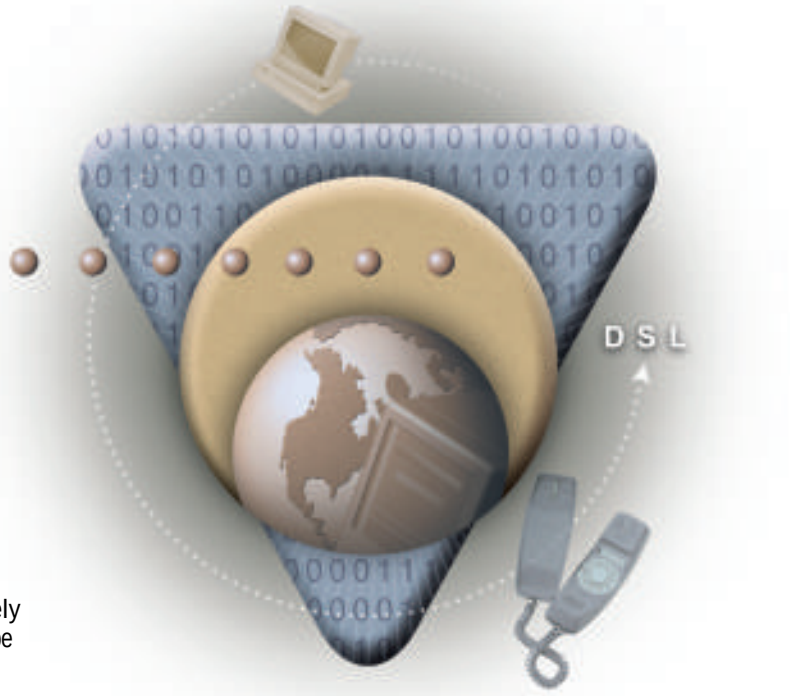
The DSL Connection

DSL Is Hot—or It's Not



Linda Kennard

Everything you have heard about the high speed and relatively low cost of Digital Subscriber Line (DSL) technology may be true—or may not be true. The truth, in this case, lies not as much in the eyes of the beholder as at the feet of the beholder: Where are you (the beholder) standing? That is, where is your home or office located? The answer to this question has everything to do with the availability, potential speed, and cost of DSL. Consequently (and more to the point), the answer will probably determine your own take on the "truth" about DSL.

TURNING COPPER WIRES INTO GOLDEN PIPES

DSL is a technology used to transmit multimedia traffic at high-bit rates over twisted-pair copper wire—in other words, over ordinary telephone lines. (Be warned, however, that DSL can refer not only to this technology but also to an actual line supporting this technology—as in the sentence, "I hope to get a 7 Mbps DSL soon.") DSL can provide intra-campus and intra-building connectivity or high-speed access to public frame relay and asynchronous transfer mode (ATM) networks. However, these are not the applications that have moved DSL into the industry limelight.

DSL turns techno-savvy heads (like yours, perhaps) because it enables high-speed access—in some cases, broadband access—to the Internet. Of course, other technologies enable high-speed Internet access as well—so what's the big deal about DSL?

The big deal about DSL relates to the underlying, industry-wide dream of providing universal broadband access to the Internet. What better technology for this job than DSL? After all, DSL starts this quest with one potential obstacle already cleared: The physical lines required to deliver DSL are already in place. Seven hundred million telephone lines already connect virtually every voice in the world. With the right equipment, DSL transforms these voice-carrying lines into high-speed digital data pipes. (For more information about how DSL works, see the related article "POTS and PANS" on p. 16.)

The right equipment typically means, among other things, a DSL modem or router at your home or office and a DSL Access Multiplexer (DSLAM) at the telephone company's central office (CO), a switching station. (See Figure 1 on p. 10.) A DSLAM concentrates data traffic from several DSL subscribers into one high-speed signal suited for the access network between the CO and your Internet Service Provider's (ISP's) network.

