The Future of Digital Subscriber Line Technology: Business Drivers, Strategies, and Markets

WHITE PAPER[1]

[1] The information presented in *The Future of Digital Subscriber Line Technology: Business Drivers, Strategies, and Markets White Paper* is the summary of the 236-page research report. All attempts have been made to provide the true summary of the entire report. Nevertheless, not all topics discussed in the larger editions of the report are adequately addressed in this *White Paper.*

Introduction

The confluence of two forces, the globalization of business and the networking of information technology, has created the Internet economy. The Internet economy drives an economic shift that will have a more profound impact than the Industrial Revolution. The Internet has changed the way people work, live, learn, and play— connecting everyone to everything. It has created new opportunities for businesses, countries, and people by leveling the playing field. The Internet economy is redefining how people do business, communicate, shop, and learn. Just as the Industrial Revolution changed the fortunes of businesses, countries, and people, the Internet will do likewise.

Technology and business drive the Internet economy. Technology drivers include the integration of voice, data, and video on a single network as traditional voice and video services converge. Internet technology has become mainstream and is a requirement for companies interested in competing in the global business world. Access to information empowers employees, customers, and business partners not only to work more effectively, but also to make decisions using timely, up-to-date information.

The Internet and the need to remain competitive lead the drive toward consolidation of financial, retail, and manufacturing markets. The Internet will help forge alliances between companies and countries looking to stay competitive. The way companies and individuals use Internet technology will determine the winners and losers. John Chambers, the chief executive officer of Cisco Systems Incorporated, expects electronic commerce (e-commerce) to account for more than a trillion dollars by the year 2000, up significantly from the 48 billion dollars in 1998.

The World Wide Web (WWW) and the Internet have permanently changed the face of retail, from financing and insurance to clothing. Not only have they changed the face of e-commerce, but they also have given birth to a new terminology and a new way of categorizing change and time. Companies that are able to move rapidly are said to operate on Internet time. Internet time refers to any rapid movements or events. Commerce Secretary William Daley put it best when he said, “ For any business, large or small, not to have an e-commerce strategy is a big mistake . . . Let’s face it, consumers are hungry for it.”

As the Internet continues to explode, demand for greater bandwidth and faster connection speeds has led to several technological approaches developed to provide broadband access to all consumers. The growth of the Internet also has led to a host of new business applications. *The Future of Digital Subscriber Line Technology: Business Drivers, Strategies, and Markets* examines the forces driving the rapid growth of broadband and high-speed access to U.S. homes and businesses via wireline networks.

The Internet has revolutionized many small and midsized businesses; technology has made geography less important than in the past. As a result, many small businesses operate from home offices or small branch offices. These companies can improve performance and provide a higher quality of life for their employees by providing them with an office location near their homes, or, in some cases, in a room in their homes. As long as employees have access to their corporate local-area network (LAN), the Internet, and other communications tools, they do not need to be at a headquarters.

The Future of Digital Subscriber Line Technology: Business Drivers, Strategies, and Markets analyzes the current state of digital subscriber line (DSL) deployment by telecom service providers. It analyzes the rollout strategies and market positions of vendors and suppliers and provides definitions of the key terms, including all DSL variants. Lastly, the report profiles the major DSL vendors and suppliers.

This report targets senior business managers and strategists in telecom companies who seek to compete in the broadband and high-speed access market.

DSL is a modem or modem pair that uses a specific access technology to transmit and receive information at high speed over the LAN. DSL technology allows service providers to offer higher-speed access over existing copper wires and relieves bandwidth congestion in the local loop.

The DSL market has undergone a complete makeover. There are eight variants of DSL, and it seems that every year another variant is invented. Some DSL variants are asymmetric, while others are symmetric. Although the asymmetric digital subscriber line (ADSL) variant was invented for video, today another DSL variant— very-high-speed digital subscriber line (VDSL)— is used for transmitting video over copper wires. Video-on-demand (VOD) has mostly fallen by the wayside as the personal computer (PC) rather than the television has become the main driver for DSL access. Consumers are clamoring for services that can provide high-speed access to the Internet and to applications on their corporate networks.

DSL Technology	**Rate**	**Distance**
ADSL	1.5 Mbps to 7 Mbps	12,000 ft. to 18,000 ft.
ADSL Lite	384 kbps to 1.5 Mbps downstream 384 kbps to 512 kbps upstream	12,000 ft. to 18,000 ft.
HDSL	1 Mb	12,000 ft. to 18,000 ft.
HDSL2	3 Mbps	24,000 ft.
IDSL	Up to 144 kbps	18,000 ft. to 24, 000 ft.
RADSL	40 kbps to 7 Mbps downstream	12,000 ft. to 18,000 ft.

