Connecting to the Home: Alternatives for the Last Mile

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Executive Summary

In the mid-1990s, the Internet became the third electrical medium—after the telephone and television (TV)—that people using personal computers (PCs) at home can use to obtain or exchange information globally. Traffic on the Internet may now surpass current voice network traffic.

Most residential users in both the United States and Japan access the Internet through the public switched telephone network (PSTN). With the 56 kilobit per second (kbps) modem, the actual downstream speed of PSTN Internet access is around 40 to 50 kbps, and upstream speed is up to 33.6 kbps—both are upper limit speeds over a PSTN line. Higher speed connectivity proposed or provided as of 1997 includes the integrated services digital network (ISDN), community access TV (CATV), digital subscriber lines (DSLs), satellite communications, mobile communications, local multipoint distribution services (LMDS), and multichannel multipoint distribution services (MMDS). Internet access via a high-altitude, long-endurance platform (HALE) or electric power lines has also been proposed.

Two important kinds of contents require high-speed Internet access, streaming video and audio and embedded software files. Some streaming video contents require 300 kbps access, and the PSTN cannot be used for them. Some software files delivered over the Internet sometimes are embedded in and enhance the look of World Wide Web pages. High-speed Internet access is indispensable for quick downloading of such software files.

As ways to access the Internet emerge and become available, users' choices widen. A variety of high-speed Internet access services are available as of early 1998. To select the service preferred, users must check actual availability, price, and quality. Certain factors will affect users' choice of service: contents; "user friendliness" of the interface (or navigation) guide; and Internet TV devices.

Chapter One

Introduction

In the mid-1990s, the Internet became the third network—after telephone and television (TV)—that people at home and primarily equipped with personal computers (PCs) can use to obtain or exchange information, or both. Electronic mail (e-mail) can be exchanged among Internet users worldwide. Text documents and images, audio and video programs all can be retrieved any- and everywhere. Enterprises can announce their products to the globe. Even individuals can show their own work or opinions to every other Internet-connected person. By the end of 1997, the Internet reportedly had about a hundred million users worldwide, more than half of them in the United States and Japan. The United States has been estimated to have 54.68 million Internet users, Japan, 7.97 million.[1]

According to Reed E. Hundt, former chairman of the Federal Communications Commission (FCC), traffic on the Internet may surpass current voice network traffic.[2] The amount of bandwidth that the Internet uses exceeds that for telephone between the United States and Japan.[3] In 1997, the Internet was already one of the main networks that mediate the distribution and exchange of digital data (text, image, audio, and video). The Internet increasingly carries many different kinds of digital data, and users with easy access to it, wherever they may be, can use those data.

The development of analog modem technology has made the public switched telephone network (PSTN) convenient for Internet access, while the integrated services digital network (ISDN) is of interest particularly in Japan. Cellular telephony and personal communications services (PCS) also are used for Internet access, and the community access television (CATV) and satellite communications industries both plan to offer high-speed Internet access through their networks. In competition with these various interests and industries, local exchange carriers (LECs) plan to provide a high-speed data transmission service using existing copper subscriber lines. Will all these services compete with one another? Or will a complementary relationship develop?

Almost worldwide, the Internet, or the "information superhighway," is considered an important development, both for what it already is and for what it may become. For industry, it is a major facilitator of commerce. For governments, it is a way to be "global," "competitive," and

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[1]See Computer Industry Almanac, Inc., "Top 15 Countries with the Most Internet Users," press release, 12 Jan. 1998, [On-line.] URL: <www.c-i-a.com/199801pr.htm> (Accessed 13 Jan. 1998.)

[2]Quoted in "Hundt Looks Ahead to Era of Packet-Switched Networks," *Telecommunications Reports* (27 Oct. 1997), 10.

[3]See Internet Association of Japan, *Internet White Book '97* (Tokyo: Impress, 1997), 27.

"up to date." For the telephone industry in particular, it may be the next major area of growth and a generator of revenue. All of these players see the same bottleneck retarding the growth of the Internet or information superhighway: lack of universal, high-speed access. The central questions that arise are, how can that be achieved, and who will get to provide it. This report reviews the state of the art: What is the frontier, and who occupies what territory there? Readers are free to follow up the implications of particular interest to them.

