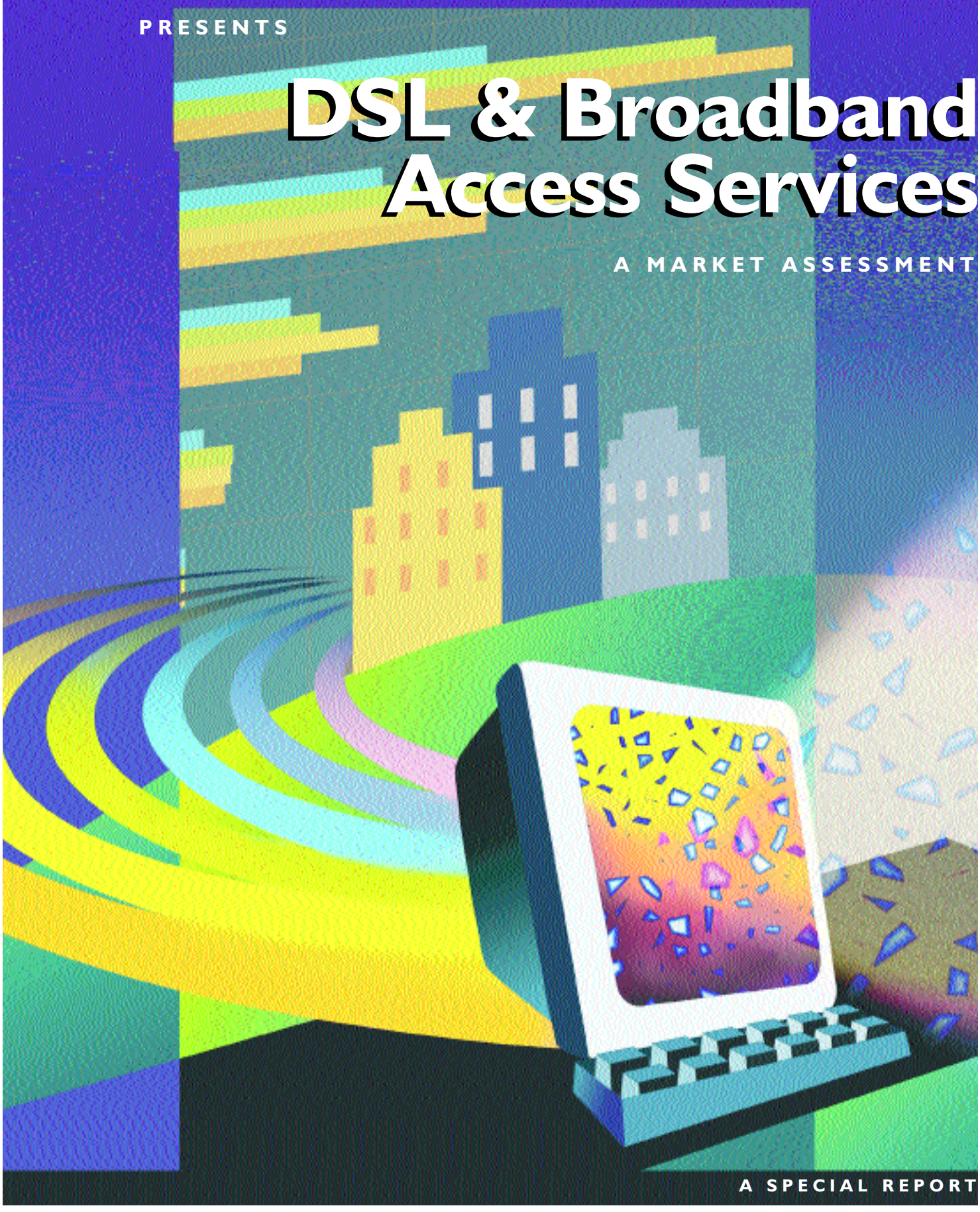
BROADBAND PUBLISHING

PRESENTS

# DSL & Broadband Access Services

## A MARKET ASSESSMENT



A SPECIAL REPORT

Letter from the Editor

## Dear Reader

Great News! Digital Subscriber Line services are taking off, growing so fast that industry analysts are revising their estimates. According to researchers at TeleChoice, the number of U.S. DSL lines grew 300%, to 160,000, during the first six months of 1999.

This rate of growth even exceeds that of cable modems, which grew by 60% during that same period. Still, with over one million cable modems deployed across North America, cable remains the leading form of broadband access for consumers.

The researchers also reported that the leading telephone companies have been hard at work upgrading their central office switching equipment to support DSL. Of the more than 22,000 central offices in the United States, over 15% are equipped for DSL. This means that as the service providers ramp up their sales and marketing efforts, the growth of DSL services will continue to increase, driven as it is by an insatiable demand for faster Internet access.

And we predict that in the not-to-distant future, small and medium-sized businesses will be the beneficiary of new Voice-over-DSL services that will offer significant price reductions for local telephony combined with high speed data access, all in one package, over a single access line.

So the good news is, no matter which broadband access technology prevails, the real winner will be the customer. A healthy competition now exists that will spur service providers of all types to offer faster, better and cheaper services.

That is why Broadband Publishing teamed up with AT&T to produce this comprehensive guide to DSL Broadband Access Services. At long last, the so-called 'last mile' to the home or office will no longer be the bottleneck to a truly enjoyable Internet experience. So sit back and enjoy the ride. It's going to be fun!

Best Regards,

David F. Hold, Executive Editor
Broadband Publishing Corporation

# Table of Contents




Publisher: Karen P. Hold
Executive Editor: David F. Hold

Writers: Curt Harler and Donell Short
Art and Design: Karen Rupkey, Typographics
Pru McDonald, Digital Illustration

This report was written and produced by the Broadband Publishing Corporation and sponsored by AT&T.

Broadband Publishing Corporation
P.O. Box 6535 Ketchum, Idaho 83340
T: 208-725-0600 F: 208-725-0854
www.broadbandpub.com



© 1999 Broadband Publishing Corporation

PRINTED IN CANADA

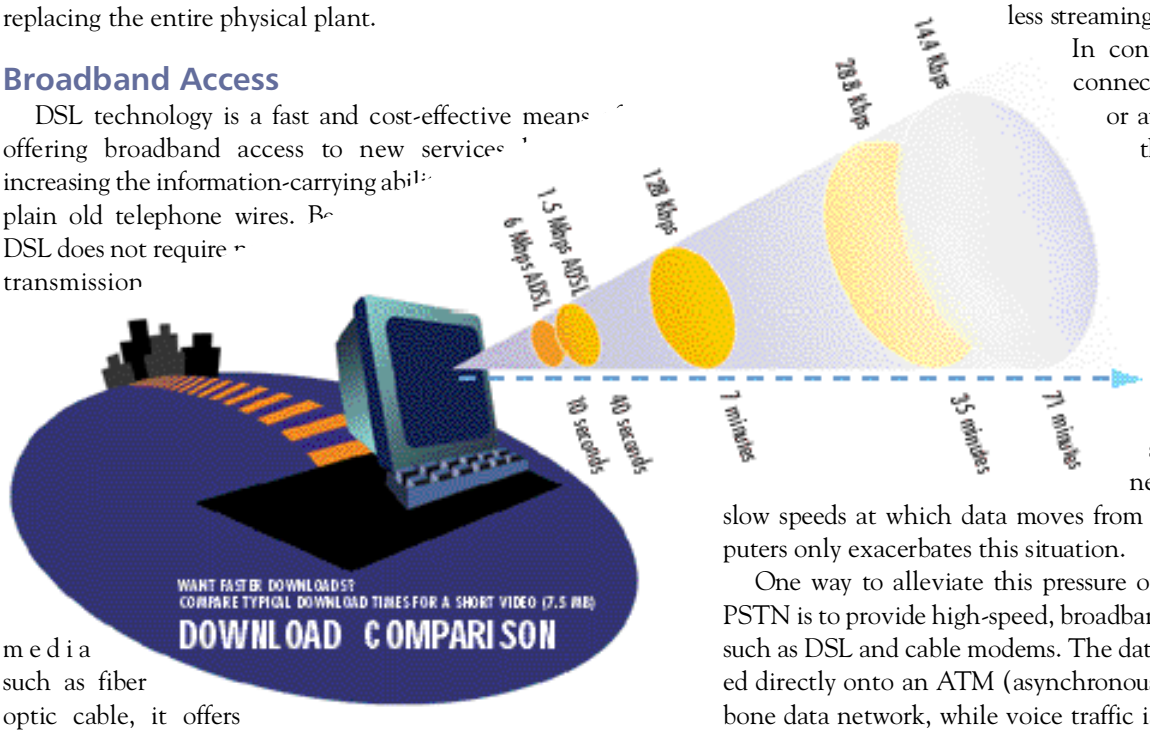
# What is DSL?