Illustration: Jessica Chen

The span of wire that runs between your home or office and the telephone company's CO is called a *local loop*. (See Figure 1.) DSL was designed to provide high-bit-rate transmissions over the length of local loops, which are commonly 12,000 to 18,000 feet (or 3.7 to 5.5 km). Generally speaking, the shorter the loop is, the higher the transmission rate a particular DSL system can provide. Conversely, the longer the loop, the lower the transmission rate a particular DSL system can provide. Loops that are longer than 18,000 feet pose unique challenges for DSL providers and may, in some cases, require special equipment, and in other cases, may simply not support DSL. (For more information, see the related article "POTS and PANS" on p. 16.)

When used as an Internet access solution, DSL offers several clear benefits. For one thing, most DSL varieties, typically called *DSL flavors*, allow voice to travel simultaneously on the same lines over which it is transmitting high-speed data. For another thing, DSL providers typically configure DSL for home and, naturally, business users to provide continuous access. As a result, you will always be connected to the Internet—no more dialing in. (As you may know, an "always-on" service such as DSL raises security issues. For more information, see the DSL Forum's white paper on corporate Internet security posted at http://www.dslforum.org/security_index.html.)

Of course, DSL's most talked-about advantage is that for a relatively low cost, DSL enables high-bit-rate transmissions. Just how high depends on, among other factors, the particular DSL flavor you're talking about. (For more information, see "DSL Flavors" on p. 12.) For example, one popular DSL flavor, Asymmetric DSL (ADSL), can transmit voice, data, and video at rates as high as 9 Mbps but more commonly at 6 Mbps. An emerging DSL flavor, Very-high-bit-rate DSL (VDSL), offers rates as high as 52 Mbps. (For more information about DSL transfer rates, see "I Feel the Need For Speed" on p. 14.)

HERE YOU SEE IT, HERE YOU DON'T

Such impressive potential makes your mouth water, doesn't it? Unfortunately, depending on where you live or work, you

may not have the option to choose among such impressive rates because DSL simply may not be available.

According to recent statistics published by TeleChoice Inc., the total number of DSLs in North America at the end of first quarter 2000 totaled 882,470. (TeleChoice is a market-strategy consultant agency for the telecommunications industry.) The United States had 754,770 of these DSLs at first quarter's end. (For more recent statistics, visit http://www.xdsl.com/content/resources/deployment_info.asp.) On June 5, the DSL Forum announced that the total number of DSLs in the United States had surpassed one million. (See http://www.dslforum.org/PressRoom/ news_sc_060500.html.)

These numbers are impressive, but for now, DSL is *not* available in more areas than it *is* available. If you are surprised that DSL is moving surely forward but arguably too slowly, you shouldn't be. Contrary to what you may assume, DSL is costly to deploy—despite the fact that the lines required to deliver it are already in place.

DSL deployment costs can be attributed in part to expensive DSL equipment and, in some cases, to the need to recondition telephone lines to support DSL. Reconditioning telephone lines may require any number of things, including removing bridged taps or load coils. (For definitions of *bridged taps* and *load coils*, see the glossary at http://www.nwconnection.com.)

Not surprisingly, Incumbent Local Exchange Carriers (ILECs) are more likely to deploy DSL in tier-one markets—markets in major metropolitan areas—according to Claudia Bacco, a TeleChoice consultant. (ILECs are the telephone companies that provided voice services long before competitive companies entered the voice-carrying market.) For example, in Texas, Dallas and Houston are tier-one markets, whereas San Antonio and Lubbock are tier-two markets.

ILECs will most likely get the biggest return on their DSL investment in tier-one markets. However, Bacco adds, the fact that ILECs are focused for the time being on tier-one markets does not mean that tier-two markets are not being served. What this fact does suggest, says Bacco, is that ILECs will probably serve tier-two markets later rather than sooner. "Competitive Local Exchange Carriers (CLECs) will probably get to tier-two markets first," Bacco adds.

Although Bacco may be right, her speculations clearly do not apply to U S WEST, an ILEC and major DSL provider. U S WEST offers DSL to select areas in its region, which covers 14 western states including Arizona, Colorado, Idaho, Iowa, and Utah. (If you live in the western United States and would like to see if U S WEST offers its DSL services in your area, visit http://www.megaspeed.com, and click the "Availability" link.) According to Barry Hawkins, a U S WEST spokesperson, U S West recently rolled out DSL to several tier-two cities including Grand Junction, Colorado; Casper, Wyoming; Pocatello, Idaho; and even smaller cities, including Norfolk, Nebraska. As a result, Hawkins claims that U S WEST serves more tier-two markets than any CLEC operating within its region.