There remains one obvious question: Who is likely to win the competition to provide this access? The answer is not yet known, and the author finds little value in trying to handicap or weight the contenders. Instead, the report offers the observation that each of the contenders seeking to enter this market believes itself to have a good chance.

Chapter Two describes emerging ways for residential users to connect to the Internet, now and in near future, and **Chapter Three** discusses the relationships among the different kinds of connectivity.

Chapter Four examines the relationship between technology and streaming video contents on the Internet, including the differences and similarities between streaming video contents and TV programs. Users want greater speed for Internet access, because the size of data contents on the Internet has been growing steadily, especially streaming video contents, increasingly transmitted over the Internet, which require high-speed Internet access. The quality of streaming video is limited primarily by the speed of Internet access. This chapter summarizes the technological characteristics of such streaming contents and describes ways by which users can choose the contents—images, text, video, or audio—they want to see on the Internet, including mention of software programs delivered over the Internet.

Chapter Two

Electrical Connectivity Between Homes and the Internet

The electrical paths that link residences to Internet access points are cable and wireless. There are three kinds of cable: twisted-pair copper, coaxial copper, and optical fiber. The PSTN, ISDN, and digital subscriber lines (DSLs) all use twisted-pair copper cable for access to the Internet, while CATV and access by cable modem use coaxial copper cable. As of 1997, optical fiber cable was rarely used to connect individual homes, but it may be constructed in the future. As of that date, the cable networks that connect homes to the Internet are the PSTN, ISDN, DSLs, and CATV. Wireless paths for Internet access are satellite communications, mobile communications (cellular phone and PCS), and wireless local loop (local multipoint distribution services [LMDS] and multichannel multipoint distribution services [MMDS]). See **Table 2-1**.

This chapter briefly explains the features of these services.

Limits to the actual data transmission speed of the Internet are set by access lines, backbone networks, and servers. This report focusses on access lines, but, where relevant, the other elements are mentioned.[1]

2.1 PSTN

PSTN lines are available to almost every home in both the United States and Japan. Analog modems are used to connect PCs to the Internet by PSTN lines. Since the beginning of 1997, 56 kilobits per second (kbps) modems have been available at the price of U.S. $100 to $200. It is a primary choice for those who want to access the Internet because phone lines are common in almost all homes.

Standardization of the 56-kbps modem is in process as of 1997, with completion planned for early 1998,[2] but until then two incompatible modems are in the market. Though both are

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[1]Some Internet Service Providers (ISPs) use caching systems to avoid congestion on servers or backbones. These systems allow the latest data of most popular servers to be temporarily cached and transmitted to users requesting the contents, without the users needing to access the actual servers. ISPs may even provide a menu page to guide users to those contents. This may be a good solution for high-speed access services, one that does not require the ISPs to address problems of servers or backbones, but it is not effective for transmitting contents that are not cached.

[2]In February 1998, modem manufactures reportedly accepted a "56-kbps standard here," *CNET News.Com* (6 Feb. 1998), [On-line.] URL: <www.news.com/News/Item/0,4,18896,00.html> (Accessed 12 Feb. 1998.)

Table 2-1

Electrical Connectivity for Internet Access, 1997

		Connectivity Options									
		PSTN	**ISDN**	**ADSL**	**CATV**	**Cellular, PCS, PHS**	**Satellite (GEO)**	**LMDS**	**MMDS**	**HALE**	**Power Line**
Medium:		Twisted-pair copper cable	Twisted-pair copper cable	Twisted-pair copper cable	HFC	Wireless	Wireless	Wireless	Wireless	Wireless	Electric
Expected Maximum Data Speed	**Down stream to home**	56 kbps	128 kbps	8 Mbps	27 Mbps per channel	cellular or PCS: 14.4 kbps PHS: 32 kbps	400 kbps	1.5 Gbps	27 Mbps per channel	2 Mbps	1 Mbps
	Up-stream from home	33.6 kbps		1 Mbps	10 Mbps		NA	200 Mbps	NA		

ADSL = asymmetrical DSL
CATV = community access TV
DSLs = digital subscriber lines
GEO = geosynchronous orbit
HALE = high-altitude, long-endurance platforms
HFC = hybrid fiber coax
ISDN = integrated services digital network
LMDS = local multipoint distribution services
MMDS = multichannel multipoint distribution services
NA = not applicable
PCS = personal communications services
PHS = personal handy-phone system
PSTN = public switched telephone network
Gbps = gigabits per second
kbps = kilobits per second
Mbps = Megabits per second

called 56-kbps modems, their actual speed is 40 to 50 kbps,[3] depending on the quality of the PSTN line.[4] Sometimes because of line problems the connection speed of a 56-kbps modem is no more than 33.6 kbps, which is the speed of the former generation of modems. Users are unable to rectify these problems, because PSTN lines do not guarantee the transmission of digital data.[5]