It seems that everyone is talking about DSL. But what is it? Well, DSL (digital subscriber line) is a technology that allows high-speed access to a variety of data and voice services over the existing copper, 'twisted pair,' telephone wires that run to most homes and businesses.

For most people, DSL's greatest promise is to reduce the eternity it takes to download files from the Internet. But it also offers solutions to strategic questions, like how to offer small office/home office (SOHO) workers, mid-sized businesses, telecommuters, and firms with branch offices, access to broadband communications without mortgaging the company. For telcos, it provides an elegant answer to questions about improving the performance of their copper network infrastructure without replacing the entire physical plant.

## Broadband Access

DSL technology is a fast and cost-effective means [illegible] offering broadband access to new services [illegible] increasing the information-carrying abil[illegible] plain old telephone wires. B[illegible] DSL does not require [illegible] transmission media such as fiber optic cable, it offers the possibility of broadband multimedia services, such as streaming video, Internet access, and even distance learning for everyone with a standard phone line.




That's why every RBOC (Regional Bell Operating Company), as well as numerous CLECs (Competitive Local Exchange Carrier) and even long distance carriers have committed to DSL. The local telcos like the fact that DSL lets them leverage their installed wiring to provide an inexpensive and immediate alternative to ISDN and cable modems.

In a typical application, DSL modems are deployed in pairs, one at a telco's central office, one at the customer premises. With DSL service in place, phone wires that were limited to 64 Kilobits per second (Kbps) throughput can carry megabits per second (Mbps). Users can receive multimedia transmissions many times faster than they can with today's typical 56 Kbps modems.

The number of business mergers and acquisitions related to DSL underscore the industry's interest. "DSL is on everyone's dance card," says Jeanne Schaaf of Forrester Research, Cambridge, Mass. Since the beginning of 1999, national CLECs like Covad and Northpoint have received equity investments from major interexchange carriers, she observed.

## The New Public Network

The current telephone network was designed to handle short duration voice calls, lasting five minutes on average. It was not designed to move enormous data streams of word processed documents, slide presentations, financial spreadsheets, and Internet home pages, much less streaming audio and video.

In contrast, today's Internet connections are "always-on" or at least for durations in the 15-minute to several hour range. The length of an Internet session thus changes the network traffic engineering models traditionally used to design the public switched telephone network (PSTN). The slow speeds at which data moves from Internet sites to computers only exacerbates this situation.

One way to alleviate this pressure on the circuit-switched PSTN is to provide high-speed, broadband access technologies, such as DSL and cable modems. The data traffic can be shunted directly onto an ATM (asynchronous transfer mode) backbone data network, while voice traffic is split-off to a gateway telephone switch.

## Access Alternatives

There are several alternative ways to move large volumes of data and video traffic. Cable TV (CATV) providers offer broadband services using cable-modem technology, but mainly in residential areas – not in office parks or industrial sections where businesses are located. Only about 25% of business locations are currently accessible by cable.

Still, for the casual or home user, CATV could be a solution to getting high-speed Internet access to homes and to those businesses where reliability equal to that provided by cable operators is acceptable.

Wireless service providers – including satellite and microwave operators – also are in the broadband access business, although these emerging technologies are in the early

stages of deployment. DSL trials have been on-going since the early 1990s, and the technology and deployment issues have evolved and matured over the years.

## DSL Deployment History

For small to mid-size businesses, as well as home workers, DSL offers a tremendous value proposition. However, the incumbent local telephone companies (ILECs), with a few exceptions, have been slow to roll-out DSL services, possibly due to the fear of cannibalization of existing ISDN and T-1 lines of business. Thus it appears that the local telco's business case for DSL has been to defend their traditional base of residential telephone customers from inroads by cable TV providers, who may seek to provide both data and voice services in the future.

## Battle for the Residence

This is evidenced by the fact that most of the incumbent's DSL offerings have been low-end consumer offers which typically support just a single user DSL modem. And the slow ILEC roll-out in the face of aggressive promotion of cable modem services by the cable companies has led some observers to predict that ADSL has already lost the battle for the residence.

However, over the past year, DSL deployment has been stimulated by an infusion of enthusiasm from national CLECs such as Covad, Rhythms, and Northpoint. It now appears that due to the interest generated by entrepreneurial CLECs combined with a new threat of incursion by the long distance carriers (IXCs), the ILECs are significantly stepping up their DSL provisioning plans for 1999.

Says Forrester's Schaaf, "To respond to the IXC's broadband push, RBOCs must deploy DSL with a vengeance."

And they appear to be listening. Bell Atlantic recently announced that it was increasing the pace of its DSL deployment, and will have 17 million lines equipped by the end of 1999. By the first quarter of the year 2000, as many as 1000 central offices in the northeast will be upgraded with DSL, covering a serving area of 21 million lines.

## Enter the IXCs

But the ILECs now have competition from the IXCs. For example, AT&T introduced business DSL services in July of 1999, and rolled out a wholesale DSL service in the Fall of 1999. AT&T expects to deploy more than 1,200 DSL PoPs (Points of Presence) nationwide over a 12 month period using their own facilities and those of other leading DSL providers. The wholesale service is targeted towards ISPs and other leading edge service providers.

Schaff says that RBOCs should double their investments in DSL. One suggestion would be to write installation contracts with value-added resellers (VARs), because as demand for DSL ramps up, many telcos are finding that they don't have sufficient field service personnel to turn up new customers.

## Technical Limitations

Some critics of DSL note that it never will be for everyone. DSL services can be deployed to a maximum of 70 percent of the houses in the U.S. since DSL can not be used where DLC (digital loop carrier) equipment has been installed. However, deployment to a sizable fraction of this 70 percent would reach millions of customers.

But many homes will still remain out of reach due to the distance constraints of DSL technology. Unlike the co-axial cable used for broadband CATV transmission, the twisted pair copper wires that extend to most households were intended to carry low frequency (typically 4 Kilohertz) voice. In recent years, telecom engineers have improved the ability to transmit high frequency signals over telephone lines for a limited distance without regeneration.

But line loss on copper wires increases with distance and frequency. The longer the loop length, the lower the bit rate, and vice versa. People living within one to three miles of a DSL equipped central office have the best prospects of getting high-bandwidth (T-1 or greater) services. Beyond that, the rate quickly drops down to ISDN-like (128-144 Kbps) speeds at best. In those areas, cable modems or even direct broadcast satellite services may be the only option for broadband communications.

Crosstalk – including line noise, interference and distortion – remains a technical problem. There are a half-dozen companies working on noise elimination software, which is creating a sub-market based on the opportunity to deal with noise abatement.

Technical issues aside, a more vexing question for most telcos is whether they will be able to support DSL across their organizations. Horror stories continue to be shared by consultants and consumers who contact their local provider to order DSL service only to be met with blank stares, and service provisioning is rarely a smooth process. The amount of training required to bring the local carrier's business offices up to date on this latest offering is huge. Likewise, the support infrastructure required to handle any mass deployment of the technology is nowhere near ready, and trained installers are already in short supply.

