM Network	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Leased Lines	$15,980	$18,377	$21,134	$24,304	$27,949
New ATM HW	$4498	$675	$776	$892	$1,026
Sell Old TDM HW	– $245				
Maintenance (entry level)	$202	$233	$268	$308	$354
Year Total	$20,436	$19,285	$22,177	$25,504	$29,329
Running Total	$20,436	$39,720	$61,898	$87,401	$116,731
Savings					
Yearly Savings	$16,418	$23,083	$26,532	$30,498	$35,058
Yearly Savings	45%	54%	54%	54%	54%
Total Savings	$16,418	$39,502	$66,034	$96,531	$131,590
Total Savings	45%	50%	52%	52%	53%
Summary					
Total Initial Investment =		$4498 + ($245) =	$4,253		
Return on Investment (ROI) =		$131,590 / $4253 =	3094%		
Internal Rate of Return (IRR) =			498%		
Time to Break Even (months) =		$20,436 / $36,854 =	6.7		
Net Present Value (NPV) =			$83,489		

Note: Company uses a hurdle rate of 15%.

2. Leased line costs may vary in different environments; however, the cost-saving trend remains the same.

Example 3—International Conglomerate

This conglomerate's separate business units are internally and externally networked with a large TDM network. Bandwidth requirements are expected to grow constantly, at an annual rate of 10 percent (see Table 6).

Table 6 Communication Requirements

Location	Voice Lines	Kbps Data Lines	Kbps Frame Relay Lines	Current TDM Network (Links)	ATM Network Solution (Links)
London (8)	74	5282	4940	84	33
New York (6)	91	2618	7846	89	29
Los Angeles (8)	148	7048	17126	77	41
Tokyo (4)	63	3072	2144	21	11
Toronto (2)	29	452	3520	17	6
Johannesburg (2)	6	394	2406	9	4
Miami (2)	70	552	768	53	14
Mexico City	1	76	0	2	2
Bombay	3	144	256	4	2
Seoul	0	368	0	9	2
Sao Paulo	7	715	38	2	2
Madrid	113	492	5120	17	4
Istanbul	0	452	1830	4	
Sydney	0	0	38	3	2
Aukland	23	0	38	2	2
Hong Kong	0	0	38	5	2
Oslo	25	24	76	12	5
Frankfurt	0	760	6400	29	2
Manilla	0	330	0	6	2
Santiago	0	0	1344	0	2
Moscow	73	356	1280	9	6
Total	726	23135	55208	227	88
Cost per Month				$7,560,833	$2,026,083

The optimized TDM network is seen in Figure 7, using 227 lines with a recurring lease cost of $7,560,857 per month. A network with the same requirements was redesigned and optimized using Cisco multiservice ATM. It requires only 88 lines and a monthly cost of $2,026,082—a savings of 73 percent. The five-year financial projection of this company's network costs which covers both TDM and ATM scenarios, is shown in Figure 8.