The 56-kbps modem system used for the PSTN is a hybrid of the PSTN and ISDN. Residential 56-kbps modems are connected to the PSTN, whereas those used by ISPs are connected to the ISDN. The actual analog portion of the connection is between users at home and the central offices (COs) of their PSTN. Even though analog modem technology has developed rapidly since the late 1980s, from 0.3-1.2 kbps to 33.6–56 kbps, it appears to have reached an upper limit. The theoretical maximum speed of the PSTN analog modem is around 35 kbps if both the user and the ISP are connected to the PSTN, or 56 to 64 kbps if the user is connected to the PSTN and the ISP is connected to ISDN.[6] As the number of 56-kbps access points increases, more ISPs will be equipped to use ISDN. In a sense, the development of the 56-kbps modem has accelerated the ISPs' deployment of ISDN.

In the United States, users can usually choose a flat-rate service for local calls, and most Internet access providers offer flat-rate services, typically $19.95 a month.[7] If the phone charge

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[3]Using the data compression function increases the actual speed of data transmission, and using the data compression protocol V.42 increases the speed fourfold, to the maximum. For example, if V.42 is used with a 56 kbps modem, the data downstream speed could be as much as 200 kbps. But much of the digital data on the Internet is already compressed, so the data compression function of the modem has little effect. In this report, the speed of a modem is the speed without data compression.

[4]See Les Freed, "Fast Connections For All?" *PC Magazine* (21 Oct. 1997), 104; the article estimates the percentage of phone lines not capable of 56 kbps connection to be between 25 and 40 percent.

[5]Bell Atlantic has reported that its optional wire maintenance plans do not cover "problems resulting from modem use on a standard voice line." See John Rendleman, "Bell Atlantic to Modem Users: Don't Call Us," *Internetweek* (13 Oct. 1997), 1, 14.

[6]As of 1997, transit networks for the PSTN are mostly digitized. The analog voice signal from home is digitized at the CO, in an analog-to-digital conversion. The digitized voice signal is transmitted at 64 kbps through transit networks. At the CO of the other party, the digitized voice signal is converted to analog voice, in a digital-to-analog conversion. In an analog-to-digital conversion, quantization noise occurs, which limits the data speed of an analog modem to about 35 kbps. However, in a digital-to-analog conversion, this noise does not occur. By connecting a 56-kbps modem system of the ISP directly to ISDN, the analog-to-digital conversion is eliminated in the direction from ISP to the home. Data are transmitted digitally from the ISP to the CO of the user through ISDN. The data are converted into analog signals at the CO of the user. Because there is no analog-to-digital conversion in this process, a 56-kbps downstream speed is possible. But a 56-kbps modem signal, for upstream data from the user to the ISP, is digitized at the CO in an analog-to-digital conversion in which quantization noise occurs. For that reason, the upstream data speed of a 56-kbps modem is in actuality limited to 33.6 kbps. See 3Com, "Shatters the Speed Barrier," [On-line.] URL: <www.x2.usr.com/technology/whitepapers.html> (Accessed 19 Nov. 1997.)

[7]See Leon Erlanger, "Internet Service Providers, Choosing Your ISP," *PC Magazine* (9 Sept. 1997), 216-217. In February 1998, America Online (AOL), the biggest ISP, announced that in April 1998 it would increase its monthly charge for unlimited use from $19.95 to $21.95, "in order to fund continued improvement of its members' online experience and keep pace with the cost of members' increased usage." This could be the beginning of a new typical

including a flat-rate service for local call is around $20,[8] users can access the Internet at 56-kbps speed endlessly for around $40 a month, which includes the ordinary telephone bill and the charge for Internet access.[9] This rate sets a start point for considering the terms for choosing among other Internet access services, because the ordinary telephone line remains today the easiest way to access the Internet.