GET OUT YOUR SHADES—THE FUTURE IS BLINDING

Regardless of the specific markets that ILECs and CLECs are targeting now, the outlook for DSL is promising, as its current deployment rate arguably suggests. For example, the 882,470 North American DSLs reported at first quarter's end represent an impressive 50 percent overall increase in the number of DSLs in the United States since the end of 1999. Canada experienced a 34 percent increase of DSLs during the same time. (For more information about DSL installation rates, visit http://www.xdsl.com and click "Deployment and Projections" in the left-hand column.)

Bacco admits that this total number of North American lines is a bit shy of what DSL proponents were hoping for. Nevertheless, she adds, the number is exciting in light of the growth rate it implies. "The quarter-over-quarter DSL growth has surpassed the quarter-over-quarter cable modem growth," Bacco explains. "This shows that DSL is finally starting to grow at a rate that indicates it is migrating out of early adopter mode."

Furthermore, if industry analysts' projections regarding DSL's future are any indication, literally hundreds of thousands more DSLs may be available in the United States than were available at the end of first quarter 2000. For example, TeleChoice predicts that by the end of 2000, the number of DSL subscribers will surpass 2.1 million in the United States alone. (See http://www.xdsl.com/content/resources/deployment_info.asp.) If TeleChoice is right, the total number of DSL lines in the U.S. will double within the next six months.

The increased availability of and demand for DSL has lead the DSL Forum to conclude that this year will be a turning point for DSL. The DSL Forum is an organization dedicated to the development and mass-market deployment of DSL. (For more information, see http://www.dslforum.org.) In fact, Hans-Erhard Reiter, chairman and president of the DSL Forum, calls 2000 "the year of DSL." Among other indicators that 2000 is a key year for DSL are the any-to-any interoperability efforts of DSL equipment providers. (For more information, see "Promising Interoperability Efforts" in the "POTS and PANS" article on p. 22.)

DSL's future beyond 2000 looks equally as, or perhaps even more, promising. According to Amy Harris, International Data Corp. (IDC) senior analyst, IDC estimates that by 2003, 27.3 million DSLs will be installed worldwide, 12.6 million of which will be in the United States. This estimate, Harris adds, is a conservative one. If IDC's projections are accurate, the total number of DSLs in the U.S. alone will increase by more than 11 1/2 million lines in only 2 1/2 years.

THE BUMPS IN THE ROAD

Meanwhile, serious inhibitors slow the potential deployment and availability of DSL. Several key challenges must be addressed before DSL can really take off. For example, if DSL is to be widely available, setting up, configuring, and managing DSL services needs to be easier for DSL users. In addition, service providers must provide services that will assuage home and business users' concerns about security and that will help these users manage their Internet identities.

Novell and Texas Instruments have recently teamed up to develop a gateway platform for broadband services that will address these and other potential obstacles facing DSL and other broadband services. The results of this joint effort may help pave the way toward actualizing the dream of universal broadband access. (For more information about this partnership, see "Novell and TI: Planting the Seeds of Universal Broadband Access" in the "POTS and PANS" article on p. 24.)

