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Bridging the T-Chasm

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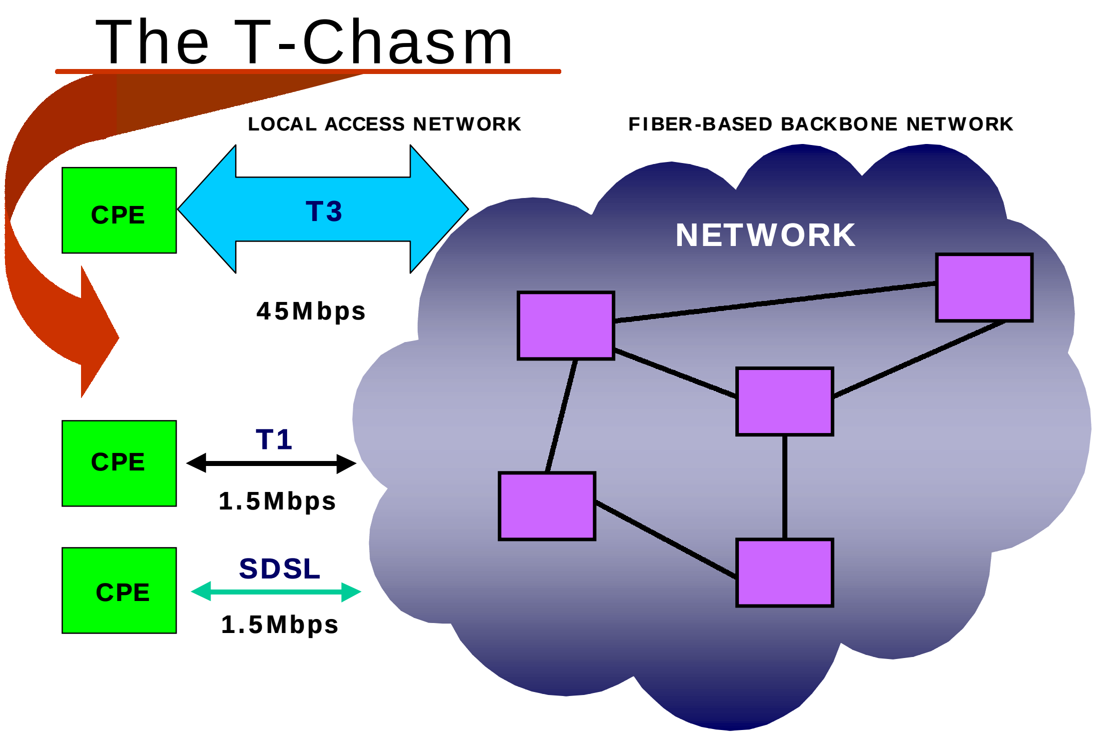
Table of Contents

Defining the T-Chasm

Medium-sized businesses (MSBs—those with between 50 and 500 customers) often find themselves at an odd juncture regarding their broadband communications connections. On the one hand, they find relatively affordable copper-based access methods, like T1 (1.5Mbps) and DSL, which provide them with limited bandwidth and flexibility. On the other hand are fiber-based broadband connections like T3 (45Mbps) and newly available Ethernet over fiber services, which can meet their needs for bandwidth but are often very expensive and not widely available. It is between these two groups of access technologies that we find the "T-Chasm"—that empty space in the market between T1 and T3, both in terms of bandwidth and of price.

Figure 1: The T-Chasm



Effect on Service Providers

Service providers, particularly those local and interexchange (IXC) carriers who wish to offer a complete integrated voice, video, and data solution, find that their current portfolio of offerings falls short when it comes to the medium-sized business. In many cases, a single T1 or DSL circuit cannot handle both voice and data needs for these customers, and technical issues, mainly relating to interference in the telco outside plant, make it difficult to provision more than a few of these circuits to a single location.

T3 or native Ethernet over fiber services would certainly fulfill their customers' needs, at least technically, but the high cost of such circuits and the limited availability of fiber to buildings make these access methods only practical for larger customers.

For many service providers, particularly IXCs and competitive providers who must lease access facilities from incumbent providers, the cost of access can make up 40 percent or more of their overall costs.

Effect on End Users

The medium-sized business finds itself in the midst of this T-Chasm too, particularly as its needs for bandwidth to support emerging services grow. As we will discuss below, many MSBs find their current access methods to be inadequate for their current bandwidth requirements, but their budgets are too limited to move up to higher bandwidth solutions like T3.

This leaves MSBs abandoned in the middle of the T-Chasm. Their current bandwidth options don't adequately support the functionality they require on their network and the next higher bandwidth options are out of their price range or not available in their area.

Local Access and the Medium-Sized Business

Medium-sized businesses (according to the US Census Bureau, there are over 80,000 businesses in the 100-to-500-employee range alone) have a wide-ranging variety of telecommunications and data applications, from simple voice and Internet connections to truly next-generation applications like ASP, e-commerce, and Intranets.

Among the "traditional" applications required by MSBs are the following:

- **Voice.** While analog POTS or Centrex support is often used by MSBs, many of the businesses in this category require T1 or equivalent bandwidth for PBXs.
- **Internet.** Simple Internet access for email and Web surfing applications is usually the bare minimum for MSBs, along with support for Web hosting and other basic Internet services.
- **Video.** Two-way videoconferencing (along with related dataconferencing) and one-way video for training, distance learning, and other applications.
- **Data networking.** Broadband access for a host of data communications applications such as access to ATM/frame relay networks, financial network connectivity, CRM, etc.

In addition to these traditional applications, dozens of newly developed applications are beginning to make bandwidth demands on MSBs, including:

- **VPN/Intranet.** Leveraging the economies of IP services, many MSBs are beginning to move from legacy private networks toward IP VPN networks, both within the enterprise (Intranets) and externally (Extranets connecting a company with suppliers, customers, and other organizations).
- **Converged voice (VoIP).** Using voice gateways or IP-enabled PBXs, MSBs can increasingly carry their voice and data traffic over a single connection, utilizing dynamic allocation of bandwidth to use their circuits more efficiently.