## DSL Market Estimates

Marketing DSL works. By the end of 1998, estimates of DSL lines in service were less than 100,000. This compares to nearly 500,000 cable modem customers. By May of 1999, however, The U.S. Telephone Association (USTA), Washington, D.C. put the number of switched-on DSL lines at 142,000. Mid-year 1999 figures from a number of consultants and analyst firms all float around the 150,000 line number.

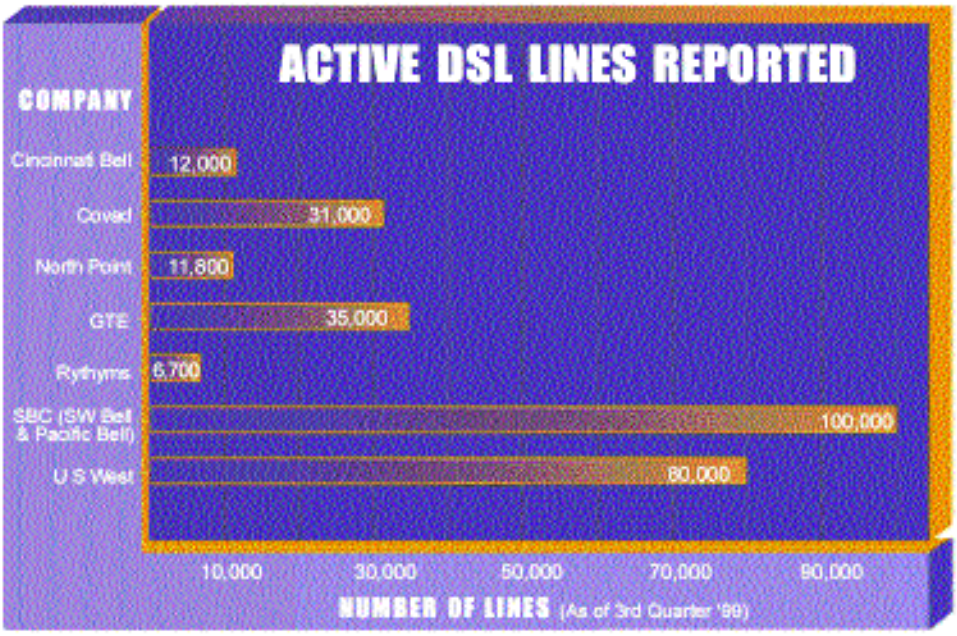
By the third quarter of 1999, US West had sold 80,000 lines; SBC had 100,000 lines; GTE, 35,000 lines; and Cincinnati Bell had 12,000. US West is adding 10,000 new DSL lines every month. In contrast, the three leading CLECs had about 50,000 lines deployed.

There is some evidence that consumers are sensitive to the price of their broadband connections. This is no surprise, but the degree of price elasticity of demand is interesting. For example, US West recently cut its prices by 20 percent and saw a doubling of sales.

## Consumer vs. Business

Forrester's Schaaf divides the market into consumer and business (including SOHO) markets. At year-end 1999, she forecasts 350,000 consumer lines, 70,000 business. Those numbers are projected to grow to 720,000 consumer and 253,000 business lines. By the year 2003, Forrester estimates that this market could reach 7.74 million consumer and 1.83 million business lines, for a total of 9.5 million DSL lines in service. The Yankee Group, Boston, Mass., puts its 2003 figure at 6.21 million lines.

And the business SOHO market may be under reported, says the research firm TeleChoice (www.telechoice.com). It appears that many home office workers are finding that the cheaper, consumer DSL packages are more than adequate.




## DSL to the Treadmill?

Now you can surf the web, watch personalized TV, listen to music CDs, track workout results, read email and earn frequent flyer miles all while working out. A national chain of health clubs is installing DSL-enabled workout machines that will offer color touch screen monitors for audio/visual Internet access.

## Businessvs.Consumer Benefits/Applications

Today, the greatest demand for DSL is for affordable, high-speed Internet access for residential and small offices. The minimum price for residential DSL service continues to drop and is now in the $30-$50 per month range.

Home users want speed, but are only willing to pay about $37 a month on average, according to a study by Dataquest, San Jose, CA. Businesses, on the other hand, are willing to budget $500 a month. They not only are accessing Web sites, but also may be hosting them and, given exposure to T-1 lines, are apt to demand higher speed service.

Users save time from faster downloads which range from 10 to a 100 times faster (at 600 Kbps to 6 Mbps) than a 56 Kbps modem. This is important for speeding up large file transfers, viewing high resolution images and enabling multimedia applications such as streaming audio/video. Future applications may include video conferencing for distance learning, video-on-demand (VoD), and other demanding uses like collaborative computing.

"The demand for speed far outstrips what is available now," says Tim McElgunn, DSL Industry Analyst for Telecommunications at Dataquest. In a 1998 report, he noted a bevy of market drivers, both on the business and on the consumer side of the market.

Driving the demand for business DSL, McElgunn points to such factors as the rise of the "virtual corporation," productivity improvements, facilities costs, environmental and regulatory issues (such as anti-pollution rules and incentives to encourage workers telecommuting). These and lifestyle changes towards more work-at-home are major drivers causing businesses to push the envelope on network speed.

## The Business DSL Market

According to a recent report from The Yankee Group (www.yankeegroup.com) there is a substantial market for delivering DSL services to small and medium-sized businesses, even though most of the attention thus far has been focused on residential ADSL services. In the business context, DSL is seen as the leader among high-speed alternatives for filling the gap between ISDN and T-1 services.

An executive for one of these new CLECs, explained why they preferred business DSL services saying, “it’s hard to make money at $39.95 a month.”

The Yankee Group predicts that thanks to the efforts of a new class of data-oriented CLECs, the number of business DSL subscribers will increase at a CAGR of 115% between 1998 and 2002.

## Voice - The New DSL driver

One of the latest developments in DSL technology is the ability to provide multiple voice channels in addition to a high speed data channel. ADSL was always intended to have one channel reserved for voice, but new products are available that will deliver a dozen or more voice lines, plus a high-speed data circuit, over a single, synchronous DSL access line. VoDSL services should be an ideal match for the needs of small businesses and branch offices.

Small businesses spend $36 Billion annually for local voice services, and $3.7 Billion for data services, according to IDC. That’s why many DSL startups are targeting the VoDSL market.

## Consumer DSL Applications

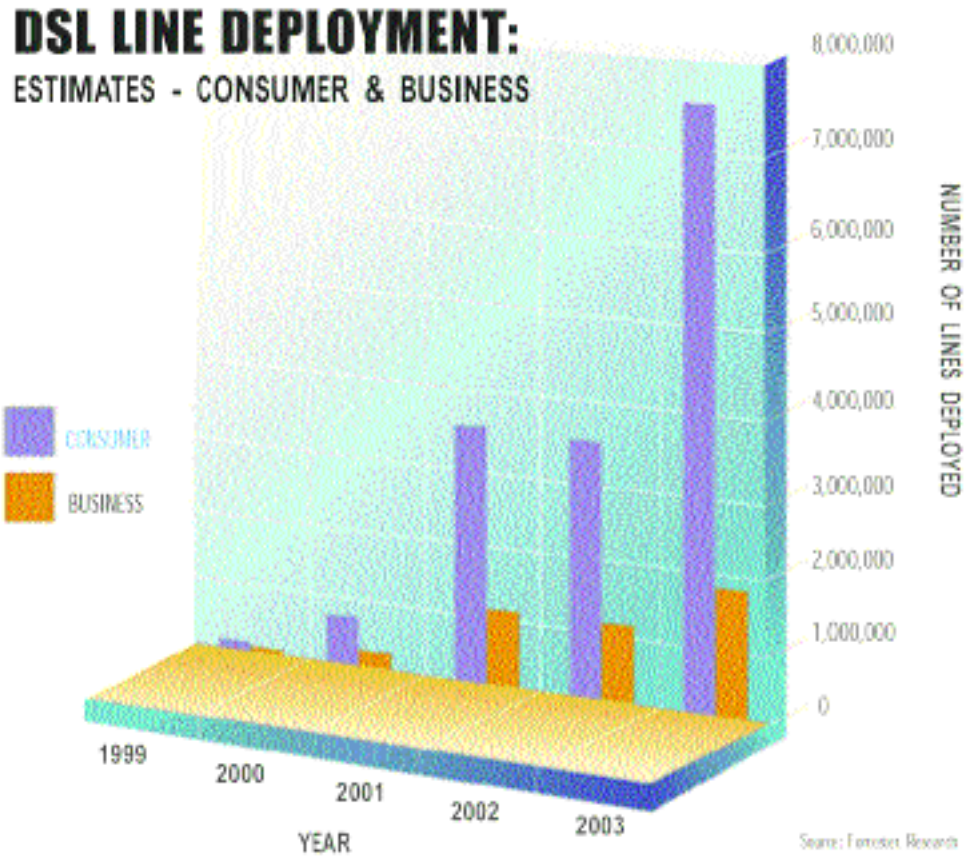
On the consumer side, the major stimulus is the craze to get onto the Internet. Awareness and interest in the Internet is at an all-time high and people are flocking to chat rooms, on-line auctions, and financial sites in record numbers. "Edu-tainment" is McElgunn's term for a blending of educational opportunity and entertainment available on the Net.