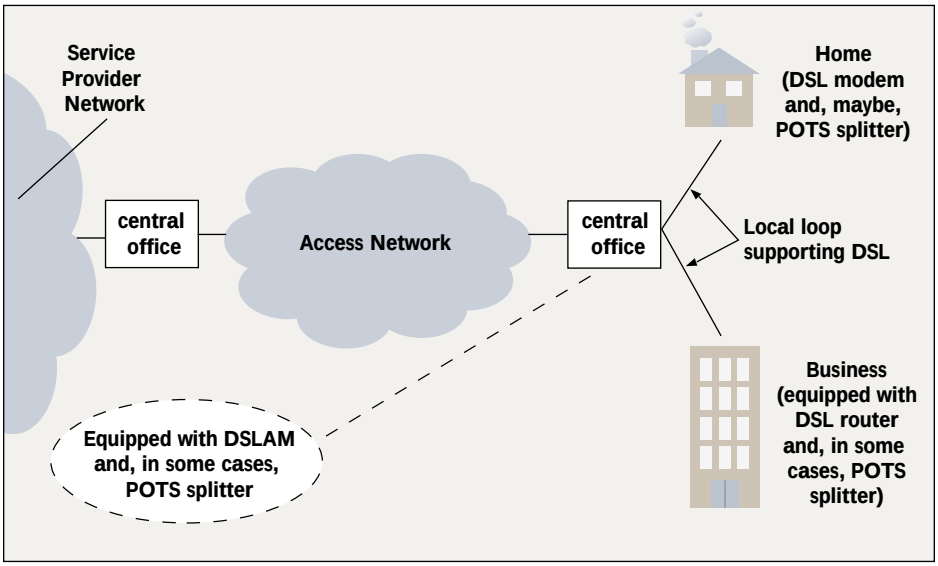


Figure 1. When used for Internet access, DSL enables simultaneous transmission of voice and high-speed data over the span of copper wire that runs between your home or office and the telephone company's central office. This span of wire is called the local loop.

TRANSMISSION RATES AND THE LOCATION-QUALIFICATION CORRELATION

Regardless of DSL's future, the reality today is that you should consider yourself lucky if DSL is available in your area and even luckier if your local loop qualifies for DSL. (For more information about qualifying for DSL, see "What Are Your Qualifications" in the "POTS and PANS" article on p. 20.)

If you are fortunate enough to be connected to a local loop that qualifies for DSL, you may be surprised to learn that you don't necessarily get the rate you're willing to pay for. (For information about the factors that contribute to the rate for which you qualify, see the related article "POTS and PANS" on p. 16.) As with availability, transmission rates are dependent on your location. Your location affects the transmission rate DSL provides for a number of reasons, including the following:

- Your location determines the DSL provider or providers in your area and, thus, determines the DSL flavor and vendor's system you get.
- Your location in relation to the CO affects the transmission rate a DSL system can provide. Generally speaking, the farther you are from the CO, the slower the transmission rate.
- Your location determines the condition and gauge (thickness) of your lines, which can affect the rate DSL can provide. For example, thicker wire enables faster transmission rates. (For more information, see the related article "POTS and PANS" on p. 16.)

YOU QUALIFY! CONGRATULATIONS—OR CONDOLENCES?

The bottom line is that you have limited control over the transmission rate you get. And the transmission rate you get, or more accurately, the transmission rate for which your line qualifies, can be exciting—or disappointing.

For example, when Steve Petersen, sales manager for American Computer Institute in Ames, Iowa, began looking for high-speed Internet access to his home office, he first considered purchasing a T1 circuit. Petersen found he would have to pay U.S. $1,900 per month (not an uncommon price) for the symmetric 1.54 Mbps transmission rate a T1 provides.

Instead, Petersen opted for U S WEST's MegaOffice service, which provides 512 kbps for only U.S. $62.40 per month. Petersen admits he is a bit disappointed that his loop did not qualify for a faster transmission rate. On the other hand, he was all too happy to settle for a fraction of the transmission rate of a T1 for a very attractive fraction of its cost.

In addition to the 512 kbps available through U S WEST's MegaOffice offering, small- and medium-sized businesses may qualify for any one of several rates available through U S WEST's MegaBit services. Depending primarily on its location in relation to a U S WEST CO, a business may qualify for any one of the following transmission rates:

- 1 Mbps downstream and 1 Mbps upstream for U.S. $120 per month
- 4 Mbps downstream and 1 Mbps upstream for U.S. $480 per month
- 7 Mbps downstream and 1 Mbps upstream for U.S. $840 per month

According to Petersen, one local business found it qualified for not one but three U S WEST symmetric 1 Mbps DSLs. Not surprisingly, this business purchased the three lines and now has a 3 Mbps connection to the Internet for only U.S. $360 monthly—that's double the rate of a T1 for one-third the price. According to Hawkins, U S WEST does not discourage the practice of purchasing multiple DSLs. However, Hawkins says, you would be more likely to qualify for multiple 256 kbps lines than multiple 1 Mbps lines.