	Up to 768 kbps upstream	
SDSL	128 kbps to 1.5 Mbps	12,000 ft.
VDSL	12.96 Mbps to 52 Mbps downstream	1,000 ft.

Figure1: *Rates and Distances for Various DSL Technologies*

Applications driving the demand for broadband access include Internet telephony, real audio and real video, multicasting, and videoconferencing using NetMeeting or similar products. Consumer applications that drive the broadband market are significantly different from business applications. Consumer applications are e-mail, electronic stock brokerage, financial services, consumer travel, on-line shopping/e-commerce, streaming audio and video, interactive TV and entertainment, gambling, and Internet and video telephony. For small offices home offices (SOHO), small businesses, and midsized businesses, these drivers are not as important. What is more important is e-mail, business travel, financial services, e-commerce, access to research, streaming audio/video, Internet and video telephony, and access to the company LAN or intranet. Many consumer and business applications are similar but used differently, and thus, the explanations of the applications are similar.

This report will discuss the consumer and business applications driving the market. Additionally, content also drives demand for consumer and business broadband access.

Potentially, DSL can enable carriers to turn 70 percent of their 800 million miles of embedded copper cable networks into high-speed data highways for a small additional investment. However, until recently, the incumbent local-exchange carriers (ILECs) have chosen, either because of regulatory issues or a fear of cannibalizing their T–1 sales, not to deploy DSL. The Telecommunications Act of 1996 served as a catalyst in moving DSL technology from the sidelines into the frontlines. The Act opened the telecom market and allowed new entrants to gain access to the central office (CO) and local loops of the ILECs. Data-competitive local-exchange carriers (CLECs) such as Covad Communications Company capitalized on this opportunity and were one of the first to bring lower-priced DSL service to telecommuters and small and midsized companies.

However, it was not until the computer and consumer-equipment manufacturers convinced the ILECs to resolve some of the lingering problems with DSL and cable operators began deploying cable modems in the residential consumer market that low-priced DSL access became a real possibility. At least five key ingredients are necessary for DSL technology and deployments to become widely deployed in the consumer and business markets. This report will discuss these critical items and explain why they are key to the success of DSL. The five ingredients are as follows: regulatory issues; state of the local loop; standards and interoperability issues; marketing tactics and strategies of ILECs, CLECs, and Internet service providers (ISPs); and systems-integration issues. For DSL to be successful, it must not only

meet the expectations generated by its marketers, but it also must be easy to install and guarantee service quality.

Otherwise, the advantages it offers (high-speed access, low cost, access to company LANs and other applications that require higher bandwidth) will be reduced substantially. Small and midsized businesses are unlikely to use the service for their mission-critical applications without service guarantees.

Although establishing standards is critical to a successful DSL deployment, technology is moving much faster than standards bodies and government regulators can handle. As a result, few DSL technologies have been granted official status. As such, no interoperability tests have been performed, and it is not known if DSL technologies will be spectrally compatible with other DSL variants or technologies, or if DSL equipment will be interoperable with equipment from other vendors. Also, regulators have been slow in updating regulations to take into account new technologies.

The Federal Communications Commission (FCC) defined broadband access as having the capability of supporting downstream and upstream speeds of 200 kbps or more. The FCC chose the 200 kbps speed because it felt that this speed would be sufficient for consumers wanting higher-speed access to the Internet. This definition does not include one-way high-speed access, such as that delivered by some cable operators, satellite operators, or wireless providers.

Suppliers or vendors of cable or DSL wrote most of the material about DSL; hence, the material is not without bias. This report will change this by providing a more complete analysis of DSL technology as well as an analysis of various business strategies and deployments. Research shows that consumers will be ecstatic about the technology. However, little information exists to document user satisfaction, and the information that does exist is anecdotal in nature.

DSL deployments are primarily in the business market and are targeted specifically to small and midsized businesses, SOHO customers, and teleworkers. This niche likely will prove successful because it is price elastic. But for DSL to become a mass-market product, as most suppliers hope, it must be easily installable and cannot become commoditized. Otherwise, residential DSL suppliers will not be able to obtain the necessary revenue to cover their costs.

Industry analysts are split about which technology will be the winner, and thus the forecasts vary greatly. However, one clear trend emerges. Unless telcos begin to market their DSL service aggressively to the mass market, they are in danger of being left behind. Cable operators have taken an early lead and are winning the access race. Telcos are about a year behind in marketing this service. Deals such as the @Home $6.7 billion purchase of Excite in January 1999 drive home this point.