On the downside, cost remains a factor, and many people cite time binds and difficulty of use as reasons for staying off the Net. But slow response times and technical limitations are the basic reasons for this complaint.

Distance learning – bringing expert lecturers, professors or trainers to remote sites via video – is another key marketplace for DSL. ADSL supports live video to remote classrooms over standard copper wires, which avoids the expense of running fiber to school buildings.

## Always On

The perceived benefits of DSL are enhanced by ‘always on’ connectivity. This is a major convenience advantage which simplifies the work experience. Many early trial users rate the convenience of not having to establish a dial-up connection as important as the fast download speed.



# The Many Faces of DSL

Known collectively as xDSL, there are several forms of DSL, as explained below. Generally, Asymmetric DSL (ADSL) is best suited for applications patterned on a client-server model. In such cases, most of the information is sent downstream from host to client; the upstream channel can support less traffic. ADSL is thus well suited for Internet applications such as web browsing.

Symmetric forms of DSL, such as HDSL and SDSL, are more effective for business applications that require a symmetric, or equal, bi-directional link, such as LAN interconnection or video conferencing. Here are the main members of the DSL family:

## ADSL

ADSL offers the fastest data rates, from 1.5 Mbps to 8 Mbps, but only in one direction. In the other direction, it is slower – from 16 Kbps-640 Kbps. That unbalanced flow is part of the attraction of ADSL. Jennifer Pigg, senior vice president for data communications with the Yankee Group, sees ADSL being widely deployed by the incumbent local telephone companies.

"It will not be exclusively deployed by ILECs or RBOCs, but since ADSL is targeted at the residential market where the ILECs have the best access, they will have the majority of the market," Pigg says.

ADSL was designed at a time when the RBOCs were planning to provide video-on-demand (VoD) services to compete with cable TV operators. Thus, ADSL's downstream rates were specified at up to 6-8 Mbps, because a single MPEG2 compressed video stream requires 3-4 Mbps. With ADSL, multimedia services can be provided to anyone with a phone line.

The appeal of VoD as a practical service has since faded, but the Internet has taken its place as the new 'killer app.' ISPs are a key market for ADSL adoption since it allows their customers to connect to the Internet at relatively lower speeds, and to download large files at very high rates. In addition, the user can make or receive a single telephone call while on-line.

## How Does DSL Work?

As is often the case with emerging technologies, there are multiple technologies underlying the installed base of DSL equipment, not all of them compatible. For example, more than one line coding method is in use today. The most popular are DMT, CAP and MVL.

The Discrete Multi-Tone (DMT) system developed by Bell Labs is the modulation technique specified in the ANSI T1E1.4 standard, and being the approved standard, DMT is the most viable long-term solution. CAP (carrierless amplitude phase modulation) technology is a simpler and less complex defacto standard which preceded DMT. A more mature technology, CAP-based equipment was used in most early deployments of DSL services.

CAP DSL also was developed by Bell Labs. It was the first ADSL transceiver to be commercially deployed and early-on in the U.S. market could legitimately claim installation on more lines than any other ADSL technology. CAP technology is a variation of Quadrature Amplitude Modulation (QAM) a modulation technique to encode signals by modulating amplitude to represent data, which is the technology used by most modems.

With CAP, the three channels (POTS, downstream data and upstream data) are supported by splitting the frequency spectrum. Voice occupies the standard 0-4 kHz frequency, followed by the upstream channel and the high-speed downstream channel. Some RBOC implementations to date are mainly CAP-based. This is no problem as long as matched modem pairs are used. However, DMT rules the market today.

DMT technology divides the three channels into a large number of equally spaced subcarriers (typically 256), each of which can be individually modulated by QAM with a variable number of levels. With DMT, the number of bits per carrier is assigned based upon channel capacity. With so many sub-carriers available, DMT-based modems can assign traffic to those with the least noise or interference.

DMT designers had the advantage of being able to buy chips from several vendors while CAP chips came from a single vendor. DMT was the more robust of the pair. It offers an extra degree of freedom in noise adjustment. DMT measures the entire frequency of the line and uses the best 4 kHz available for the voice channel. DMT also offers finer granularity when stepping up or down its transmission rates, and supports higher data rates, up to 8 Mbps.

G.Lite is perhaps the newest of the technologies. An ITU standard, it supports ADSL-style service based on DMT. Operating at a lower-line rate, up to T-1 or E-1 (1.5 - 2.0 Mbps), G.Lite does not need a splitter at the customer premises, which means customers can do-it-themselves.

Also on the market is a proprietary product from Paradyne called MVL, or Multiple Virtual Line. Based on CAP technology, it is basically a proprietary version of G.Lite. "MVL is a competitor to G.Lite," says Claudia Bacco, a Dallas,Texas-based analyst with Telechoice.

The maximum working distance for ADSL is about 18,000 feet (18 kilofeet). That puts it within reach of the majority of homes and small businesses served by urban or suburban central offices.

## G.Lite

G.Lite is the common way to refer to a standards-based at-home version of ADSL. G.Lite – approved by the International Telecommunications Union (ITU) early in 1999 – is slower than 'full-rate' ADSL, but is still eight to ten times faster than ISDN.

Called 'splitterless' DSL by some vendors, it is designed to be installed by small office or home users who can buy the modem from their service provider or at an electronics store. Several large computer manufacturers have been pushing this standard in hopes of an 'ADSL Christmas' with DSL modems or specially equipped PCs becoming an under-the-tree option to boost year-end sales.

Since it is primarily a consumer market product, Pigg expects the RBOCs and ILECs to be the leaders. "Clearly, G.Lite will be the most aggressively marketed product, along with HDSL-2," Pigg says. She sees it as one of the largest markets for DSL.

Claude Romans, director for loop access at Ryan Hankin Kent in South San Francisco, CA says the G.Lite product is being successfully deployed by telcos. Telcos install a DSL access multiplexer (DSLAM) in the central office equipped with line cards that handle either G.Lite or full-rate ADSL.

Compaq and Dell are also installing G.Lite-compatible modems in their computers, he points out. This will make installation even easier for the consumer.

"As the telcos cost per port drops, you will see more implementations of mature or regular ADSL, as well," Pigg concludes. Indeed, Alcatel claims to have a working implementation of a full-rate ADSL modem that is also splitterless.

A proprietary competitor to the G.Lite standard is Multiple Virtual Line (MVL) from Paradyne. It is based on CAP technology. "It is not going to operate with any G.Lite solutions," notes Claudia Bacco, of Telechoice. She says this will limit the success of MVL in the U.S. market. In other countries the MVL offering may have more success.