In Japan, a flat-rate service for local calls is available only after midnight. The Internet access charge is around ¥2,000 ($20)[10] a month, but connection time is limited typically to fifteen hours.[11] After fifteen hours, users must pay surcharges. The additional local call charge is ¥3,000 ($30) (or ¥1,800 [$18] with a flat-rate contract, all calls must be placed between 11:00 P.M. and 8:00 A.M.). The basic charge for PSTN service is ¥1,750 ($17). Thus, Japanese users can access the Internet for fifteen hours at a cost of ¥6,750 ($67) a month. See **Table 2-2**.

Table 2-2

PSTN Service: Examples from the United States and Japan, 1997

	United States	Japan
Speed (maximum)	56 kbps downstream 33.6 kbps upstream	56 kbps downstream 33.6 kbps upstream
Residential Monthly Charge	$40 for unlimited time: • $19.95 to ISP • $20 to LEC	$67 for 15 hours: • $20 to ISP • $30 to LEC as PSTN connection charge • $17 to LEC as PSTN basic charge

ISP = Internet service provider
LEC = local exchange carrier

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price. See America Online, "AOL to Increase Price for Unlimited Use by $2 Monthly Starting in April," press release, 9 Feb. 1998, [On-line.] URL: <www.db.aol.com/corp/news/press/view?release=299&> (Accessed 12 Feb. 1998.)

[8]In the Boston, Mass., area, Bell Atlantic provides flat-rate local call service for residential users for $16.85 a month.

[9]This is not an additional phone charge for subscribers to the flat-rate local call service for voice communication, because these subscribers do not need to subscribe again for data communication. The unlimited 56 kbps Internet access charge of $19.95 a month includes the phone cost. Some subscribers may need another phone line if they access the Internet for many hours a day, because they will need to satisfy the ordinary telephone needs of the family.

[10]As stated, ¥100 is roughly equivalent to U.S. $1.00.

[11]Japanese ISPs may claim that the difference in price in the United States and Japan comes from the high cost of dedicated lines and of connections to ISPs or Network Access Points in the United States. As for the latter matter, they insist providers in the United States should pay a portion of costs of the Internet backbone to connect between the United States and Japan like the case of ordinary telephone network. See "Nichibei-kan no Internet setsuzoku cost, Nippon ha haraisugi?" [Does Japan Pay Too Much for the Cost of Connecting the Internet Between Japan and the United States?], *Nikkei Communications*, 1 Sept. 1997, 126-127.

2.2 ISDN

ISDN guarantees transmission of data at 64 kbps per B-channel.[12] Because one ISDN line has two B-channels, the maximum connection speed for ISDN Internet access is 128 kbps using the two B-channels simultaneously. ISDN B channels can be multiplexed, so that users get 256-kbps Internet access using two ISDN lines, or 384 kbps using three ISDN lines—if, of course, their ISPs offer such services. ISDN can wholly replace the PSTN: it uses the same copper lines as the PSTN, and its customers' peripheral equipment usually has analog ports, to which an ordinary telephone can be connected.

In Japan, ISDN lines are replacing PSTN lines among users desiring Internet access. The major ISPs have ISDN access points in major cities. Users use these access points without a surcharge for ISDN Internet. The fees for Internet access in Japan through the ISDN and the PSTN are the same: each charges a basic monthly fee (a similar amount) as well as a usage-based fee. In the United States, access points are limited.[13] Although in the U.S. LECs promote ISDN, few ISDN lines are available for Internet access.[14]

ISDN is faster and more stable than the PSTN for data transmission, but with the release of the 56-kbps PSTN modem the difference in speed was reduced. ISDN has a 16-kbps D-channel, used to transmit control signals and X.25 packet data. D-channel packet data service suggests the possibility of an "always-on" Internet connection that will enable users to connect to the Internet always, just as with dedicated lines.[15] Building the ISDN is comparatively easy for carriers, because it uses existing copper twisted-pair lines for subscriber lines. The main reason the ISDN is not available in some areas of the United States is the distance between the subscriber and the CO.[16]

In Japan, after low-cost terminal equipment to adapt PCs for the ISDN became available in 1996, ISDN became popular for Internet access. The prices of ISDN equipment remain high for individual users, in comparison to the prices for PSTN modems. The per-use rate of ISDN is the

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[12]The B-channel is the data transmission path of ISDN.

[13]As of 1997, AOL, the biggest ISP, does not have an ISDN access point.

[14]See also section 2.9.