- **Distributed computing / ASP.** Many MSBs find that "owning" and maintaining all of their own applications support for non-mission-critical applications (or for those outside of the core competencies of the MSB) is a great expense, both in terms of cash expenses and also in terms of hard-to-find IT personnel. Outsourcing these applications to expert third parties and accessing them via IP networks is increasingly a viable option to doing it all in-house.
- **E-commerce.** Much hyped in recent years, and similarly much denigrated during the recent dot.com downturn, e-commerce remains a vital application for MSBs in the coming years. Using e-commerce to reach more customers, at reduced expense, with better integration into back-end inventory, supply, and human resources continues to be a compelling application for most MSBs.

Services for Today's Medium-Sized Business

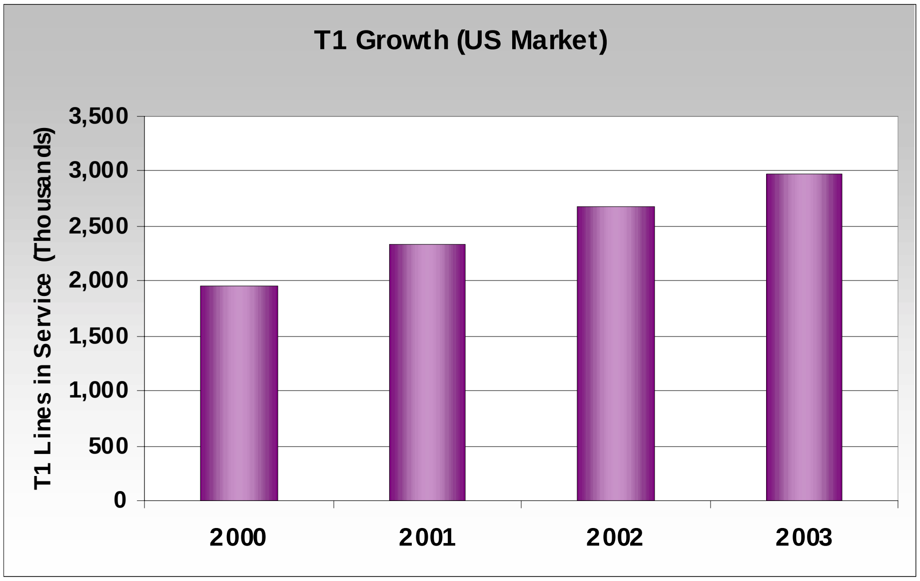
To explain the T-Chasm a bit more fully, it is instructive to look in more detail at today's available access options for the medium-sized business.

Below the T-Chasm

T1 Services

The service provider answer to an MSB looking for connectivity has long been the T1 circuit. With a guaranteed bandwidth of 1.544Mbps, high reliability, and wide availability (particularly with the advent of HDSL-based T1 provisioning over the past decade), the T1 is a good product for many business users. Typically priced between US$400 and US$800 per month, a T1 is a relatively affordable product for most MSBs.

Figure 2: T1 Growth (US Market)

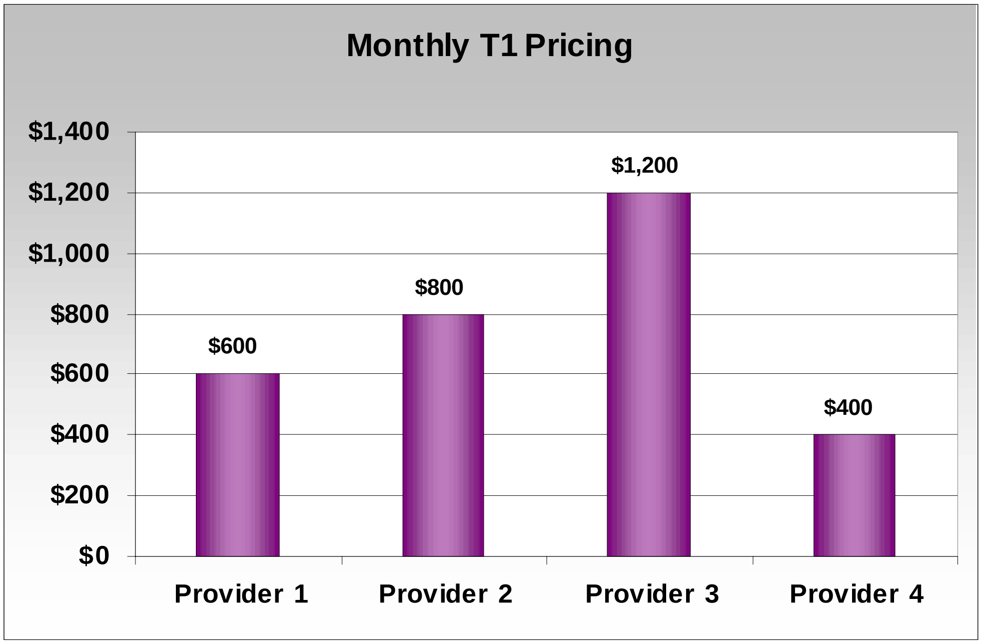


CAGR = 15%   Source: Morgan Stanley

There are some shortcomings, however, including:

- **Highly variable pricing/availability.** The advent of competitive providers has lowered T1 pricing significantly in some areas of the country, while in other areas monopoly providers are able to command a premium price for the service.

Figure 3: T1 Pricing Is All Over the Map



Source: TeleChoice

- **Technical limitations to multiple T1 connections to a single location.** The underlying line coding used to provide T1 speeds over copper twisted pair lines is inherently noisy and interferes with other signals being carried in adjacent copper pairs. Service providers are limited to offering only a few T1 lines per bundle group because of this interference, often limiting the number of T1s that can be provisioned to a single location.

- **Limited bandwidth flexibility.** When a T1 line is paired with an Integrated Access Device (IAD) to provide both voice and data services, the bandwidth of the T1 line is allocated into fixed channels for each service. This is an inefficient use of bandwidth since voice services are often not used at their full capacity, and such a fixed allocation is unable to dynamically allocate voice bandwidth for bursty data traffic needs. Many MSBs will utilize separate T1s for voice and data/Internet applications, increasing network costs, CPE costs, and overall network complexity.