Of course, even if you live in an area where U S WEST is offering DSL, the local loop to your home or office may not qualify for any of the aforementioned MegaBit services, all of which are based on Rate-Adaptive DSL (RADSL). U S WEST customers on long local loops (that is, longer than 18,000 feet) may not qualify for the MegaBit RADSL services. However, they might qualify for U S WEST's MegaBit Integrated Services Digital Network DSL (IDSL). That's the good news.

The bad news is that IDSL rates are disappointing. IDSL offers symmetric rates of up to only 144 kbps and requires a dedicated telephone line. As a result, you will be paying not only for the DSL but also for a second telephone line.

In light of this rate, the cost of U S WEST's MegaBit IDSL may be even more disappointing. The monthly costs of U.S. $69.95 are not bad. However, you must also pay a one-time activation fee of U.S. $250, compared to the U.S. $69 activation fee for the MegaBit services based on RADSL. You must also pay U.S. $110 for the modem installation. In contrast, you can install the modem or router required for the MegaBit RADSL services yourself and, consequently, pay no installation fee.

SAME RATE, DIFFERENT REACTION

MegaOffice, MegaBit RADSL services, and MegaBit IDSL are aimed primarily at small- to medium-sized businesses. In addition to these services, U S WEST also

DSL Flavors: You Get What You Get

Digital Subscriber Line (DSL) service and equipment providers have designed several variations of DSL, collectively referred to as *xDSL*. Each DSL flavor is designed to serve a different purpose, and consequently, each flavor offers a different transmission rate. As you read through the following list and explanations of DSL flavors, take care to avoid what you may assume. That is, set aside the notion that you will be able to choose which DSL flavor you would like to purchase. Without exception, you'll get whatever DSL flavor is available in your area—and the flavor and transmission rate for which your line qualifies. (For more information, visit the DSL Forum web site at http://www.dslforum.org. For less technical information, visit http://www.dsllife.com, another site maintained by the DSL Forum.)

ASYMMETRIC FLAVORS

Asymmetric DSL (ADSL). As its name implies, ADSL provides different upstream and downstream transmission rates. According to the DSL Forum, ADSL systems are typically configured to deliver 6 Mbps downstream. However, actual transmission rates can range anywhere from 1.5 Mbps to 9 Mbps. Upstream rates are frequently reported anywhere from 64 kbps to 1 Mbps.

ADSL is well-suited for Internet access for at least two obvious reasons: First, the downstream rate ADSL offers is more impressive than its upstream rate, and Internet users are typically more concerned with downstream speeds than upstream speeds. Second, ADSL allows for the simultaneous transmission of voice and high-speed data—a capability that appeals to both home and business users. Not surprisingly, ADSL is the most popular DSL flavor being offered to home Internet users and among the most popular DSL flavors for small- to medium-sized business Internet users.

ADSL consists of the local loop, an ADSL transmission unit at both ends of the loop (that is, one at the central office (CO) and one at the customer premises) and a Plain Old Telephone Services (POTS) splitter also at both ends of the loop. Alternately, DSL providers can deploy splitterless ADSL, which requires users to place a low-pass filter on each telephone in the house.

The advantage of the splitterless implementation is that users can install the customer equipment for a splitterless ADSL system themselves. In contrast, users cannot install a POTS splitter on their own. POTS splitters and the low-pass filters separate POTS from DSL signals to ensure that your telephone conversations don't impede your DSL transmissions and that those transmissions don't cause interference during telephone conversations. (For more information, visit the DSL forum's web site at http://www.dslforum.org.)

G.lite ADSL. As its name suggests, G.lite (typically called simply *G.lite*) is a light version of full-rate ADSL. That is, G.lite's maximum downstream and upstream data bit rates are slower than those of full-rate ADSL. G.lite can deliver rates of up to 1.5 Mbps downstream and up to 500 kbps upstream. Sometimes called Universal DSL, G.lite was developed specifically to appeal to home users and, thus, to increase the likelihood of widespread availability of universal high-speed Internet access. To appeal to home users, the system can be self-installed: G.lite never requires a POTS splitter and although some configurations can require filters, users can typically install the customer premises equipment required for a G.lite system themselves. Like full-rate ADSL, G.lite systems simultaneously deliver voice and high-speed data.