[15]That is, always connected to the Internet, so that, for example, e-mail messages are automatically delivered to the mailbox of the user's PC. See Shinsuke Kawasaki, "ISDN 200-man kaisen jidai" [The Era of 2 Million ISDN Lines], *Nikkei Communications*, 4 Aug. 1997, 80-81.

[16]Most central switches are now digitized in the United States and Japan. For example, Nippon Telegraph and Telephone (NTT) announced that it would complete digitization of domestic switches in December 1997 ("NTT Completes Digitization of Domestic Telecommunications Network," press release, 6 Nov 1997, [On-line.] URL: <www.nttinfo.ntt.co.jp/NR/1997/11_6_2.html> (Accessed 24 Nov. 1997.) Digitized switches easily provide ISDN services using supplemental devices or as the basic function of the switch. The existing phone cable can be used for ISDN, usually with no additional devices. If the distance between the user's home and the central office is too great, repeaters may needed.

same as that of PSTN, and the monthly charge for one ISDN line is roughly twice that for the PSTN. This difference is reasonable, because one ISDN line has the capacity of two B-channels; put another way, the capacity of two PSTN voice lines is roughly equivalent to that of one ISDN line. Users who access the Internet and need two PSTN lines began to use ISDN when the prices for terminal adapters went down. In the first half of FY1997, in Japan the number of PSTN lines decreased by 0.5 percent while ISDN lines increased 124 percent.[17]

In the United States, using ISDN is more expensive than using two PSTN lines. The monthly charge is greater than for two PSTN lines.[18] Flat-rate services for 64-kbps data transmission are limited. Though ISDN terminal adapters are not so expensive in the United States, ISDN is not so popular. Recently, though, carriers began to promote ISDN for Internet access. For example, Bell Atlantic offered a discount in the installation fee of ISDN in 1997 for residential ISDN subscribers. Pacific Bell offers limited flat-rate service for data transmission of ISDN.[19] See **Table 2-3**.

ISDN could replace the PSTN completely. It features voice communication and 64 to 128-kbps data transmission. In Japan, replacement of the PSTN with ISDN was popular among Internet users before 56-kbps modems became available at the beginning of 1997. By contrast, in the United States, 56-kbps modems were available before ISDN became popular for Internet access; in some areas of the country, further, faster access services, which used cable modems, satellite, and ADSL, had already started.

2.3 CATV

The CATV network was designed to distribute TV programs to homes. It usually consists of copper coaxial cable, which can transmit more data than twisted-pair copper cables. Any channels or bandwidth available for other than TV signals could be used to transmit digital data using cable modem technology. To transmit data on the frequency band of one TV channel, the downstream (to the home) data transmission speed is 27 Mbps, using current modulation technology, and for

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[17]See Noburu Kojima, "NTT no 9-gatsu chukan-kessan, gen-syu gen-eki" [NTT's Statement of Accounts in September Shows a Decrease in Income and Profits], *Mainichi Daily Mail Internet*, 21 Nov. 1997, [On-line.] E-mail: dm-info@mainichi.co.jp.

[18]In 1997 in Boston, the monthly charge for residential ISDN is about $33, which includes the line charge ($13.41) and an ISDN service charge ($19). This monthly charge is more than twice that for the PSTN (about $14), which does not include flat-rate local-call service for voice. Flat-rate local-call service for ISDN is available only for voice communication at the same price as the PSTN. Prices for ISDN are from Bell Atlantic's World Wide Web (WWW) site, "ISDN Pricing and Availability," [On-line.] URL: <www.nynex.com/isdn/isdn.html> (Accessed 6 Oct. 1997.)

[19]Local usage, including data transmission, on weekday nights and weekends is at a flat-rate for the first two hundred hours of every month. For details, see Pacific Bell, "FasTrak Personal ISDN, Pricing and Availability," [On-line.] URL: <www.pacbell.com/products/business/fastrak/networking/isdn/home-isdn/pricing.html> (Accessed 31 Dec. 1997.)