T1 IMA

To meet the needs of customers requiring more bandwidth than a single T1 circuit, a standard called Inverse Multiplexing over ATM (IMA) has been established. Using IMA, multiple T1 circuits can be configured to behave as a single, higher-speed connection. Although not widely available, T1 IMA works well in practice but is limited in scalability by the inherent noisiness of T1. While it is possible to inverse multiplex multiple T1 lines, many service providers offer a maximum of only 2 T1 circuits, or 3Mbps total bandwidth, using IMA due to this factor.

T1 CPE and CPE Pricing

T1 CPE is widely available and relatively inexpensive—for basic T1 services a Channel Service Unit/Data Service Unit (CSU/DSU) can be as little as US$500. IADs for T1 are considerably more expensive (typically greater than US$1000), and equipment for T1 IMA is also more expensive than low-end CSU/DSUs. Additionally, the MSB will need to purchase or lease a router to connect between the V.35 interface on the CSU/DSU and the office LAN, as a native Ethernet interface is not usually offered on T1 equipment.

DSL Services

During the past several years, Digital Subscriber Line (DSL) technologies have offered both businesses and consumers a new generation of T1-like services at greatly reduced costs. Millions of businesses and consumers have adopted DSL from two groups of service providers.

The first, and most applicable to MSBs, are Symmetrical DSL (SDSL) services offered by Competitive Local Exchange Carriers (CLECs). These services utilize Unbundled Network Elements (UNEs) (or leased copper pairs) from the incumbent telco and provide symmetrical bandwidth up to 1.5Mbps using proprietary SDSL technology. The second group, incumbent telcos, does not offer business-class Symmetrical DSL services, instead focusing on the low-end small business and residential markets with Asymmetrical DSL (ADSL) offers with limited upstream bandwidth.

Symmetrical DSL services are typically less expensive per megabit than T1, with most competitive providers offering 1.5Mbps for prices between US$250 and US$400 per month. DSL CPE is also relatively inexpensive, with low-end routers costing approximately US$250, and more fully featured routers (including such features as firewall, VPN, etc.) costing closer to US$600.

Asymmetrical DSL services often offer abundant downstream bandwidth—up to 7Mbps—but are typically limited to upstream bandwidths considerably lower than T1. In fact, many ADSL offerings are limited to just 384Kbps in the upstream direction. Because of this fact, many MSBs find these services to be inadequate for their needs, as this asymmetrical nature doesn't enable common services such as Web or email server hosting, videoconferencing, and e-commerce.

Business-class SDSL services suffer from several shortcomings:

- There are significant limitations to availability due to copper loop length limitations.
- Proprietary SDSL technologies, like T1, are noisy and prone to causing interference in the twisted pair binder group, so deployments may be limited by this factor.
- SDSL services have to date been offered exclusively by data CLECs, and these providers have been experiencing severe financial difficulties and indeed most have left the market due to bankruptcy.

Fixed Wireless Services

Other recent entrants into the access market are fixed wireless providers using Local Multipoint Distribution System (LMDS) or Multichannel Multipoint Distribution Service (MMDS) technologies. The initial proponents of such services offer a variety of speeds, with T1 equivalent services usually priced between US$650 and US$1100. Some large IXCs have also begun to offer similar services for both consumers and businesses, with pricing and speeds similar to DSL service offerings (in other words, on the low end of the MSB needs scale).

Like the DSL market, the fixed wireless market has so far been quite unsuccessful for service providers, with most of the initial entrants into the market failing and falling into Chapter 11 bankruptcy proceedings. Fixed wireless is relatively easy to provision where offered, as no physical link is needed between the service provider and customer, but the cost of the technology has limited deployments to date, and line-of-sight limitations mean that many businesses are out of reach of existing deployments.

Above the T-Chasm

T3 Services

Moving up from copper-based broadband services, MSBs will find the gap that defines the T-Chasm—the next service level available from most providers is the 45Mbps T3. Provided using high-bandwidth facilities such as optical fiber or microwave radio (often unavailable to the MSB), T3 connections are priced much higher than T1, with typical pricing in the range of US$15,000 to US$18,000 per month.

Like T1, T3 facilities can be established with a mix of both voice and data services over a single line, and again like T1, this bandwidth mix is not typically dynamically allocated. In other words, the T3 line can be configured with a certain amount of bandwidth allocated for voice channels, and this allocation cannot be changed “on the fly” by the end user.

Fractional T3 services, using a full T3 access line but throttling the throughput down to a lower level, are offered by some carriers but are not yet widely available. Such services are less expensive than full 45Mbps T3 services, but because the full T3 facility is required to provide them, they are typically more expensive than T1 or multiple T1 solutions.

As is the case with T1, T3 CSU/DSU equipment requires an external V.35 router and is typically expensive, with prices starting at US$5000 and above.