1999 will be a big year for DSL deployments, with significantly higher DSL deployments in the business and consumer markets. However, an industry panel convened by the International Engineering Consortium (IEC) for this report thought that DSL would not become widely deployed until 2001, with many panel members thinking it would take until 2003.

Data CLECs and ISPs appear to have a solid hold on the small-business/SOHO/teleworker market, and it looks as if they will keep this edge. Their strategy is first to target the small-business/SOHO/teleworker market. After gaining a certain amount of business customers, these companies began to target the residential market. Covad began to target the residential market in April 1999, more than a year after targeting the business market. The only companies that can challenge CLECs for the small-business and teleworker market are the ILECs, which seem to be ignoring the business market for regulatory reasons and fear of cannibalizing their T–1 revenue stream. Data CLECs will continue to grow rapidly until they cover the entire business and consumer markets in the United States. ISPs also are working hard to capture a large percentage of this market. Many ISPs are working in concert with data CLECs and ILECs to gain a larger share of the DSL market. ISPs represent the best chance consumers will have for competition in the DSL market.

In the business market, DSL will be the chosen technology, as it is unlikely that businesses will choose cable operators to provide service. Wireless technologies will have an easier time competing where there is no cable infrastructure, such as business districts or where the telephone network has not been upgraded to support DSL. Competition for wireless broadband services depends on the cost of these services. Although cost is a factor in all scenarios, it is much more a factor in wireless than in others. Fixed wireless operators, such as Teligent and Winstar, are launching data offerings for SOHOs and small and midsized businesses and could pose a threat to DSL in the next few years. Currently, there is no successful deployment of wireless services for broadband access that can indicate what users are willing to pay. However, any estimate for broadband access and for the percentages that DSL and fixed wireless will have must be based on factors such as geographic region, cost, and population density. After analyzing these factors, it can be determined which technology will be most successful.
Widespread installation of DSL has been impeded by physical constraints of the local loop (number of load coils and bridge taps and distance from the CO), interoperability problems between products, and spectral compatibility issues. The need for software improvements and DSL standards, especially a DSL Lite standard, also has hindered the spread of DSL. The business case for DSL depends greatly on how it will be used and who will use it. The type of consumer purchasing DSL also determines the price and the type of access. Business cases for DSL fall into four categories: remote access to a corporate LAN; high-speed broadband access by residential or business users; high-speed

access needs of the hospitality or campus environments; and, lastly, the creation of home networks (i.e., home-based LANs).

An excellent business case can be made for consumer and telecommuter access to corporate LANs and high-speed Internet access. However, developing, launching, and marketing a DSL service is a complex process involving business strategy, marketing, engineering, outside plant, and operational systems. Companies must address each of these elements before commencing operation.

Demand for bandwidth has led to several technological approaches developed to provide broadband access to business and residential customers. DSL is not the only path to achieving high-speed broadband access. Several competing technologies such as cable, wireless, and satellite, are trying to achieve the same goal. This report will examine the market strategies and deployment of these alternative services. Although DSL has numerous advantages, other means of obtaining high-speed access may be preferable. The competing technologies that will be discussed include cable modems, broadband satellites, and wireless. Three new wireless technologies are beginning to challenge traditional wireline and cable for the data market: local multipoint distribution systems (LMDS), multipoint-multichannel distribution service (MMDS), and digital electronic message service (DEMS) (24GHz).

Market Drivers: Current Demand for Broadband-Access Technologies

Broadband Market Size

Many variables go into determining the size of the broadband market. Some groups look toward the number of PCs purchased and extrapolate from there, while others look to the number of Internet or on-line users. Additionally, many organizations have adopted different methodologies for determining the size of the market for high-speed access.

PC Owners

According to the Department of Commerce, more than 45 percent of U.S. households own a PC. This penetration continues to rise as PC prices drop. According to the *Wall Street Journal,* computer manufacturers expect PC sales to grow an additional 17 percent in 1999, continuing their record growth.

More than 31 million Americans, or about 25 percent of U.S. households, own more than one PC. The number of multi-PC households is increasing rapidly, by more than 30 percent annually, with large numbers of families purchasing PCs first for their children and then for themselves. As a result, the number of multi-PC homes is growing faster than the number of single-PC homes. This percentage, along with the percentage of people who are on-line today, about 35 percent, illustrates the magnitude of the potential market for high-speed access. Following these estimates and the rising growth rate for Internet subscribers, by 2002 close to 50 percent of all households will have Internet access, with about 20 percent of these households owning more

than one PC. The increasing number of multi-PC households will be a major driver for broadband access.