Table 2-3

ISDN Service: Examples from the United States and Japan, 1997

	United States	Japan
Speed	64 kbps for 1 B-channel	64 kbps per 1 B-channel
Residential Monthly Charge	$83 for 15 hours • $19.95 (monthly charge) + $15 (per use charge) to ISP • About $15 to LEC as ISDN data connection charge • $33 to LEC as ISDN basic charge	$78 for 15 hours • $20 to ISP • $30 to LEC as ISDN connection charge • $28 to LEC as ISDN basic charge

Note: IBM Internet: $1/hr. Microsoft Network (msn): monthly charge = $49.95 for unlimited use. ISDN charges to LEC based on Bell Atlantic (Boston, Mass.).

upstream (from the home) data transmission, the speed is 768 kbps to 10 Mbps.[20] But because subscribers share bandwidth, the actual access speed for each user could be far slower.[21] Downstream channels could be added, but adding them would decrease the number of channels available for TV programs.

In the United States, CATV service was available to almost everyone.[22] The CATV network was originally a coaxial network, but to increase channel capacity and improve signal quality it needs to be upgraded to a hybrid network of optical fiber and coaxial cable, called hybrid fiber coax (HFC).[23] HFC can provide two-way data transmission. It is "serving 10 million U.S. homes" and coaxial cable is "serving more than 50 million U.S. homes."[24] Since 1991, homes subscribing to CATV have stayed flat, at around 60 percent,[25] so CATV companies have good reason to offer new services, such as CATV Internet services, to gain more revenue.[26] Because upgrading to provide Internet access costs about $1,000 per subscriber[27], CATV Internet access service was

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[20]For details, see George Abe, *Residential Broadband* (Indianapolis, Ind.: Macmillan Technical Pub, 1997), 189.

[21]For example, if ten users download files from the Internet simultaneously, the speed is reduced to one-tenth for each user.

[22]Ibid., 161.

[23]Ibid., 166-168. Abe pointed out two more reasons, robustness and ease of design and operation.

[24]Les Freed, "Faster Connections," *PC Magazine* **17**, 3 (10 Feb. 1998), 229.

[25]Abe, 217.

[26]CATV Internet, as TV, has an advantage for providing Internet access through TV. CATV signals are delivered to TV sets through set-top boxes. As of 1997, CATV Internet services were provided mainly to connect PCs, a situation that may change in the future with installation in many homes of digital set-top boxes with Internet TV access. See section 5.3.

[27]Abe, 213.

available in 1997 only in limited areas of the United States. It is welcome in areas where CATV is already provided.[28]

In Cambridge, Massachusetts, for example, MediaOne™ provides a CATV Internet service. Subscribers get up to 1.5 Mbps for downstream and 300 kbps for upstream through the CATV network.[29] The monthly charge is $39.95 for CATV subscribers and $49.95 for nonsubscribers. The installation charge is $99, and a network interface card for a PC is $49.[30] Compared with charges for the PSTN, these appear attractive for those desiring high-speed Internet access.

Because direct broadcast satellite (DBS) companies provide more channels than CATV for digital TV programs, this service is gaining in popularity in the United States, and CATV companies are upgrading from only coaxial networks to HFC to increase the number of channels they can provide and improve the quality. This move may accelerate the preparation of infrastructure for CATV Internet access.[31]

In Japan, the spread of CATV networks is limited, but CATV companies are considering providing CATV Internet services and in 1997 some already provided them. For example, Musashino-Mitaka Cable Television provides CATV Internet access at a monthly charge of ¥7,100 (U.S. $71),[32] which includes ten hours of Internet access at up to 10 Mbps. Many CATV companies conducting trials of CATV Internet may begin service in 1998. See **Table 2-4**.

2.4 DSLs

DSLs in reality encompass all kinds of cable, physical or wireless, but in this report DSLs are limited to only twisted-pair copper cable because nearly all homes have that kind of cable.

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[28]For example, *PC Magazine* columnists Bill Howard and Bill Machrone celebrated the speed of CATV Internet at their homes. See *PC Magazine* (7 Oct. 1997), Bill Howard, "The Cable Modem Guy," 95, and Bill Machrone, "Speed Kills: The Dial-up Internet," 85.

[29]See MediaOne, "50 Times Faster," [On-line.] URL: <www.mediaone.com/express/northeast/files/faster.html> (Accessed 15 Dec. 1997.)

[30]See MediaOne, "The Best Prices," [On-line.] URL: <www.mediaone.com/express/northeast/files/best_price.html> (Accessed 15 Dec. 1997.)