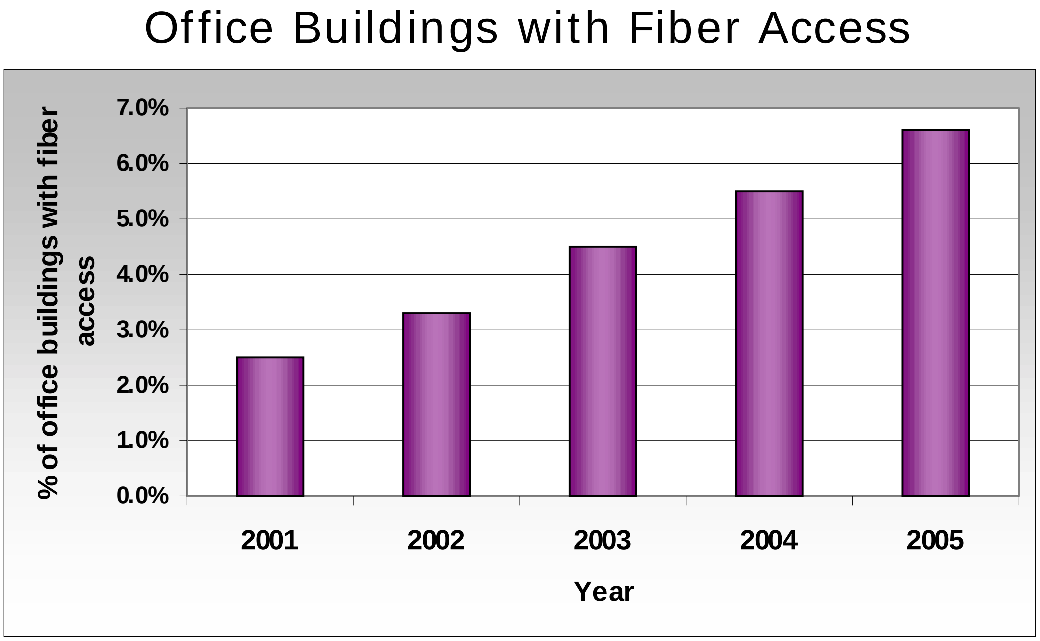
Metro Fiber Services

The newest entrants into the local access market for MSBs are the next-generation optical Ethernet providers. These companies, such as Yipes and Cogent, offer customers connected to the metro fiber ring a native Ethernet service at speeds of 1, 10, 100Mbps, or faster. Typical pricing for these new services is somewhat variable, with some providers charging US$1000 per month for 10Mbps service, and others charging the same amount for a 100Mbps connection. Because these services present a standard Ethernet interface to the customer, CPE requirements for the MSB are relatively inexpensive.

Most metro fiber Ethernet services are extremely flexible due to the capacity of the fiber connection, and additional bandwidth can often be provisioned "on the fly" using Web-based account management software.

The biggest drawback to this emerging access method for most businesses is simply one of availability. Only a small percentage of businesses (less than 3 percent) are currently connected to one of these metropolitan fiber networks.

Figure 4: Chart of Fiber Availability



Source: TeleMac, March 2001

Table 1: MSB Access Comparison

Technology	Bandwidth	Cost / Month	Availability	Support for Voice and Data	Dynamic Bandwidth Allocation?
T1	1.5Mbps	$400-$800	High	Yes	No
T1 IMA	3Mbps	$800-$1600	Medium	Yes	No
SDSL	1.5Mbps	$250-$400	Medium	Limited (VoDSL)	Limited (VoDSL)
Fixed Wireless	1.5Mbps	$650-$1100	Low	Yes	No
T3	45Mbps	$15,000+	High	Yes	No
Ethernet over Fiber	10Mbps+	$1000	Low	Limited	Yes

The T-Chasm Gap

When comparing the various MSB access options listed in the table above, the nature of the T-Chasm becomes obvious. For many MSBs, *today's access costs too much and delivers too little!*

T1 Isn't Enough

As mentioned above, T1 has been the mainstay of MSBs for decades. Unsurprisingly, what was once a high-end service now falls short of application demand for many businesses. Existing voice requirements from the PBX and even basic data requirements quickly eat up 1.5Mbps. For example, using a not-so-conservative 4:1 oversubscription ratio, it takes only 96 voice lines to utilize a full T1; similarly, 96 Internet users sharing at T1 would be guaranteed only 16Kbps of bandwidth during simultaneous usage—significantly less than a dial-up connection.

As mentioned above, using T1 IMA can increase this bandwidth but only to a limited degree due to provisioning issues.

T3 Is Often Too Much

A full T3 connection, with its 45Mbps, offers more than enough bandwidth for the vast majority of MSBs, but at more than $15,000 a month it is simply too expensive for all but the largest of these providers. Additionally, because most T3 circuits are provisioned over fiber optic facilities, many MSBs who would consider such a service will require an expensive new installation with a lengthy waiting period.

Today's DSL Offers Fall Short

DSL services have promised broadband access for dial-up prices, and indeed they do provide that for consumers and small businesses. When the more sophisticated and bandwidth-intensive needs of MSBs are considered, current DSL services don't make the grade. Proprietary SDSL services are limited to T1 speeds (equipment to provide bonded SDSL services, similar to T1 IMA services, is available but has not been widely deployed by any providers), are often unreliable, and are offered by providers that are increasingly suspect as viable business concerns.

Fiber Is Great, When You Can Get It

Next-generation Ethernet over fiber solutions have many of the characteristics needed to bridge the T-Chasm: flexible bandwidth of 10Mbps or greater; support for converged voice, video, and data services; and relatively low pricing. However, the vast majority of businesses (of any size) simply are not connected to the fiber network and won't be for some time.

As show in Figure 4, fiber access penetration in the last mile—to the building—is very low, and even looking forward to 2005 fiber will *not* reach over 93 percent of office buildings in the US.

10 Megs Is the Sweet Spot

The level of service offered by these fiber services, however, does fit the needs of MSBs extremely well. If one were to envision what kind of service these businesses require, there would be a few must-have criteria:

- **Speed to support today's and future services.** Data/Internet access speeds of 10 or more Mbps plus bandwidth to support PBX-based or VoIP voice services, with flexibility in bandwidth provisioning to allow lower speeds for smaller businesses and rapid growth as needs change.

- **Affordability.** Service pricing at or below current T1 pricing levels for lower-speed variants, well below T3 for higher speeds.

- **A "natural" interface speed.** CPE with a T1/10Base-T/T3 interface for easy connection to existing LAN router/hub equipment, plus standardized interfaces for connection to PBX systems.

- **Ability to leverage copper infrastructure.** Fiber to the building is far from being a reality for most businesses, so the ability to access the existing copper twisted pair infrastructure is essential to assure availability and affordability.