The falling prices of PCs have resulted in more consumers making a first-time purchase or purchasing a second or third computer. The market for the sub-$1,000 PC remains extremely strong: 35 percent to 40 percent of all U.S. retail sales for the fourth quarter of 1997 went to this segment. In 1998, this number increased to 45 percent before leveling out. In January 1998, Compaq and Hewlett-Packard announced prices below $800 for PCs, and in the summer of 1998, prices fell again. Prices today are continuing to fall as another semiconductor price war appears to be breaking out between Intel and AMD. According to the *Wall Street Journal,* computer systems from companies such as IBM can be purchased for as low as $599, and a South Korean joint venture has announced computer systems for below $500. However, these systems are often last year's technology (*Wall Street Journal,* 11/4/98). Most consumers would rather spend more money and get more up-to-date features. As a result, PC prices appear to be stabilizing at around $1,130.

In 1997, a completely different picture was seen as manufacturers raced to see who could make a system priced below $1,000, and buyers were purchasing these systems almost as fast as they were produced. This rapid explosion in the number of interested buyers for low-priced systems forced retailers and manufacturers to cut costs and trim inventories. As a result, manufacturers and retailers began to find creative ways of steering consumers to higher-priced machines (i.e., more profitable), by bundling different hardware and software with the machine.

In late 1998, many computer manufacturers decided to adopt a direct-sales approach and began marketing their computers by direct mail and through their Web sites. Dell has been extremely successful in this approach and, as a result, has been copied by all the major manufacturers, including Compaq and Hewlett-Packard. Selling directly to the consumer bypasses the traditional retail channels that computer manufacturers had established.

1999 brought another change in marketing, as aggressive distributors such as Ingram Micro Incorporated (IM), which had purchased minority stakes in on-line merchants, began to use these merchants to sell their goods. Ingram Micro's ally, Buy.com, directly targets consumers with products that are often below cost. Other on-line merchants are following the lead, resulting in cheaper computers. OnSale, which in the past sold secondhand computers, has recently signed an agreement with Tech Data to sell new PCs and accessories at wholesale prices. OnSale is gambling that fees for service contracts, leases, handling charges, and advertising will allow it to cover its costs. OnSale will take orders for PCs and arrange for billing, while Tech Data will ship the products from warehouses in at least four states. The company expects to sell more than 31,000 new products at sizeable discounts from the manufacturers' list prices. OnSale's

goal is to cut out the middleman and give consumers a better deal.

The number one reason why PC purchases increased in 1998 is the demand for Internet and on-line access. Computer manufacturers are predicting that the PC market will continue to grow rapidly in 1999 and expect the average growth rate to be as high as 17 percent, as demand for Internet access continues to grow. These manufacturers are doing everything they can to convince consumers to purchase newer PCs. Many major manufacturers have joined with telephone and cable companies to promote broadband access. They have even joined these groups in lobbying before the Federal Communications Commission (FCC) for regulatory relief for regional Bell operating companies (RBOCs). Broadband access will spur consumers to purchase newer PCs that have universal serial bus (USB) connectors, DSL, or built-in cable modems. Additionally, some manufacturers have joined with the Home PNA and other home-networking alliances to promote their cause. This coordination with companies outside the industry is geared toward convincing consumers that they must purchase newer PCs sooner than planned.

The proliferation of alternative technology, such as WebTV and WorldGate Incorporated, has introduced families without PCs to the Internet. As consumers get more familiar with the Internet, they will spend more time on it. Consequently, they will begin to demand higher access speeds either through cable modems or DSL.

Internet Users

According to Banc Boston Robertson Stephens, there are 83 million Web users worldwide, the majority of which are in the United States. They also estimate that more than 300 million people use PCs at work; thus the potential population of on-line users could jump significantly if these users were on-line. Banc Boston Robertson Stephens estimates that Web use will grow by 25 million users each year, and in the year 2000, there will be 131 million Web users. However, International Data Corporation (IDC) estimates that the number of sub-scribers will actually be much higher, more than 200 million, for a growth rate of 36 percent. IDC also estimates that the number of home-office households will have a combined average growth rate of 9.3 percent, increasing from approximately 35 million at the end of 1997 to approximately 50 million by the end of 2002. Other estimates for the size of the Internet include 70.5 million by Nielson/CommerceNet, 67.1 million by Intelliquest, and 56.9 million by Media Metrix.

On-line audience sizes continue to grow dramatically, particularly with the help of broadband and e-mail access at home and work. According to a 1998 study by the Department of Commerce, 100 million people logged onto the Internet in 1997, up from 40 million people in 1996. Moreover, these figures continue to climb. Traffic on the Internet has doubled every 100 days, and Web use appears to grow at a rate of 10 million people per quarter. Jupiter Communications, a technology consulting firm, projects that 70 percent of all American households with PCs and

modems will be on-line by the year 2000. Today, only 35 percent of the population are on-line.