The biggest single advantage of the splitterless design of G.Lite or of MVL is that both will reduce installation costs. Standard forms of ADSL require a 'truck-roll' (service visit) and technician time to install a splitter to separate the voice and data at the customer premises.

Early trials of this splitterless technology have showed that the consumer is successful in completing a self-installation in 80-90 percent of all cases. This savings of telco labor are crucial to any hopes of mass deployment to millions of customers, since there are simply not enough installers to visit hundreds of customers every day.

Since G.Lite is a rate-adaptive technology, it will allow the telco to provide tiered services (at tiered costs) to its customers. Being rate-adaptive means that it is more forgiving of variable line quality that is often less than that found in laboratory conditions.

## RADSL

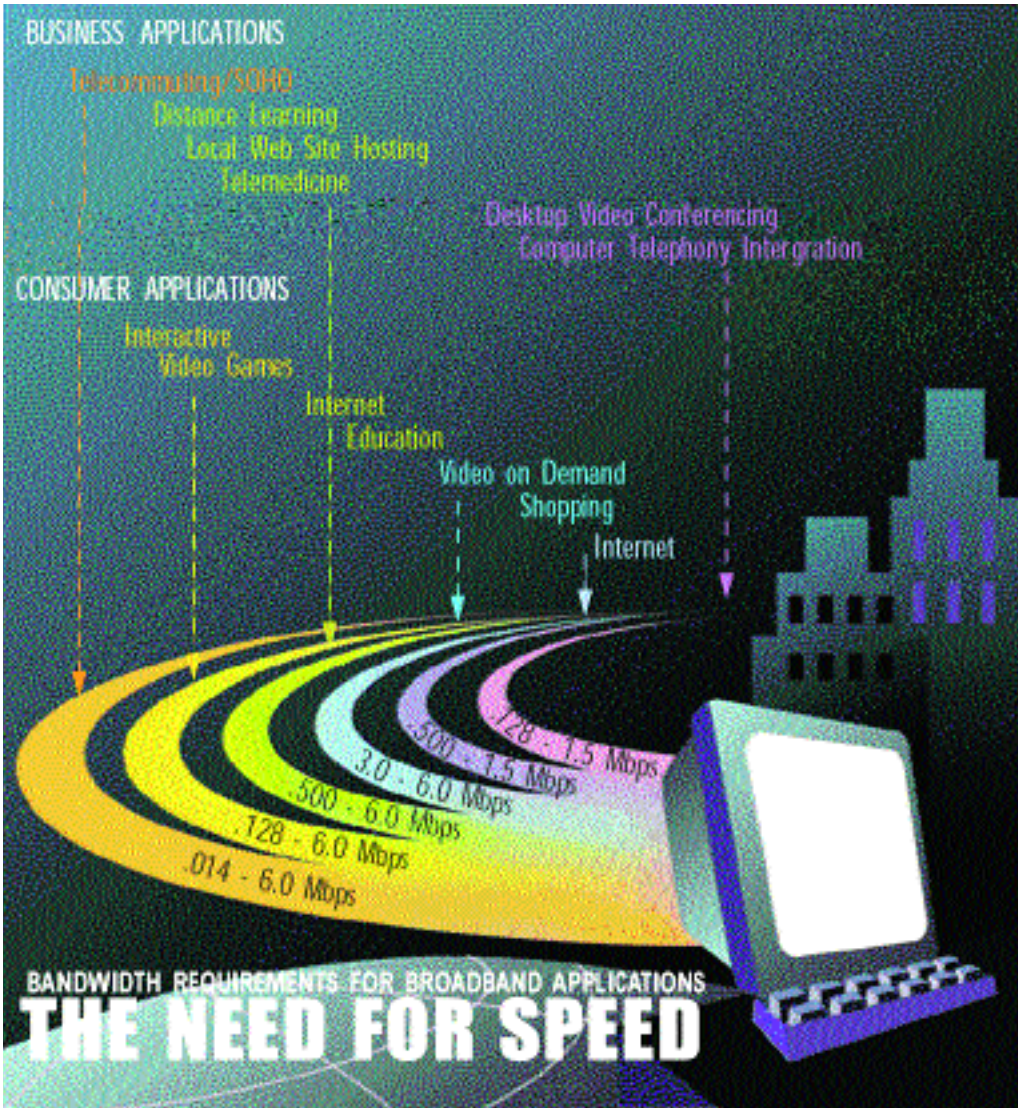
RADSL (rate-adaptive DSL) is the rate-adaptive version of ADSL. RADSL sends and receives data at rates comparable to standard ADSL, except that if line conditions are less than optimal, it will step down the data rate to one that can be supported. By doing so, RADSL extends the distance the subscriber can be from the central office.

**xDSL FAMILY MATRIX**

| Type | Mode | Data Rate Send | Data Rate Receive | Line Code | Physical Media | Maximum Distance | Application |
|---|---|---|---|---|---|---|---|
| ADSL | Asymmetrical | 16 - 640 Kbps | 1.5 - 8 Mbps | CAP/DMT | 1 Wire Pair | 18 K ft. | Web Surfing, Downloads VoD, Distance Learning |
| G. Lite | Asymmetrical | 500 Kbps | 1.5 Mbps | G. Lite | 1 Wire Pair | 18 K ft. | SOHO and advanced home Internet applications |
| RADSL | Asymmetrical | 16 - 640 Kbps | 1.5 - 8 Mbps | CAP/QAM | 1 Wire Pair | 18 K ft. | Same as ADSL |
| HDSL | Symmetrical | 1.5 - 2 Mbps | 1.5 - 2 Mbps | 2B1Q | 2-3 Wire Pairs | 12 K ft. | PBX & T-1 access |
| HDSL-2 | Symmetrical | 1.5 - 2 Mbps | 1.5 - 2 Mbps | OPTIS | 1 Wire Pair | 12 K ft. | PBX & T-1 access |
| SDSL | Symmetrical | 128 Kbps - 1 Mbps | 128 Kbps - 1 Mbps | 2B1Q | 1 Wire Pair | 10 K ft. | Small/med business applications; integrated LAN & telephony access |
| VDSL | Asymmetrical | 1.5 - 2 Mbps | 13 - 52 Mbps | NA | Fiber/Copper | 1 - 4 K ft. | ATM & Switched Digital Video in FTTC architecture |
| IDSL | Symmetrical | 144 Kbps | 144 Kbps | 2B1Q | 1 Wire Pair | 18 K ft. | ISDN applications |

Previous DSL technologies were limited to 18,000 feet. RADSL changes that assumption by dropping the rate and extending the distance. For example, RADSL can provide a customer at 21,000 feet with 600 Kbps downstream and 128 kbps upstream. Since RADSL extends the permissible distance to the subscriber, the resulting addition in the number of homes serviceable by the telco means more revenue.

Unfortunately, RADSL is based on the now-bypassed CAP modulation, so it is expected to take only a small part of the DSL market. Fortunately DMT is also rate adaptable.




## HDSL

HDSL (high-bit-rate DSL) is symmetrical, with data rates of 1.5 Mbps to 2 Mbps in both directions and is useful for applications like operating T-1 (1.5 Mbps) phone lines through existing wiring. "HDSL will be deployed as T-1 replacement over copper to small and mid-sized businesses," Pigg says. In addition to the ILECs, she expects to see CLECs deploying HDSL and HDSL-2.

"But keep in mind that it is copper-based technology," she reminds. "In many cases the CLECs have fiber installed for major customers. But for the smaller buildings which still are using copper technology, this will be a solution." Usually, repeatered T-1/E-1 gives poorer signal quality than fiber optics and HDSL. Troubleshooting repeaters is costly. To reconfigure repeatered T-1/E-1 lines for additional services, repeaters must be removed at additional cost.

HDSL is the quickest and most cost-effective option to deploy T-1/E-1 circuits because it allows provisioning high-speed digital services over the existing copper in a day's time. HDSL transports full duplex T-1 or E-1 (2.048 Mbps) on copper without repeaters. It works best to a distance of 9-10 thousand feet.