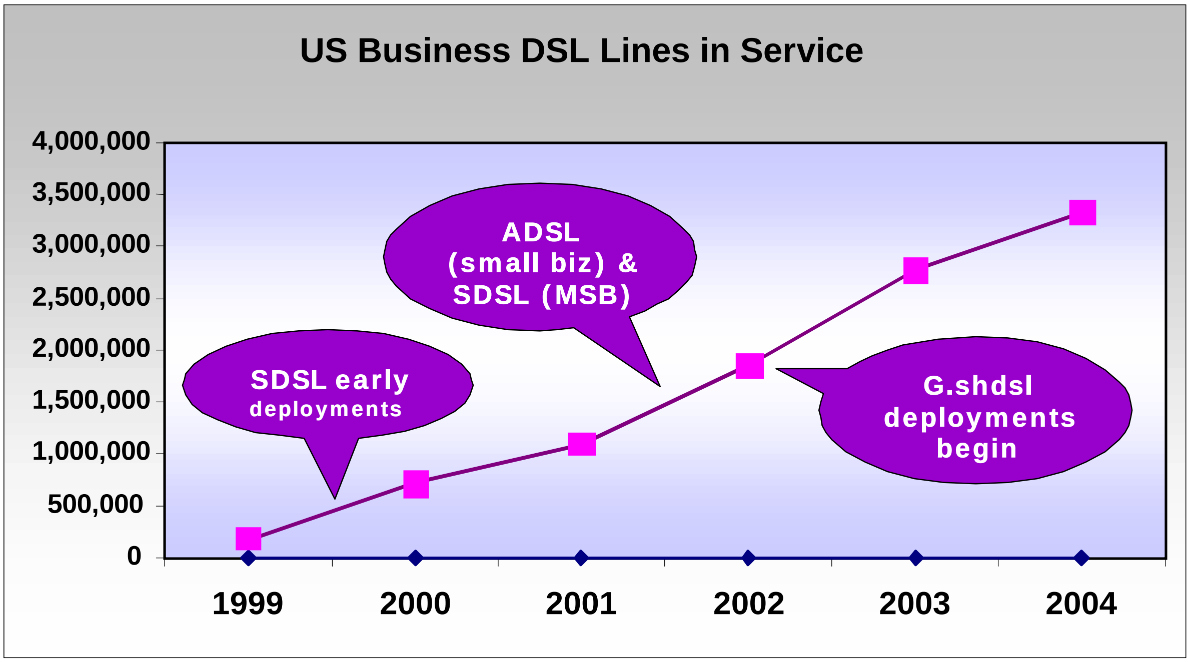
- **Quality of Service-enabled dynamic bandwidth allocation.** Utilize ATM QoS mechanisms to assign bandwidth to different applications while enabling a full range of services (voice, video, and data) over a single connection.

A New Alternative: Bonded G.shdsl

One way to provide this "chasm-bridging" type of service is to utilize the new generation of DSL—the ITU standard G.shdsl—in a bonded multiline service over inexpensive existing copper twisted pair UNEs. Utilizing an IAD with the capability to bond up to 8 G.shdsl connections allows service providers to cheaply and easily provide services with speeds of over 15Mbps (up to 2.3Mbps per G.shdsl line) to MSBs which have outgrown their T1s and aren't ready to make the leap to T3.

Figure 5 shows the migration of business-class DSL services from SDSL to ADSL and G.shdsl.

Figure 5: US Business DSL Growth



Source: TeleChoice

How is this different from T1 IMA or traditional SDSL business services? It's different in several ways, actually, including the following:

- **G.shdsl vs. SDSL or HDSL.** G.shdsl is an international standards-based DSL, unlike SDSL or the HDSL used to provide many T1 services. It was designed from the start as "friendly" DSL, with very low noise characteristics and a very low probability of interfering with other services in adjacent copper pairs. Where only a few T1 lines can be placed in a single binder group, G.shdsl was designed to be spectrally friendly with up to 24 of the 25 pairs of lines in a binder group able to carry G.shdsl signals without interference.

- **Access to fiber backbone over copper.** Where T1 or SDSL services can offer only relatively limited speeds—nowhere near the natural 10Mbps Ethernet interface that fiber over Ethernet systems offer—Bonded G.shdsl can easily scale from 1.5Mbps all the way up to 15Mbps or more.

- **Greater reach.** G.shdsl has a loop reach of up to 20 percent greater than proprietary SDSL systems and can be easily repeatered for very long loops. G.shdsl can also be offered over longer loops at lower speeds, but the ability to bond up to 8 lines together as 1 means that even if the speed of each line was scaled back by 33 percent to increase loop length, a 10Mbps service could still be offered.

- **Reliability.** By distributing communications over multiple UNEs, a Bonded G.shdsl system has fewer single points of failure than a T1 or SDSL service. If one of the UNEs experiences a failure anywhere in the network (a physical line break, a misconfiguration in the central office, etc.), the remaining connections would continue to work and still provide a high-bandwidth service until that UNE was repaired.

- **Support from major infrastructure vendors.** G.shdsl is an international standard, and unlike proprietary SDSL, is already supported by major DSL Access Multiplexer (DSLAM), chipset, and other infrastructure vendors. The DSLAMs already in place in many service providers' networks, for example, can easily accommodate G.shdsl with simple line card upgrades.

How Bonded G.shdsl Fits into a Service Provider's Network

Bonded G.shdsl systems can fit into many different service provider deployment scenarios. Three of the most likely initial applications are:

1. **High-speed transport.** As a replacement for existing T1 or other broadband facilities to carry voice and data between a customer premises and the central office.

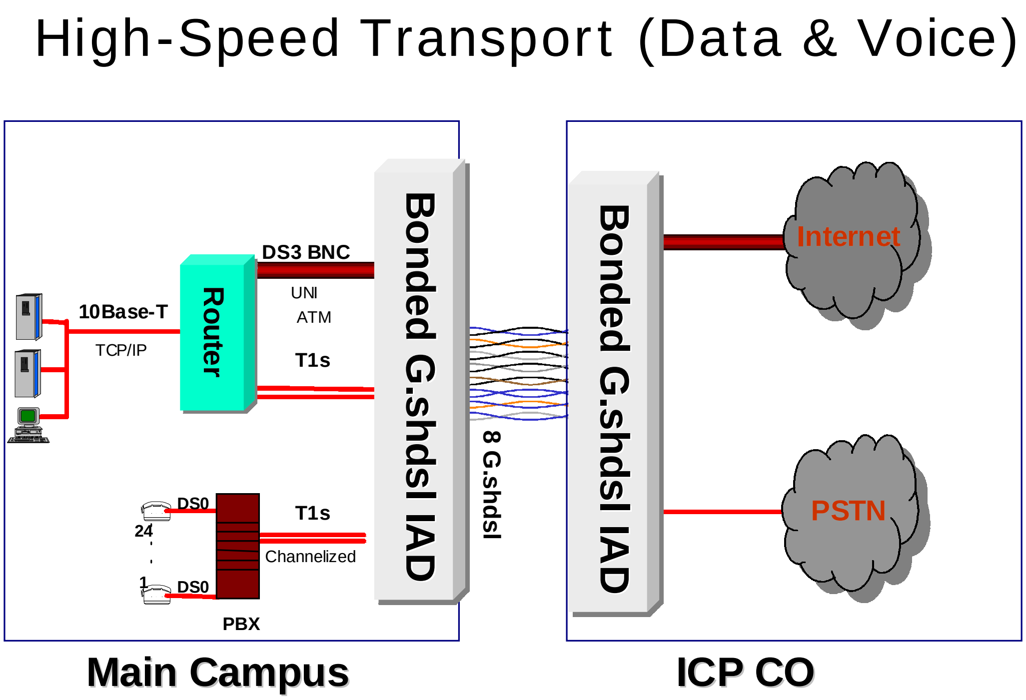
2. **Corporate networking.** As a local transport method for connecting MSB offices to an ATM or other private data network.