Since 1995, the number of commercial domain names (Web addresses that end in .com) has risen dramatically, from 27,000 to 764,000 at the end of 1997 and to 12.1 million at the end of 1998. The number of Web sites also has exploded. There were 130 sites in June 1993, 2,738 in June 1994, 23,500 in June 1995, more than 2.5 million in June 1998, and 43.2 million in January 1999.

In the past, each Internet host represented one computer. In 1997, however, the definition of hosts changed to reflect prevailing use of Internet host computers. Today it is common for a single computer to act as many hosts, with many names and many addresses. Network Wizards, the company that tracks the number of Internet hosts, stated that it became impossible to determine the exact size of the Internet by counting the number of computers acting as hosts and revised its counting methodology. The number of hosts as of January 1999 is 43.2 million.
Internet traffic data has shown a similar explosion and has doubled every three months. Bandwidth consumption and growth has been gained almost exclusively by adding new users and by current users using the Internet and the Web more. Moreover, according to Telegeography, corporate customers (who accounted for about half of all users) generated 0.4 Mbps of traffic during peak use in 1996, but 1.7 Mbps in 1998. Internet use will increase as drivers such as video-, music-, and network-based applications begin to represent a much larger percentage of future uses.

Most significant, the Internet growth rate is faster than that of television and radio when they were introduced. According to the Department of Commerce, television took 13 years to reach 50 million users, while radio took 38 years. The Internet reached 50 million users in only four years. Analysts from Robertson Stephens expect the Web's audience to double from 83 million people in 1998 to more than 130 million by the year 2000. This is compared with a total of 30 million users in 1996 and 57 million in 1997. This market expansion is driving dramatic increases in computer purchases as well as software and related hardware, (e.g., digital video disc (DVD) players, digital cameras, new storage facilities, advanced compact-disc (CD) equipment, and communications services).

Other Access Users
Additionally, many new digital appliances that will exploit communications of voice, video, and data across digital networks are on the horizon. Michael O'Dell of UUNet believes that silicon cockroaches, always-on devices such as mobile telephones, personal digital assistants, DSL and other broadband services, and any future multipurpose devices will be key drivers for bandwidth. Applications such as shopping robots, or bots, are gaining mass-market popularity. These devices require constant connectivity, and users are increasingly turning to them to assist them in their lives. The demand for bandwidth will increase as new consumer electronic devices are introduced.

Increasingly, consumer electronic manufacturers are installing silicon chips into all new consumer appliances. These appliances can be linked in a network or draw data remotely through wireless means to communicate with databases or other electronic components. Society has gone gadget crazy, and consumer manufacturers are feeding this frenzy. As more appliances have the capability of networking or IP access, and as consumers are increasingly turning to such devices to surf the Web or receive-mail, demand for always-on Internet access increases.

Forecasts for Broadband Access: Consumer and Business

Consumer

Demand for high-speed access to the Internet is growing larger and larger. In many parts of the country, there is a war going on between the cable operators and the telcos to determine who will be the high-speed access provider of choice to the millions of on-line users. Controlling the line to the home will enable the service provider to offer a host of value-added services as well as basic services such as telephony. It is clear that the cable operators' main purpose in providing high-speed broadband access to the home is for Internet and other data applications; however, the infrastructure they have built and installed can easily be used for voice applications such as telephony.

Analysts are split regarding which technology will be the winner, and thus the forecasts vary greatly. However, one clear trend emerges: unless telcos begin to market their DSL service aggressively to the mass market, they are in danger of being left behind. Cable operators have taken an early lead and are winning the access race. Already telcos are about a year behind in marketing this service. Deals such as the @Home $6.7 billion purchase of Excite in January 1999 drive home this point even more.

1999 will be a big year for DSL deployments, with significantly higher DSL deployments both in the business and in the consumer market. An industry panel convened by IEC for this report, however, thought that DSL would not become widely deployed until sometime in 2001, with many panel members thinking it would take until 2003 before DSL becomes widely deployed.

According to Salomon Smith Barney, consumer versions of DSL are far behind where they should be in terms of commercial deployment, relative to other competing technologies. DSL is behind other technologies because companies have not focused on deployment issues; rather, they have devoted their energies to debating standards, discussing technical problems with DSL, and fighting the FCC and other companies for access to their COs. However, the lack of progress on any sort of standardization of DSL modems and equipment is probably the most critical reason why commercial deployments are behind schedule. Concerns about regulation continue to delay regional Bell operating companies (RBOC) data initiatives. For a detailed explanation and overview of these issues, please see the regulatory chapter of the report.