Rate Adaptive DSL (RADSL). RADSL supports both asymmetric and symmetric applications and allows adaptive transmission rates up to 7 Mbps downstream and 1 Mbps upstream. RADSL adjusts transmission rates automatically, depending on the current capacity of the line. Like ADSL systems, RADSL systems deliver voice and high-speed data simultaneously. (For more information, visit the DSL Forum's web site at http://www.dslforum.org.)

Very-high-bit-rate DSL (VDSL). VDSL can only operate over short local loops (no more than 3,750 feet or 1,200 meters) and, consequently, offers higher rates. Reports on the possible rates vary from source to source. According to the DSL Forum, for example, VDSL offers up to 26 Mbps. This rate represents the symmetric rate possible given a loop with 24-gauge wire that is no more than 1,000 feet (or 300 meters) from the CO. The authors of *Understanding DSL* are more optimistic, claiming that VDSL offers rates up to 56 Mbps (Starr, Cioffi, and Silverman, Prentice Hall, 1999).

This rate represents the downstream rate only; the upstream rate is limited to 6.4 Mbps given the same loop length. In either case, VDSL is fast. No one yet offers VDSL for commercial purposes. However, the DSL Forum reports that VDSL has been introduced "in market trials to deliver video services over existing phone lines." (For more information, visit the DSL Forum's web site at http://www.dslforum.org.)

SYMMETRIC FLAVORS

High-bit-rate DSL (HDSL). HDSL was developed in the late 1980s as an economical alternative means of provisioning T1/E1 services at speeds of 1.5 Mbps or 2.3 Mbps both downstream and upstream using typically two (or three) twisted copper pairs. Unlike ADSL, G.lite, or RADSL, HDSL cannot simultaneously deliver voice and high-seed data over the same copper wire. (HDSL is standardized through ITU G.991.1 and is also defined in the ANSI Technical Report (TR) 28. For more information, visit the DSL Forum's web site at http://www.dslforum.org.)

HDSL-2. HDSL-2, or second-generation HDSL, offers 1.5 Mbps both downstream and upstream over one copper pair and is, therefore, even more economical than HDSL. Like HDSL, HDSL-2 cannot simultaneously deliver voice and high-speed data on the same copper wire. HDSL-2 is standardized through American National Standards Institute (ANSI).

Integrated Services Digital Network DSL (IDSL). IDSL supports symmetric data rates of up to 144 kbps over a single copper pair. Like HDSL and HDSL-2, IDSL cannot deliver voice and high-speed data simultaneously on the same wire.

As its name suggests, IDSL combines ISDN and DSL technologies. The result is that like other DSL flavors, IDSL is an "always-on" service. However, unlike other DSL flavors, IDSL can use existing ISDN modems in remote terminals to deliver services to Digital Loop Carrier (DLC) customers. (DLC customers have copper from their premises to a remote terminal, which is connected to the CO over fiber optic cable.) In contrast, providing ADSL and G.Lite services to DLC customers requires new equipment (specifically DSL Access Multiplexers or DSLAMs) in each DLC remote terminal. Installing new equipment is a realistic possibility but a costly one. Consequently, it may be a while before DLC remote terminals in major metropolitan areas are equipped with ADSL or G.Lite DSLAMs, and may be a longer while before remote terminals in other areas are similarly equipped.

I Feel the Need for Speed

Digital Subscriber Line (DSL) was designed to operate over the typical lengths of a local loop, generally 12,000 to 18,000 feet (3.7 to 5.5 km). The following table shows transmission rates that various DSL flavors can offer under optimal conditions. The distance shown represents the maximum length of wire between the telephone company's central office (CO) and the customer's premises. Keep in mind that the specific transmission rates and distance limitations vary, depending on a number of factors. For a more detailed (and, therefore, more accurate) table, visit http://www.tuketu.com/dsl/xdsl.htm or http://www.everythingdsl.com.