3. **High-speed Internet.** As an access method between the customer premises and a DSLAM located at the central office and also as a means of providing high-speed access between Internet Service Provider (ISP) regional hubs and the central office.

High-Speed Transport

Bonded G.shdsl can be incorporated in an Integrated Communications Provider's (ICP) network as the last-mile link in an integrated high-speed offering providing both voice and data services to the customer. In this scenario, Bonded G.shdsl IADs can be installed both at the customer premises and in the central office, and multiple copper pairs can be provisioned to provide connectivity to the MSB office. Within the MSB office, the Bonded G.shdsl IAD can be connected to both the internal LAN, via a router, and to the PBX for voice services. In the central office, the IAD is then connected to standard ATM switches and voice switches so that traffic can be exchanged over the Internet and the Public Switched Telephone Network (PSTN).

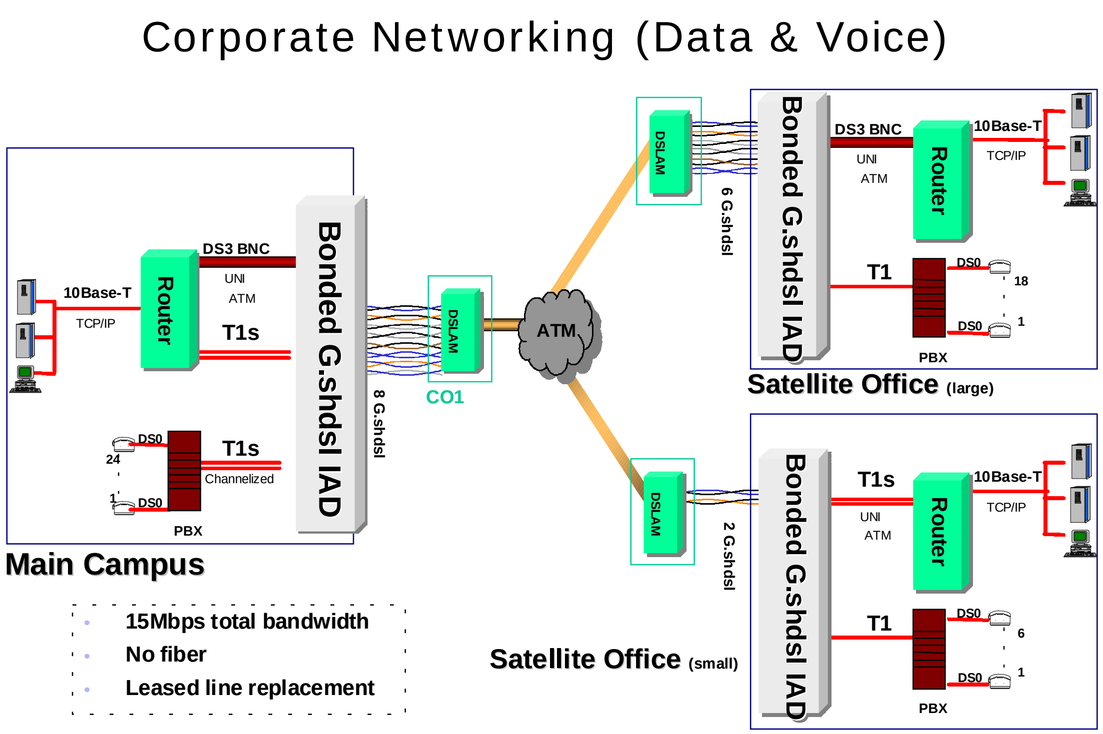
Figure 6: The High-Speed Transport Scenario



Corporate Networking

Bonded G.shdsl can be implemented in an enterprise network configuration providing access to an ATM private network or an IP VPN, as well as ATM-based voice services for IXCs and other ICPs. In this scenario, the Bonded G.shdsl system can be used at each office location (branch or headquarters) with an appropriate number of G.shdsl lines enabled for each location to meet their bandwidth requirements. On the customer premises side, the Bonded G.shdsl CPE would be simultaneously connected to both the data LAN router and the PBX, while on the network side, the G.shdsl lines would be terminated at a standard G.shdsl-enabled DSLAM with ATM virtual circuits connecting remote locations to each other. This scenario is demonstrated in the diagram below. For service providers without substantial DSL deployments (and without a G.shdsl-enabled DSLAM), a second Bonded G.shdsl access device could be deployed in the central office to terminate the connection and forward traffic to the ATM cloud.