Traditionally, cable service has been regulated and delivered as an integrated video, information, content, and conduit service. Cable operators are not subject to interconnection or facilities' unbundling requirements; rather they are subject to carriage requirements that require them to reserve channel capacity for certain programming provided by other entities. Cable operators and services are governed by Title VI of the Communications Act of 1934, while wireline telecom falls under Title II of the Act and enhanced or information (Internet and data) services are treated as nonregulated and regulated under the looser rules of Title I. Moreover, telecom carriers are regulated as common carriers while cable operators do not have these same regulatory burdens. Thus Internet access through cable systems is treated differently from Internet access over wireline networks. As a result, two parallel universes of regulations exist, one for cable operators and one for wireline operators.

This asymmetric regulation of Internet access, favoring cable TV operators over incumbent wireline operators is one of the factors that have delayed, and continue to delay, ILEC deployments of DSL. It also is one of the issues that have held back DSL deployments by data CLECs. If the regulatory situation were clearer and if the ILECs were not seeking to hold onto their monopoly over the local loop as long as possible, DSL deployments would occur at a faster pace than what we are seeing today. Hopefully, the resolution of many of the regulatory issues discussed in the later regulatory chapter will allow for a more rapid deployment of DSL in the consumer and business markets.

Salomon Smith Barney believes that cable Internet access will capture 25–30 percent of the market during the next five years. However, analysts from Credit Suisse First Boston think cable's penetration rate will be only 11 percent. Cable's penetration rate will depend on certain things, notably, pricing, customer and technical service, introduction of DOCSIS modems, and introduction of new set-top boxes that include modems. Equally important will be whether cable operators can form a partnership with AOL. Currently, relations between AOL and the cable operators are a bit tense, with AOL demanding that regulators deregulate cable infrastructure and allow AOL to purchase transport only from cable operators. If cable operators are unable to come to some amicable partnership with AOL, the current forecasts will change. AOL has more than 17 million subscribers and is a powerful force in influencing who has control over the broadband market. Currently, AOL has deals only with telephone and satellite companies, but this too will likely change.

Business

Data CLECs and ISPs appear to have a solid hold on the small-business, teleworker, and SOHO market, and it looks like they will keep this edge. These companies have stated that their strategy is first to target the small-business, SOHO, and teleworker market. After gaining a certain amount of business customers, these companies began to think of targeting the

residential market. Covad began targeting the residential market in late April 1999, more than a year after it began targeting the business market. The only companies that can challenge today's CLECs for the small-business and teleworker market are the ILECs, which seem to be ignoring the business market for fear of cannibalizing their T–1 revenue stream.

Data CLECs will continue to grow rapidly until they cover the United States. ISPs also are working hard to capture a large percentage of this market. Many ISPs are working in concert with data CLECs and ILECs to gain a larger share of the DSL market. ISPs represent the best chance consumers will have for competition in the DSL market. ISPs such as Concentric have made alliances with other data CLECs and even with ILECs and are using these alliances to attack the consumer and business markets. Concentric is targeting its service at high-volume consumers who had been paying more than $100 a month for ISDN access.

In the business market, DSL will be the chosen technology because it is unlikely that businesses will look to cable operators to provide service. Wireless technologies will have an easier time competing where there is no cable infrastructure, such as business districts or where the telephone network has not been upgraded to support DSL. Competition for wireless broadband services depends on the cost of these services. Although cost is a factor in all scenarios, it is much more a factor in wireless than in others.

Fixed wireless operators, such as Teligent and Winstar, are beginning to launch data offerings for the SOHO, small, and midsized businesses and could pose a threat to DSL in the next few years. Currently, there is no successful deployment of wireless services for broadband access that can indicate what users are willing to pay. However, any estimate for broadband access and for the percentages that DSL and fixed wireless will have must be based on factors such as geographic region, cost, and density of population in a region. After analyzing these factors, one can determine which technology will be most successful.

Consumer and Business Forecasts

In 1998, there were about 35,000 DSL lines in use (excluding HDSL), and these were primarily for small businesses and teleworkers, not consumers, as compared with 600,000 cable modems. According to the ADSL Forum, the GartnerGroup projects DSL lines to increase by more than 300 percent between 1997 and 2002, with more than 1 million DSL lines installed by 2001. All other consultants estimate that cable-modem subscribers will approximately double the number of DSL subscribers.