To get HDSL running, a single HDSL-compatible card is installed at the central office and another as CPE. HDSL creates a mathematical model of the copper wire, allowing the transmission device to compensate for copper-based distortion. This adjustment happens continuously, so the signal does not degrade as conditions change.

HDSL in the United States is based on 2B1Q (two binary, one quarternary) line encoding, although there is some CAP-based HDSL internationally. At present T-1 HDSL requires two pairs and E-1 HDSL requires three.

RHK's Romans says that HDSL has been more successful than ADSL to date, although it is invisible to the end-user. The principal application is for business, not consumer use. "There are 600,000 HDSL modems shipped," he states, "but this is mostly for PBX connection and T-1-WAN connectivity so it is largely unheralded."

## HDSL-2

HDSL-2 is a newer version of the standard which will provide 1.5 Mbps speeds on a single copper pair. The T1E1.4 committee targeted HDSL-2 as offering 12,000-foot reach, spectral compatibility with other services in the same cable, and equipment interoperability. HDSL-2 can also coexist with ADSL.

## SDSL

SDSL (symmetric DSL), as the name suggests, provides symmetric – bi-directional, high-speed, variable rate communications on a single phone line. Many think of it as a variation on HDSL-2.

SDSL addresses business applications which require a symmetric data rate – such as accessing servers and for remote LAN access – where HDSL might otherwise be needed. SDSL data rates range from 160 kbps to 2 Mbps, with transmission rates typically running at 384 kbps in each direction.

Basically, SDSL is a single line version of HDSL, transmitting T-1 over a single twisted pair which then can support POTS (plain old telephone service) and T-1 at the same time. Sometimes SDSL is called Single-Line Digital Subscriber Line (HDSL over a single telephone line). This name has been adopted by a single vendor, not a standards group, and may not stick. SDSL is best suited to small and medium-sized businesses.

When comparing SDSL to ADSL, note that SDSL will not extend much beyond 10 kilofeet, a distance over which ADSL achieves rates above 6 Mbps. The question of whether SDSL or HDSL-2 will drive this sector remains open, and since the two are similar may eventually become a moot point.

## VDSL

VDSL (very high-speed DSL) is super-fast, with 51 Mbps throughput for short distances in one direction, and 1.6 Mbps in the other. VDSL uses asymmetric transceivers at data rates higher than ADSL but over shorter lines. The closer the customer is to the central office, the higher the data rate. VDSL can deliver data rates of 13 Mbps at distances of 5,000 feet. The data rate doubles if the customer is only 2,000 feet from the central office, and doubles again to 51 Mbps for customers located within 1,000 feet of the switch.

One proposed implementation of VDSL is in the final few hundred feet to the home in an FTTC/FTTH (Fiber-to-the-Curb/Home) architecture. But Bell Atlantic did some early VDSL trials and abandoned it since it was not cost effective for them. "They did not see huge demand, either," Pigg says. "In general, we don't consider that it will take over the world any time soon."

However, VDSL has some advantages over ADSL, including simplicity. Shorter lines impose fewer transmission constraints, so the basic transceiver technology is much less complex, even though it is ten times faster. VDSL is targeted towards ATM (asynchronous transfer mode) networks, and

## DSL Deployment & Marketing Challenges

**A senior executive for a western regional Bell operating company recently told the International Engineering Consortium's xDSL ComForum that their biggest marketing challenge is finding enough installers for the service. "We're averaging 500 sales (of DSL services) a day," he said. "When you think about 500 sales a day, there aren't enough installers in the world to do it."**

**The savior is self-installation. About 90 percent of the company's 40,000 subscribers did their own installations without a truck roll. "We've been somewhat lucky in that the early market has consisted of a lot of early adopters who have been willing to do this," he says. The consumers' biggest fear seems to be removing the lid on computers and tinkering with what is inside.**

**"For DSL to become a mass-market success, it has to be something where you can drop ship the modem to the customer, they can plug it in, install a couple of filters, and run with it," he said. He says installing the NIC (network interface card) is the hardest part of the job. "This is because the splitterless system we use requires the PC to have a compatible Ethernet jack," he continues. Unfortunately, most home PCs aren't equipped with Ethernet modems.**

**One answer to this challenge is to eliminate the need for a NIC by going to a USB port on the modem which can be plugged into a compatible USB port on the PC. The G.Lite standard, developed by the International Telecommunications Union (ITU), will allow this.**

### Understanding the Customer

**While analysts concede that the revenue potential does make sense from a purely academic standpoint, key issues remain about what the services will be and how much money the carriers will truly make. Writing in the July 1999 COMMUNICATIONS NEWS, Dan Taylor and Bart Taylor pinpointed the toughest questions: What will make consumers change their behavior about how they watch movies: price, convenience, preference, or something else? "Any replacement technology needs to offer better value and commodity, packaged pricing of goods and services," they maintain. "For now, there are no solutions compelling enough to force a wholesale change in consumer behavior for video programming." So it appears that Internet access will remain the killer application for residential DSL.**

also allows passive network terminations, so more than one VDSL modem can be connected to the same line, like adding extensions to voice phone lines.

Dan Taylor and Bart Taylor, analysts with Giotto Perspectives, Brighton, MA, predict a resurgence of VDSL based on the future growth potential of VoD. They note that the CLECs have gained funding from bankers and venture capitalists "apparently struck amnesic by a dazzling display of high bandwidth" for a number of VoD initiatives.

However, Giotto expects to see fewer than five million households with VDSL service by 2009. "If two or more carriers have to share this small subscriber base, the business will be slim pickings," they note.

"I don't think VoD is real," argues RHK's Romans. While he admits that the US West trials in Phoenix are attracting attention, he sees no flood-tide of consumers to VoD. "People have been talking about it for a long time," he says, indicating that it will be even longer before it becomes a wide-spread reality.

On the good-news side, chipsets for VDSL are available today in UDP (Universal Deployment Prototype) designs.

## IDSL

IDSL is DSL using ISDN chipsets. This provides the longest reach of any DSL variant, although at slower speed. Beyond 18,000 feet, typical DSL applications break down, but IDSL can still function. However, IDSL delivers only 128-144 Kbps speeds where other DSL technologies can reach 10 times that speed over shorter distances.

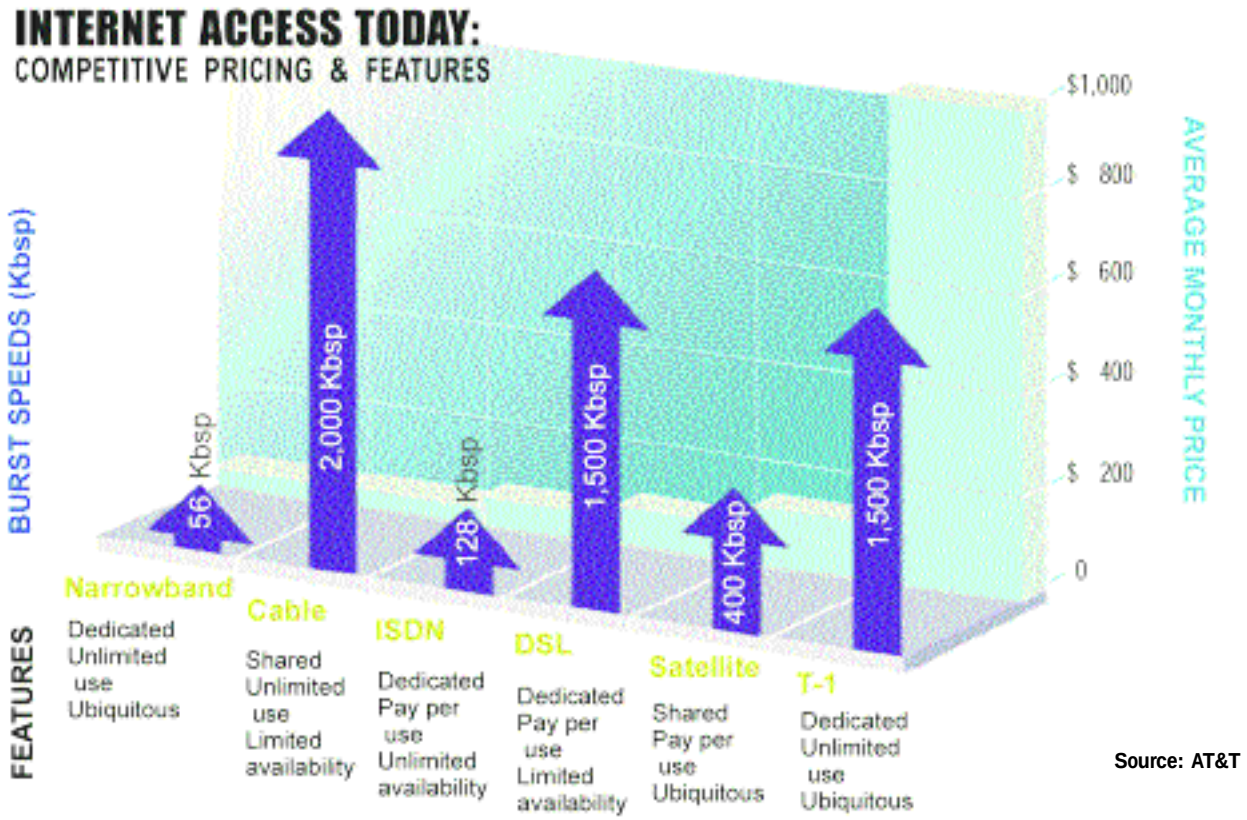
"RBOCs lead in this category in the number of subscribers," Romans says. However, the total is small compared to SDSL and others. The primary market for IDSL will be to reach those subscribers who are beyond the limited range of the faster DSL types, since it has virtually no distance restriction.