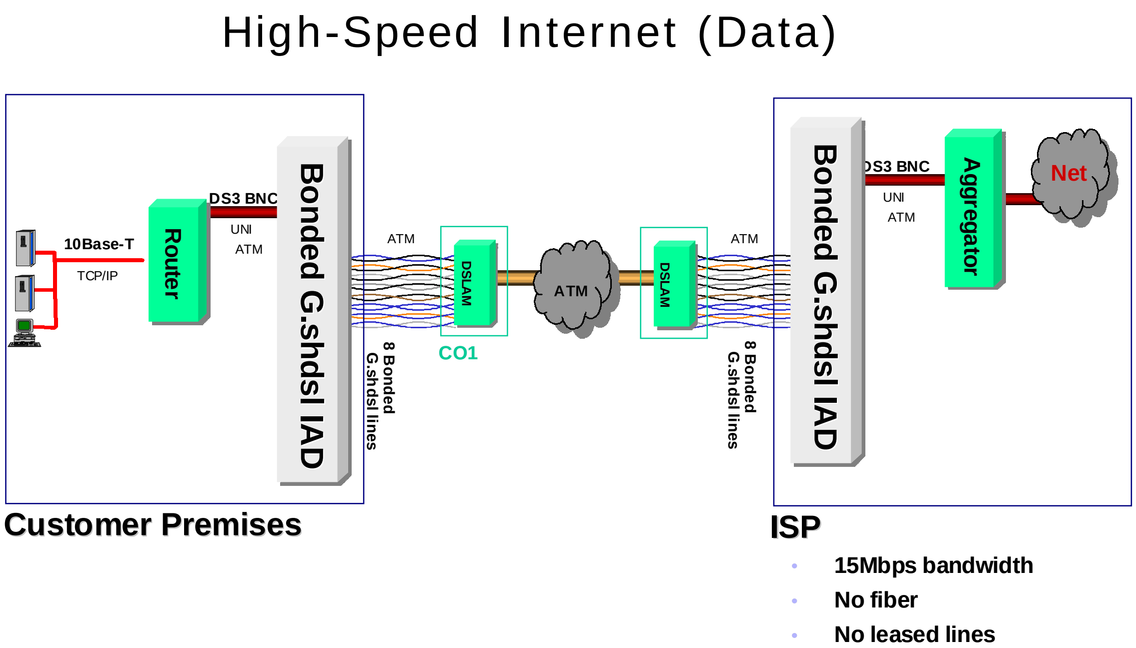
Figure 7: The Corporate Networking Scenario



High-Speed Internet

In a traditional Internet service model, Internet and other IP services would be carried between the central office G.shdsl-enabled DSLAM and the customer premises over multiple G.shdsl connections. In the customer premises, the Bonded G.shdsl access device would be connected to the customer's LAN through existing routers, while on the central office side, ATM virtual circuits would carry data upstream from the central office to the ISP's regional Point of Presence (POP). Bonded G.shdsl may also be used in this scenario within the ISP's network, providing the local transport between the ISP's POP and the central office where the customer's lines are terminated. Figure 8 demonstrates this application.

Figure 8: The High-Speed Internet Scenario



The Business Case for Bonded G.shdsl

Providing just data or just voice services alone is increasingly a commodity business. Service providers have two choices in today's market: (1) offer commodity services and try to survive in a low-margin business, or (2) move up the value chain and offer a full range of enhanced services to their customers. Many ILECs, IXCs, and ISPs are attempting to do the latter by becoming Integrated Communications Providers (ICPs).

What are the access requirements of an ICP?

- **A single connection to the customer.** Provisioning different access lines and their associated CPE is a nightmare scenario for an ICP. Indeed, the entire concept of the ICP is to move away from today's multiplicity of voice T1s, Internet access T1s, ATM private network access T1s, etc.
- **Bandwidth to provide multiple services over a single connection.** For a small business, a single SDSL or T1 connection may be adequate, but for MSBs a service provider will often need 10Mbps or more with the ability to increase bandwidth over time by quickly adding new circuits as needed.
- **Quality of Service (QoS) mechanisms.** For most ICPs (or potential ICPs), the QoS and guaranteed bandwidth of ATM services will allow them to provide for both bursty data transmissions and toll-quality voice connections.

Bonded G.shdsl provides exactly these things to the ICP—a new way of providing a reliable, high-speed link to the customer, at greatly reduced prices. As discussed earlier, many service providers have access fees totaling up to 40 percent of their overall expenses. Using Bonded G.shdsl over relatively inexpensive and easily obtained UNEs can bring about a 50 percent or greater reduction in access costs while providing a level of service unmatched by T1 or traditional DSL.

Table 2: The Business Case for Bonded G.shdsl

Technology	Bandwidth	Rev/Month	Meets MSB Customer Bandwidth Reqmts?	Outside Plant Required	CO Capex	Support for ICP Services
T1	1.5Mbps	$400-$800	No	2 UNEs	Medium	Limited (fixed allocation)
T1 IMA	3Mbps	$800-$1600	No	4 UNEs	High	Limited (fixed allocation)
SDSL	1.5Mbps	$250-$400	No	1 UNE	Low	Limited (VoDSL)
Bonded G.shdsl	10Mbps+	$1000+	Yes	Up to 8 UNEs	Low	Yes
Ethernet over Fiber	10Mbps+	$1000	Yes	Fiber to customer	High	Yes
T3	45Mbps	$15,000+	Yes	Fiber to customer	High	Yes

Why Choose Bonded G.shdsl?

For the service provider, Bonded G.shdsl provides:

- **An easy-to-provision service that competes with the offerings of new fiber-based service providers**, without the need to sink capital expenditures into new outside plant facilities. Bonded G.shdsl takes advantage of the installed base of copper plant, not requiring a new installation of fiber.
- **A service that can be provided anywhere in the service provider's network.** Unlike fiber-based systems, the copper-based telephone network is already in place and connected to just about all MSBs, allowing a ubiquitous service offering based on Bonded G.shdsl.
- **Ability to leverage existing capital equipment (such as DSLAMs) without a "forklift upgrade."** Most existing DSLAM and other central office equipment can be upgraded to support Bonded G.shdsl with inexpensive, incremental upgrades.
- **Limited impact on existing network services.** Because Bonded G.shdsl uses an international standard line code designed for low interference, it has very little impact on currently provisioned services like voice, T1, ADSL, etc. So a service provider can begin service introduction without worrying about service degradation or interruption to existing customers.
- **Support for the migration to a fully integrated network.** By offering a native speed 10Base-T data interface and support for dynamic allocation of voice bandwidth, Bonded G.shdsl solves the last-mile issue for service providers and allows them to offer truly integrated services over a single connection.