Allied, another market research firm, however, estimates that DSL will capture 37 percent of the market, with cable modems accounting for only 26 percent, satellites for 7 percent, and ISDN for 11 percent. The Strategis Group forecasts that DSL will not see much growth until after the year 2000 and will top off at

2.9 million in 2003. In comparison, Strategis estimates that there will be 6.2 million cable-modem households by 2003, roughly double the number of DSL households. The Yankee Group estimates that DSL sub-scribers will number 250,000 by 1999, against cable-modem subscribers of 1 million. They further predict that in the year 2000, while there will be more than 2 million cable-modem subscribers, DSL subscribers will total only 700,000. This trend continues in 2001, with an estimate of only 1.5 million DSL subscribers to cable's 3 million.

Insight Research states that by 2000, cable will have 11 percent market-share compared with DSL's 4 percent and by 2002, cable will have 22 percent penetration compared with DSL's 11 percent. Other forecasts include those of Forrester Research, which believes that cable operators will capture 80 percent of the broadband residential market, an estimated 16 million customers. Specifically, they believe that cable modems will grow from 600,000 in 1998 to more than 2 million in the year 2000, and 13.6 million by 2002. If Forrester Research's estimates are correct, the compound average growth rate for high-speed access for cable operators is 150 percent. Salomon Smith Barney predicts that the combined average growth rate for cable modems will be 87 percent.

Any estimates for broadband access and the percentages that DSL and cable modems will have must be based on factors such as geographic region, cost, and density of population in a region. After analyzing these factors, one can determine which technology will be most successful. Today, DSL and cable modems compete in few places, but this will change dramatically in the coming year, as both the cable operators and the ILECs begin aggressive rollouts of broadband access. In 1998, there were only about 30,000 DSL lines in use, not including HDSL lines used as repeaters, as compared with 600,000 cable modems; neither represents any significant penetration rate of the 101 billion people in the United States.

In summary, it is believed that in consumer or residential markets where cable infrastructure is firmly in place, including customer service and back-office operations, cable-modem technology will be more successful for mass-market consumers than DSL technologies. This will be especially true in rural areas covered by cable, where loop lengths are too long for ADSL or other DSL technology to work. Here, cable is the winner. Some analysts originally thought that rural cable systems would not have the cash necessary to upgrade and in many cases rebuild their systems, but this too has changed. Several broadband-access companies are currently working with rural cable companies to help them upgrade their plants, even @Home, the largest broadband-access company funded by the large multiple-system operator (MSO), had created a program that specifically targets the smaller rural cable companies. Besides upgrading their network, rural cable systems can look to technology to solve some of their plant and capacity problems. Terrayon's system can turn a one-way cable plant into a broadband-access plant through the use of spread spectrum technology.

DSL vs. Competing Broadband-Access Technologies

The demand for higher-speed access to the Internet has motivated telecom and cable suppliers to come up with different solutions for meeting these needs. Cable operators had already begun upgrading their networks to handle more channels and offer more services before the Internet and the Web became household items. Cable operators were primed to take advantage of this opportunity to provide high-speed access because, once their network was upgraded, adding high-speed access would not be a large expense. Additionally, these operators saw that if they speeded up their planned upgrades, they could take a large chunk of the market for broadband-consumer access. Cable operators had been watching as other video competitors, such as DBS operators, had been taking away their customers and saw broadband access as an additional value-added service they could offer to keep customers from switching to DBS and to bring in higher revenue and a large share of the data market.

Demand for bandwidth has led to several technological approaches developed to provide broadband access to business and residential customers. DSL is just one means of achieving high-speed access; there are numerous other ways of achieving the same or higher bandwidth. One way is through cable modems. Although DSL has numerous advantages, other means of obtaining high-speed access may be preferable. This chapter will compare the relative strengths and weaknesses of the competing technologies for the consumer market as well as for the SOHO and small-business market.

The competing technologies that will be discussed are cable modems, broadband satellites, and wireless. Three new wireless technologies are beginning to challenge traditional wireline and cable for the data market: LMDS, MMDS, and fixed wireless. The chief advantage of wireless technology is the speed of deployment. Another big advantage of wireless is that a large portion of deployment costs is incurred only when a customer signs up for service. Because microwave can be rolled out on a segmented basis, it is often less costly than other technologies, especially for carriers penetrating a new market or in regions with widely dispersed customers.

Broadband wireless systems consist of a radio transmitter that sends a signal on a combination of channels to numerous receivers, including homes and businesses. Digital versions of wireless cable promise to provide digital TV, interactive services, high-speed Internet access, and data networking services. Breakthroughs in digital technology and digital compression now permit operators to dramatically increase the amount of data that can be sent in a finite amount of spectrum. Each of the three wireless technologies operates on a different part of the radio spectrum. Spectrum allocation varies widely from country to country and is controlled by regulators.