## VoDSL

VoDSL (voice over DSL) is an emerging technology that will allow transmission of both voice and data over DSL lines. The key part of this technology is the voice side of the offering. "The CLECs are working on implementing voice and data," Pigg says. "This will allow them to compete with the bundled voice/data solutions of the RBOCs."

The target market is the millions of small businesses with 5-to-25 workers - branch offices are but one example. A CLEC could offer to supply half-a-dozen voice lines plus high speed internet access, all over a single access line, at a fraction of the price that the ILEC would charge for traditional services. The ability to provide an integrated, bundled voice and data service also helps to reduce churn, or high customer turnover, which can be deadly to CLECs struggling to build a revenue base.

She notes that the service still faces technical difficulties. However, for VoDSL those limitations are not so much distance and speed problems but rather solving ticklish CAP vs. DMT integration issues and finding ways to provision VoDSL service without an expensive truck roll (a real advantage of ADSL's G.Lite and MVL services). A splitterless, twisted pair copper solution would be the optimum solution for VoDSL.




Source: AT&T

# AT&T DSL Services

The intention of the Telecom Act of 1996 was to foster competition in the local loop. Prior to the Act, the only competitive local services came from fiber-based access providers, such as the former Teleport Communications Group (TCG), who installed fiber rings in metropolitan areas for their business customers. With the unbundling of the local loop as called for in the Act, consumers and businesses in many areas now have a choice of competitive local service providers.

The first CLECs were venture-capital backed start-ups,but with the standardization of DSL technology, the leading inter-exchange (long distance) carriers are now entering the market. As the nation's largest provider of communications services, AT&T is determined to offer a full range of competitive local access services, including Cable Modems, Digital Subscriber Line (DSL), fixed-wireless and even satellite-based communications.

Beginning in the third quarter of 1999, AT&T began rolling out DSL services in major cities around the country. AT&T plans to have services available in no less than 40 metropolitan areas by the end of 1999, and over the next 12 months will activate more than 1200 DSL PoPs (points of presence.)

## Wholesale & Retail

DSL services for 'retail' business customers were launched July 30, 1999 following DSL trials with business customers in a number of major cities, including Boston, Chicago, Los Angeles San Francisco, San Jose, Oakland, Santa Cruz & Santa Rosa and Seattle.

AT&T will also offer DSL services to 'wholesale' customers, such as ISPs and on-line service providers, as part of the AT&T Private Label IP Portfolio. These service providers will then be able to offer high-speed Internet access packages to their customers. Wholesale DSL service will initially be available, beginning in the Fall of 1999, in nine markets: Boston, Los Angeles, New York, Philadelphia, Sacramento, San Diego, San Francisco, Seattle and Washington, D.C.

## Build or Buy

In order to make DSL services available to its customers in the shortest possible time, AT&T will pursue a 'build-or-buy' strategy. In many areas they will provide DSL over their own local access facilities, including those of the former Teleport Communications Group which AT&T acquired in 1998, while in other areas the company will resell DSL services from a variety of facilities-based providers, including Covad, a national DSL service provider.

## Speeds & Feeds

AT&T will offer three flavors of DSL service: ADSL, IDSL, and SDSL. With those three services, AT&T expects to be able to achieve nearly 100% coverage, with ADSL targeted at residential users, SDSL for the business customer, and IDSL for more distant locations where the first two are not available. G.Lite may also be offered at a later date, depending on the availability of suitable CPE.

DSL access speeds will range from 144 Kbps to 1.5 Mbps, depending on the type of service offer. Business rates are symmetric, ranging from 144 Kbps to 1.1 Mbps. There is also a high end, asymmetric offering of 1.5 Mbps downstream and 384 Kbps upstream. Consumer access rates are asymmetric, ranging from 128 Kbps upstream, 348 Kbps downstream, to 384 Kbps upstream, 768 Kbps downstream.

These sub-T-1 access speeds were selected because AT&T believes that is the 'sweet-spot' of the bandwidth market, particularly for small and medium-sized businesses. Although many people think that DSL services will provide low-cost competition for T-1 leased lines, AT&T executives are not convinced. T-1, based on TDM circuit switched technology, still provides a higher, more consistent level of throughput than an equivalent DSL line, because of the amount of aggregation that occurs between the customer, the CLEC's DSLAMs, and the ILEC backbone networks. They see DSL services offering the potential to cannibalize the market for sub-T-1 rate leased lines and ISDN.

## Service Pricing

AT&T's DSL service pricing will vary depending on type of service and speed, but will be competitive with other service providers.

## Applications

AT&T plans to make a variety of IP-based services available to its DSL subscribers. These include access to the public Internet, plus LAN or Intranet access by remote users or telecommuters, as well as IP-VPNs and Extranet applications. Large businesses in particular are expected to use DSL as a means to connect remote and branch offices to IP-VPNs. AT&T will also offer value-added features such as SLAs (Service Level Agreements) for their DSL customers. This will be a differentiating feature, since very few ILECs currently offer any type of SLA on DSL services.

## One Stop Shopping

In addition, AT&T predicts that in the not-too-distant future, small and medium sized businesses will be able to take advantage of Voice-over-DSL services. New equipment coming to market will provide, for example, a half-dozen RJ-11 telephone jacks and an Ethernet port, so small business users can receive telephone service plus high speed Internet access from a single provider, at a lower cost than would be possible buying separate voice and data services. VoDSL is consistent with AT&T's 'one-stop-shopping' strategy, which seeks to offer customers the ability to purchase all local and long distance voice and data services from one provider.

## Broadband Alternatives

AT&T also has major plans to offer cable modem services following the acquisition of cable operators TCI and MediaOne. While there will be some overlap between cable modems and DSL services, AT&T believes that cable modems are most applicable to residential customers, while DSL is better positioned to serve both the residential and commercial markets, since telephone lines go everywhere. In contrast, only about 25% of business locations have cable access. And AT&T executives believe that DSL offers the best value-proposition to small and medium-sized businesses.

Where neither DSL nor cable modems are available, AT&T will utilize a variety of fixed-wireless and even satellite-based communications to provide alternative broadband access. The reliance on multiple access technologies is a key component of the AT&T strategy to provide ubiquitous nationwide coverage anywhere that its customers might operate.