Figure 7 TDM Network Before and After Cisco ATM Optimization

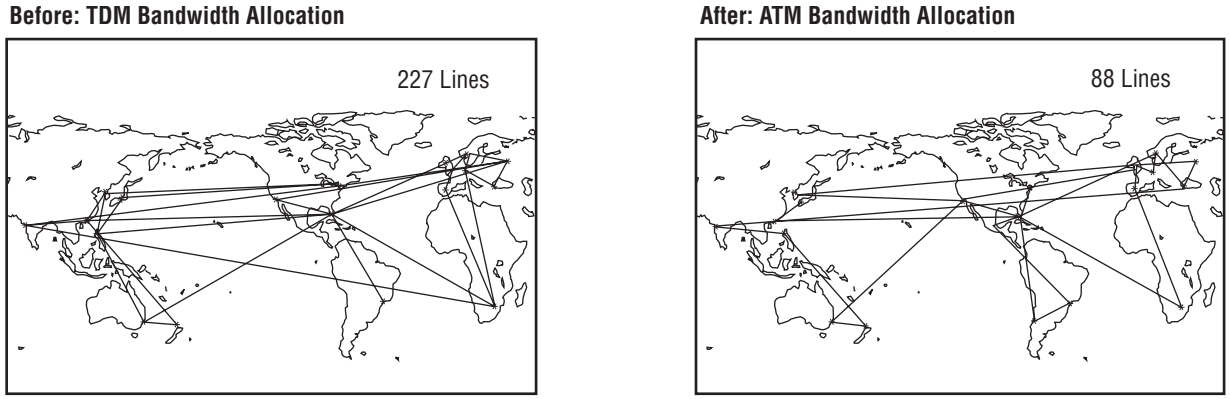
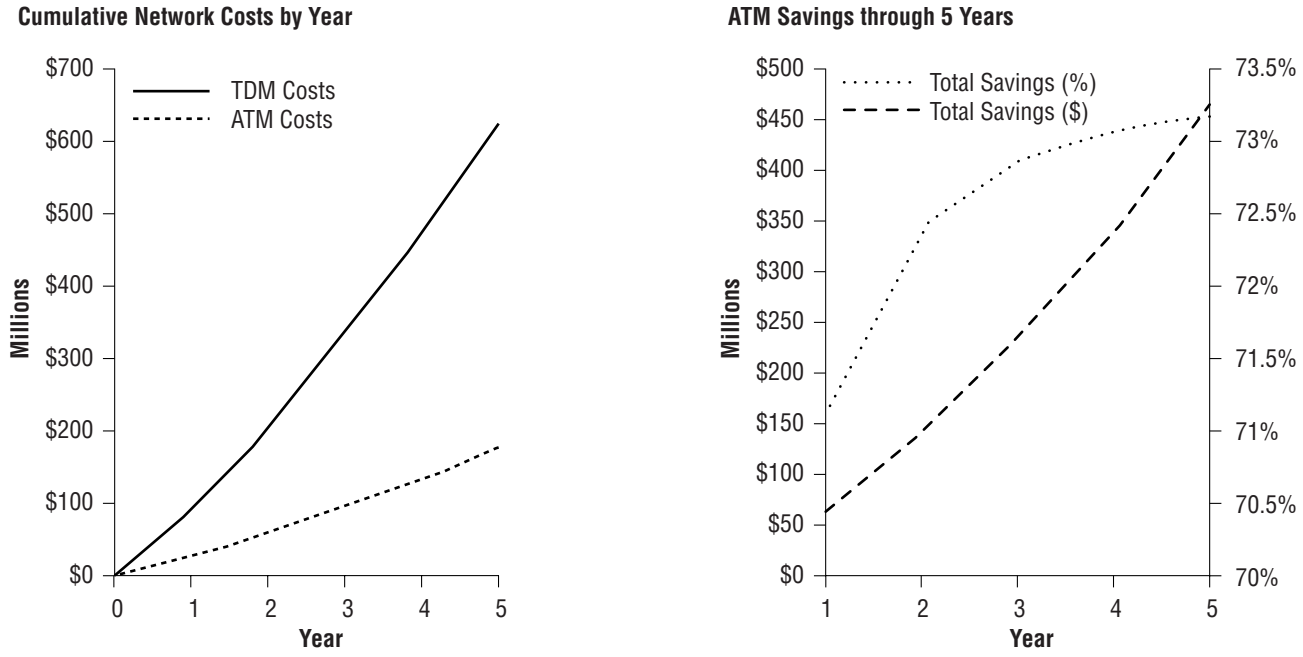


Figure 8 Financial Projection of Network Costs



The Bottom Line

This company's $2.3 million net investment is more than paid for within the first year, and it returns an additional 19,000 percent over the first five years—an average of 288 percent per year (see Table 7). Savings of total network costs average 73 percent per year over the first five years, totaling $450 million.

Savings for this international company are especially high because of the large reduction in highly expensive international lines, especially the costly, but seldom-used redundancy lines. Average savings this large cannot be expected in every business case.

Table 7 TDM Versus ATM Cost Comparison[3]

Constant Dollars (000s)					
Old TDM Network	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
T1/E1 Circuits	$90,730	$107,788	$128,052	$135,223	$160,644
New TDM HW		$280	$308	$339	$373
Maintenance (entry level)	$252	$265	$279	$294	$311
Year Total	$90,982	$108,333	$128,638	$135,855	$161,328
Running Total	$90,982	$199,315	$327,953	$463,809	$625,137
New ATM Network	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
T1/E1 Circuits	$24,313	$28,884	$34,314	$36,236	$43,048
New ATM HW	$2578	$258	$284	$312	$343
Sell Old TDM HW	– $280				
Maintenance (entry level)	$116	$128	$140	$154	$170
Year Total	$26,727	$29,269	$34,738	$36,702	$43,561
Running Total	$26,727	$55,996	$90,734	$127,436	$170,996
Savings					
Yearly Savings	$64,256	$79,063	$93,901	$99,154	$117,767
Yearly Savings	71%	73%	73%	73%	73%
Total Savings	$64,256	$143,319	$237,220	$336,373	$454,141
Total Savings	71%	72%	72%	73%	73%
Summary					
Total Initial Investment =		$2578 + ($280) =	$2298		
Return on Investment (ROI) =		$454,141 / $2298 =	19766%		
Internal Rate of Return (IRR) =			2915%		
Time to Break Even (months) =		$26,727 / $90,982 =	3.5		
Net Present Value (NPV) =			$292,341		

Note: Company uses a hurdle rate of 15%.

The Future Is Now

Managing the data explosion is becoming increasingly resource-intensive. For businesses that plan to compete in the next century, now is the time to take a hard look at what network capabilities will be required to successfully compete. Migrating to a multiservice ATM wide-area network infrastructure now offers the opportunity to preserve investments in existing applications while future-proofing the WAN for tomorrow's IP-based applications.

For more information about Cisco WAN solutions, visit Cisco at www.cisco.com/warp/public/790/.

3. Leased line costs may vary in different environments; however, the cost-saving trend remains the same.

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