For the medium-sized business, Bonded G.shdsl allows:

- **Affordable bandwidth to bridge the T1 to T3 gap.** Services requiring higher bandwidths (like e-commerce and videoconferencing) are no longer out of reach for MSBs, with speeds up to 10 times faster than T1 available for less than twice the price of T1 and up to fifteen times less than price of T3.
- **A scalable solution.** Bonded G.shdsl services can be offered at bandwidths between 1.5 and 15Mbps and can easily be upgraded within that range by provisioning additional copper pairs.
- **Ubiquitous access.** Fiber services, such as T3 and Ethernet over fiber, are often difficult if not impossible to obtain for many MSBs. Because Bonded G.shdsl uses ubiquitous copper pairs and provides longer range than most SDSL and T1 solutions, it is available to a wider number of MSBs.

Throughout this paper, we have discussed the limitations of existing copper- and fiber-based access methods for medium-sized businesses. Many MSBs have outgrown their existing T1 and DSL connections but haven't grown into T3 in either bandwidth requirements or ability to pay for such services. Fiber-based Ethernet services would provide the perfect solution for many of these businesses, if only they were available. Using Bonded G.shdsl as a means of leveraging existing copper-based networks and connecting to the fiber backbone is a way for service providers and businesses to bridge this T-Chasm and meet today's and future communications needs.

Glossary

10Base-T. A 10Mbps Ethernet LAN that runs over twisted pair wiring. This network interface was originally designed to run over ordinary twisted pair (phone wiring) but is predominantly used with Category 3 or 5 cabling.

Asymmetrical Digital Subscriber Line (ADSL). BellCore term for delivery of digital information over ordinary copper phone lines. ADSL uses a system of frequency division whereby lower frequency POTS signals are delivered to the home unaltered while digital signals traverse the phone line at higher frequencies. Asymmetrical refers to the fact that the downstream (to the user) channels can outweigh the upstream (to the network) channels by a ratio as high as 20:1.

Asynchronous Transfer Mode (ATM). A protocol that packs digital information into 53-byte cells (5-byte header and 48 bytes of payload) that are switched throughout a network over virtual circuits.

Bandwidth. This is a reflection of the size or the capacity of a given transmission channel.

Binder Group. Cable pairs are typically arranged under the cable sheath in binder groups. The binder is a spirally wound colored thread or plastic ribbon used to separate and identify cable pairs by means of color-coding. The enclosed pair group is called a binder group. The groups are composed of insulated twisted copper pairs that are also twisted within each binder. Typically they are wrapped in 25-pair bundles.

Central Office (CO). A circuit switch that terminates all the local access lines in a particular geographic serving area; a physical building where the local switching equipment is found. xDSL lines running from a subscriber's home connect at their serving central office.

Channel Service Unit/Data Service Unit (CSU/DSU). A digital interface device that connects end-user data communications equipment to the digital local access lines such as T1.

Competitive Local Exchange Carrier (CLEC). A LEC that, when competition begins, has the less dominant position in the market; the carrier entering the market and challenging the ILEC market position.

Customer Premises Equipment (CPE). A wide range of customer premises-terminating equipment that is connected to the local telecommunications network. This includes telephones, modems, terminals, routers, set top boxes, etc.

Digital Subscriber Line Access Multiplexer (DSLAM). A CO device used to aggregate data traffic from many DSL subscribers into one high-speed signal for handoff to the data communications network.

Ethernet. A network protocol used to connect devices within a building or campus network at speeds of 10, 100, or 1000Mbps. Within the OSI model, Ethernet is defined at layer one (physical) and layer two (data link). Based on Carrier Sense Multiple Access/Collision Detection (CSMA/CD).

Fiber Optic Cable. A transmission medium composed of glass or plastic fibers; pulses of light are emitted from a laser-type source. Fiber optic cabling is the present cabling of choice for all interexchange networks and increasingly for the local exchange loops as well; it is high-security, high-bandwidth, and takes little conduit space.

G.shdsl. International Telecommunications Union (ITU) standard for Symmetrical DSL over a single copper pair. Provides speeds of up to 2.3Mbps per copper pair.

High Bit Rate Digital Subscriber Line (HDSL). Modulation method that enables T1 and E1 signals to be delivered over two and three pairs of copper wire respectively.

Incumbent Local Exchange Carrier (ILEC). A LEC that, when competition begins, has the dominant position in the market; the original carrier in the market prior to the entry of competition.

Integrated Access Device (IAD). A CPE device that enables simultaneous connection of both voice and data traffic to a network connection.

Interexchange Carrier (IXC). An IXC is a long distance telecommunications provider that offers a range of circuit-switched, packet-switched, leased line, and enhanced communications services; any company that provides communications services between exchanges on a long-haul basis.

Internet Service Provider (ISP). The telecommunications company providing subscriber access into the Internet.

Inverse Multiplexing over ATM (IMA). A technique for combining several access lines of a lower speed (such as T1) into a single virtual connection of a higher speed (for example 2 T1s for a circuit speed of 3Mbps).

Megabits Per Second (Mbps). A measure of bandwidth capacity or transmission speed. It stands for a million bits per second.

Point of Presence (POP). A POP refers to a node of an ISP or other NSP. A POP is usually a network node.

Quality of Service (QoS). Using ATM or other protocols, network traffic can be assigned different levels of priority in the network to assure minimum levels of throughput, latency, packet loss, and other performance metrics. QoS is often used within a network to provide higher levels of service for traffic such as voice and video that requires these higher levels of performance more than other types of data.

RJ-45. Eight-pin connector used to attach data transmission devices to standard telephone wiring. Commonly used in 10Base-T connections.

Symmetrical Digital Subscriber Line (SDSL). A DSL connection that provides equivalent upstream and downstream transmission rates. Most SDSL systems are proprietary and utilize a 2B1Q encoding scheme.

T1. This is a Bell system term for a digital carrier facility used for transmission of data through the telephone hierarchy at a transmission rate of 1.544Mbps. Typically provided over copper wire.

T3. This is a Bell system term for a digital carrier facility used for transmission of data through the telephone hierarchy at a transmission rate of 45Mbps. Typically provided over fiber optic cable or using microwave radio facilities.

Telco. A generic term for the local telephone company operator in a given area.

Unbundled Network Element (UNE). An ILEC-owned copper pair facility made available to competitive providers.