## GLOSSARY

**2B1Q:** 2 Binary, 1 Quarternary Line Encoding
**ADSL:** Asymmetric DSL
**ATM:** Asynchronous Transfer Mode
**CAGR:** Common Average Growth Rate
**CAP:** Carrierless Amplitude Phase
**CATV:** Cable TV
**CLEC:** Competitive Local Exchange Company
**CO:** Central Office Telephone Switch
**CPE:** Customer Premise Equipment
**DLC:** Digital Loop Carrier
**DMT:** Discrete Multi-Tone
**DSL:** Digital Subscriber Line
**FTTC/FTTH:** Fiber-To-The-Curb/Fiber-To-The-Home
**G.Lite:** Splitterless ADSL or At-home ADSL
**HDSL:** High-Bit-Rate DSL
**IDSL:** ISDN DSL
**ILEC:** Incumbent Local Exchange Company
**ISDN:** Integrated Digital Services Network
**ISP:** Internet Service Provider
**IXC:** Inter-Exchange Carrier
**LAN:** Local Area Network
**MVL:** Multiple Virtual Line
**MSO:** Multi-Service Operator (Cable TV)
**NIC:** Network Interface Card
**QAM:** Quadrature Amplitude Modulation
**PoPs:** Point of Presence
**POTS:** Plain Old Telephone Service
**PSTN:** Public Switched Telephone Network
**RADSL:** Rate-Adaptive DSL
**RBOC:** Regional Bell Operating Company
**SDSL:** Symmetric DSL
**SOHO:** Small Office/Home Office
**T-1:** 1.544 Mbps TDM Circuit
**TDM:** Time Division Multiplexing
**USB:** Universal Service Bus
**VAR:** Value Added Reseller
**VoD:** Video On Demand
**VoDSL:** Voice Over DSL
**WAN:** Wide Area Network
**xDSL:** "X" Refers to the Collective Forms of DSL

# One on One with Mike Jenner

## Vice President, General Manager, AT&T Global IP Network Services

*Mike Jenner, Vice President, General Manager AT&T Global IP Network Services, is responsible for developing and managing AT&T's Broadband, Dedicated, Dial, VPN and Private Label Internet services for businesses. He was previously the Chief Operating Officer, VP Business Development and Strategy for AT&T Internet Services. In this position Mike took a very active role in AT&T's acquisition campaigns and was responsible for creating AT&T's strategy which improved its position in the busi - ness Internet service marketplace from #10 to #2 in 2 years.*

AT&T Internet Services Vice President Michael Jenner discusses the benefits of broadband access technologies with Broadband Publishing's Executive Editor David Hold.

**Broadband Publishing: We wanted to start with the subject of broadband access. We hear people talking about broadband all the time, different people have different ideas as to what broadband means to them. So, we just wanted to start off by discussing the importance of broadband access to homes and businesses. Why do we need it and how will it be deployed?**

Michael Jenner: Why does broadband access matter? Quite simply because it lets businesses and individuals communicate in a richer and more meaningful manner. For businesses, broadband Internet access allows them to bond more closely with their customers. The broadband platform, where voice, video and data converge, is a highly compelling and engaging selling environment. Businesses love the idea of 'broadband eyeballs' interacting with their websites.

From a consumer standpoint, it goes without saying that broadband will deliver a rich, dynamic and highly personalized consumer experience. But beyond interactive and engaging content, broadband is an "always-on" technology, delivering a steady flow of information. This "always-on" capability is one of the unique aspects of broadband services and is what will extend the Internet beyond the PC. I can easily see broadband being a big driver behind "intelligent appliances," which connect to both the Internet and to one another.

**BPC: Okay, in a general sense again, how do you expect to see it being deployed over the next few years?**

M.J.: Here at AT&T, we talk about the 'broadband mosaic.' Incorporated into this 'mosaic' are cable, DSL, satellite and wireless technologies. We think that AT&T is better positioned than anybody in the market to combine these four technologies into an integrated broadband platform.

> "Why does broadband access matter? Quite simply it lets businesses and individuals communicate in a richer and more meaningful manner."

For example, let's say an enterprise wants broadband access for their remote work force which is spread throughout the country. More than likely, the footprint of any one particular broadband technology will serve only a portion of the company's remote work force. AT&T's strategy is to provide integrated broadband solutions using a variety of access technologies. In other words, by focusing on the total solution and not simply on one particular broadband technology, AT&T will be positioned to deliver an integrated, end-to-end solution.

At the end of the day it's all about providing customers with a world-class end-user experience. AT&T's heritage is based on providing customers with world class customer support. We are very focused on extending that into the broadband arena.

**BPC: Specifically, how do you see the DSL market developing over the next couple of years and how do you think it's going to be accepted by businesses and consumers?**

M.J.: Like any technology associated with the Internet, I expect the DSL marketplace to snowball and grow like crazy. With that said, there are two key drivers that will allow the marketplace to expand rapidly. The first is physical – ensuring that there are enough copper loops to support DSL. The second is logical – making sure that the technical support and provisioning processes are in place. To the extent that these two items are addressed, the physical and the logical, usage of DSL is going to explode. It's going to expand to satisfy consumers who are upgrading from 56 Kbps dial-up connections and it's going to expand to small and mid-sized businesses. Broadband allows millions of small and mid-size businesses to participate in the global networked economy.

**BPC: And what is going to drive this explosive demand of DSL? Is there a lot of pent up need for broadband access?**

M.J.: Yes. There is incredible demand and it's coming from multiple directions. The bandwidth requirements of existing applications continues to grow, more and more devices are becoming Internet-enabled and, of course, there is the ongoing drive for new applications…like voice.

**BPC: So DSL will not only be used for just Internet data, but for voice, as well.**

M.J.: Absolutely. It's still an emerging technology and not quite ready for prime time, but DSL is a great technology for providing converged services, particularly for small businesses and remote workers.

**BPC: Okay, DSL has a great future, but so far, people in the media and industry analysts have noted that DSL has been rather slow to roll out over the last year. Why do you think it was slow in the past and why do you think it is going to speed up in the future?**

M.J.: The challenge of bringing any new technology to market is centered around delivering both the underlying technology, as well as the customer support services that wrap around the technology. These are not trivial challenges. As the market moves beyond early adopters, users will naturally want to make certain that the traditional levels of service they have grown accustomed to will remain. To me, the accountability of the service providers was something that was lacking in the early phases of the DSL marketplace. As simple as it may sound, trust plays a big role in the adoption of emerging technologies. That's beginning to change and I feel it will open up the marketplace.

**BPC: Is this why AT&T wasn't in the market before, but now you will be?**

M.J.: Certainly, AT&T has a reputation for quality and reliability. We are not going to deliver services until they are ready to be delivered to the marketplace.

"The broadband platform, where voice, video and data converge, is a highly compelling and engaging selling environment. Businesses love the idea of 'broadband eyeballs' interacting with their websites."

**BPC: You mentioned four access technologies for providing broadband access to consumers and businesses, with DSL being one. AT&T is obviously involved in the cable TV and cable modem markets, or will be soon. Where do you see DSL fitting in with those other broadband access methods?**

M.J.: Well, there's certainly an overlap around tele-worker applications, but in general, cable is more heavily used by consumers, while DSL seems to be a little better suited to small businesses and remote offices.

**BPC: What about satellite and wireless, since those are both non-terrestrial applications?**

M.J.: Well, certainly they are going to be better suited than cable or DSL to very remote areas, again there would be overlap in the highly populated areas.

**BPC: And as you said before the goal is to provide access to anybody, anywhere. Since this brings AT&T into the local market, is that a departure from your traditional role as a long distance or inter-exchange carrier?**

M.J.: Providing local broadband access is just one of the ways that AT&T is redefining itself for the future. Along with our commitment to the Internet, one of the key planks of AT&T's strategy is to be a facilities based end-to-end solution provider.

**BPC: Well, it sounds like a good strategy. Best of luck with your new services.**