Providers of the three technologies being analyzed have a common desire to provide broadband access to as many people as possible. Cable operators, satellite providers, and wireless providers are targeting the same group— small businesses, SOHOs, and teleworkers. However, only cable operators, ILECs, and some ISPs are targeting the consumer market. ILECs will predominantly use ADSL, RADSL, or ADSL Lite, while ISPs will use either of these or SDSL.

Cable modems, because they are already being deployed rapidly, are the most direct competitor to mass-market residential DSL service. Cable modems can offer speeds as high as 10 Mbps, much faster than all but VDSL technology. Additionally, once the cable plant has been upgraded to two-way broadband, adding high-speed access is extremely cheap. Most of the expense for cable operators is in upgrading the plant to carry two-way traffic. Once accomplished, the cost of adding subscribers is incremental. Adding new subscribers on a traditional wireline network is expensive, as it is on a wireline network.

Conclusions

DSL technologies can be successfully deployed without having technologies obtain official certification— SDSL is one example. SDSL has never gone through any of the official standards bodies, yet it is one of the most popular DSL technologies in the business market. Thus, IEC's expert panel members thought that while standards coordination has been one of the factors delaying the deployment of DSL technologies, it will be less of a problem in the future. Many DSL technologies in use today will likely never obtain official status by any standards body. The only standards that have gone through the normal standards-accreditation process are ADSL and ADSL Lite.

Although establishing standards is critical to a successful deployment of DSL, technology is in many cases moving much faster than standards bodies and government regulators can handle. In the past, government regulators could have taken time to create new standards; however, Internet time precludes this from occurring. The FCC and other state regulators are attempting to modify regulations and work with the standards bodies to create new standards, but this takes time. Unfortunately, time is the one commodity that vendors and carriers do not have. This is particularly important in the area of spectrum compatibility. Currently, there is a lack of long-term standards and practices concerning spectrum compatibility and management As the report pointed out, Spectrum management policies and practices differ from state to state, making it extremely hard to determine which type of interference will occur in the lines as DSL becomes widely deployed throughout the business and consumer markets.

Other regulatory issues also have been a significant hindrance to the deployment of DSL technology. These have basically surrounded local competition and advanced services. Since 1999, through various courts and other legal battles, ILECs have managed to postpone opening their networks to competitors. As a result, DSL technology has not become widely available at reasonable prices until the past few months. However, now that these legal battles have been concluded and the FCC has adopted new tougher rules that clearly spell out the rights that CLECs have to obtain the necessary interconnection and co-location within the ILEC CO, regulatory issues should begin to recede into the background, instead of being one of the largest factors hindering the delay of DSL deployments.

IEC's panel of experts were split about whether the government would continue to have a role in standards-setting issues, especially as they concerned the Internet and the ability to use DSL or other advanced technology to bypass certain regulations, specifically those regulations imposed on ILECs and other common carriers, concerning the role that IP telephony would have in the market. Government reaction to IP telephony and other technologies, such as Internet access over cable, have resulted in the creation of huge cracks in previous government regulatory frameworks.

In summary, it is believed that in consumer or residential markets where cable infrastructure is firmly in place, including customer service and back-office operations, cable-modem technology will be a more successful technology for mass-market consumers than DSL technologies. In the business market, DSL will be the chosen technology, as it is unlikely that businesses will look to cable operators to provide service. Wireless technologies will have an easier time competing where there is no cable infrastructure, such as business districts or where the telephone network has not been upgraded to support DSL.

As highlighted in the report, the business case for DSL depends greatly on how it will be used and who will be using it. The type of consumer purchasing DSL also determines the price that can be charged and the type of access chosen. We have arranged the business cases for DSL into four categories: remote access to a corporate LAN; high-speed broadband access by residential or business users; high-speed access needs of the hospitality or campus environments; and the creation of home networks (i.e., home-based LANs). There is an excellent business case to be made for consumer and telecommuter access to corporate LANs as well as to high-speed Internet access.

As discussed in the report, a CLEC’s main advantage over ISPs, lies in its ability to gain access to the ILECs’ copper loops. Accordingly, it is much easier for CLECs to use DSL technology as a bypass solution and also for deploying DSL technologies in the workplaces of small businesses, teleworkers, and consumers. Regulatory and revenues considerations have forced ILECs to service the consumer market, rather than attacking the more lucrative business markets. As such, DSL rollouts by ILECs have only now began to be announced and marketed.

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About the Author

Judith Hellerstein has more than 10 years' experience in business and competitive analysis in the telecommunications and technology markets. Ms. Hellerstein has a master's in public administration with a concentration in international management from Columbia University. Before founding Hellerstein & Associates, she worked for MCI Communications, the Federal Communications Commission, the Office of the Vice President of the United States, and two New York government agencies.