DSL Flavor	Upstream Rate	Downstream Rate	Distance Limitations and Other Comments
HDSL	1.544 Mbps 2.048 Mbps	1.544 Mbps 2.048 Mbps	12,000 feet (3.7 km) Requires 2 or 3 lines POTS not available
HDSL2	1.544 Mbps 2.048 Mbps	1.544 Mbps 2.048 Mbps	12,000 feet (3.7 km) Requires only 1 line POTS not available
G.lite	500 kbps	1.5 Mbps	18,000 feet (5.5 km) User installable No POTS splitter required
ADSL & RADSL	1 Mbps	9 Mbps	18,000 feet (5.5 km) POTS splitter or easy-to-install low-pass filters required
VDSL	2 Mbps	52 Mbps	1,000 feet (300 m) POTS splitter required
IDSL	144 kbps	144 kbps	18,000 feet (5.5 km) POTS not available

offers MegaBit 256 Select and MegaBit 256 Deluxe services aimed at the residential market. MegaBit 256 Select and MegaBit 256 Deluxe both offer 256 kbps at a cost of either U.S. $19.95 per month or U.S. $29.95 per month, respectively. The difference in cost is due to the difference in service availability: MegaBit 256 Deluxe is continuously available, while MegaBit Select is not. MegaBit Select offers unlimited two-hour sessions with 10-minute requisite waits between sessions.

I opted for MegaBit 256 Deluxe and am happy with the rate and comfortable with the cost, which comes to U.S. $47.95 per month (including the cost of the DSL and my ISP account). In contrast, Dennis Fredette, owner of Niche Associates in Sandy, Utah, was quite disappointed to learn that Rhythms, Inc., one of the few DSL providers in the Sandy area, could only offer Niche the same rate—that is 256 kbps.

Fredette's disappointment is understandable. After all, 256 kbps to a single user is impressive, but 256 kbps divided among the multiple employees of a business is much less so. Fredette researched the cause behind the disappointing rate and learned that the local loop to Niche has a preponderance of bridged taps, as many of the local loops in the Sandy area apparently have.

At the available transmission rate, Niche will have to purchase more than one line to adequately serve its 20 employees. The limited transmission rate would have been somewhat more appealing if the cost per line was the same as in my local area. However, Rhythms Inc. quoted Niche a cost of U.S. $118 per month for a 256 kbps DSL line, with additional charges for multiple IP addresses. The total cost was U.S. $144. Costs from other providers serving the Sandy area are similar.

Like the disappointing rate, the disappointing cost cannot be blamed on Sandy area providers. According to Bacco, such cost discrepancies are in many cases the result of this simple fact: The provider doesn't own the CO and, consequently, must rent or buy space from an ILEC to deploy DSL services. Buying or renting the space adds to the cost of DSL deployment.

THE BOTTOM DSL LINE

Given its potential, DSL is well worth investigating. Your first step should be to find out if DSL is available in your area. If DSL is available, find out whether or not the local loop to your home or business qualifies and, if so, at what transmission rate. (To find out if DSL is available in your area, no matter where in the world you are, visit http://www.dsllife.com/started/clickmap.htm.)

However, when you start checking out the availability of DSL, don't be surprised (even if you are disappointed) if you discover that one or more of the following applies to you:

- DSL is available in your area, but the local loop to your home or business doesn't qualify.
- The local loop to your home or business qualifies for DSL. Unfortunately, the transmission rate your line can support is disappointingly lower than the speed you'd dreamed of.
- The local loop to your home or business qualifies for DSL at an adequate (or even spectacular) transmission rate. Unfortunately, the price is alarmingly higher than the price you'd hoped to pay for high-speed Internet access.

On the other hand, don't be surprised if none of these disappointing possibilities applies to you. You may discover that your local loop qualifies for DSL at an attractive transmission rate and an equally attractive price.

The bottom line, at least for now, is this: Whether or not you can get DSL and the transmission rate for which your local loop qualifies depends on where your home or office is located. Consequently, your location will dictate your DSL experience and, thus, ultimately determine your perception of DSL.

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