[31]Using digital compression on a coaxial CATV network is another way to increase the number of channels and improve the quality of transmission, but it does not enable CATV networks to provide two-way data transmission. Even if new set-top boxes for digital CATV include the feature of CATV Internet browsing, other lines, for example, the PSTN, are needed for upstream data transmission. See FCC, *Fourth Annual Report*, 13 Jan. 1998, CS Docket No. 97-141, Para. 172, [On-line.] URL: <www.fcc.gov/Bureaus/Cable/Reports/fcc97423.pdf> (Accessed 15 Jan. 1998.)

[32]See Musashino-Mitaka Cable Television, Ryokin no goannai [Price List], [On-line.] URL: <www.mmcatv.co.jp/INPRICE.HTML> (Accessed 25 Feb.1998.)

Table 2-4

CATV Service: Examples from the United States and Japan, 1997

	United States: MediaOne (Cambridge, Mass.)	Japan: Musashino-Mitaka Cable TV (Tokyo)
Speed (maximum)	1.5 Mbps downstream 300 kbps upstream	192 kbps to 10 Mbps
Residential Monthly Charge	$39.95 for CATV subscribers $49.95 for nonsubscribers to CATV, unlimited time	$71 for 10 hours

Twisted-pair copper cable, used for the PSTN, can transmit higher speed data with special modems that use upper frequency bands. The central switch for the PSTN, in contrast, manages up to 3.4 kHz voice and digitizes it as 64-kbps data. These characteristics limit the speed of PSTN modems to up to 56 kbps.[33] DSLs modems must be used at both ends of the twisted-pair copper cable. A DSL modem, located anterior to a central switch, uses the full capacity of twisted-pair copper cable. There are several types of DSLs: ADSL, the most commonly used (downstream 1.5M to 8 Mbps, upstream 16k to 1 Mbps); high bit rate DSL (HDSL; 1.5M to 2 Mbps); and very high bit rate DSL (VDSL; downstream 13 M to 55 Mbps, upstream 1.6 M to 2.3 Mbps). ADSL is more popular for Internet access, because users receive more and send less data from servers on the Internet[34] and because the distance between a CO and a home can be much longer with ADSL (2.7 to 5.5 kilometers [km]) than with VDSL (0.3 to 1.5 km).[35]

Ameritech™, for example, started ADSL Internet access service in Ann Arbor, Michigan, in December 1997 and plans to start it in Chicago in mid-1998. According to the company's announcement, the service provides unlimited Internet access service of up to 1.5 Mbps downstream and up to 128 kbps upstream for $59.95 a month. The installation charge is $150 and the modem cost is $199.[36] The monthly charge for this service is higher than for CATV Internet,

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[33]For details, see section 2.1.

[34]For example, when browsing a Web page, users send a small amount of data, including the location of the page; then they receive a large amount of text and image data that comprise that Web page.

[35]See Hiromi Nakagawa, Hiroyasu Mizuno, and Takahiro Kikuchi, "xDSL no zenbou" [All about xDSL], *Nikkei Communications*, 18 Aug. 1997, 81.

[36]See Ameritech, "Ameritech Launches High-Speed Internet Service," press release, 9 Dec. 1997, [On-line.] URL: <www.ameritech.com/news/releases/dec_1997/09_01.html> (Accessed 30 Dec. 1997.) As for other ILECs, U S West started DSL service, 192 kbps Internet access for $59.95 a month, in Phoenix, Arizona, in October 1997. See U S West, "U S West Takes Wait out of Getting On-Line With First-in-Nation Consumer and Business Offer of High-Power DSL For Speedy, 'Always-On' Internet Access," press release, 28 Oct. 1997, [On-line.]URL: <www.uswest.com/com/insideusw/news/102897.html> (Accessed 30 Dec. 1997.) Pacific Bell began a marketing trial in California in 1997. See Pacific Bell, "FasTrak DSL, Frequently Asked Questions," [On-line.] URL:

but because the line for ADSL access is not shared users can use the full bandwidth. See **Table 2-5**.

Table 2-5

DSL Service: Example from the United States, 1997

	Ameritech, Ann Arbor, Michigan
Speed (maximum)	1.5 Mbps downstream 128 kbps upstream
Residential Monthly Charge	$59.95 for unlimited time

Note: DSL service is not available in Japan, but field trials are under way.

With the ADSL modem system, users can simultaneously access the Internet and make phone calls. In this sense, ADSL can add a high-speed Internet access to the existing PSTN. ADSL is expected to reduce congestion at the PSTN local switch caused by the large Internet access traffic, because it does not use a local switch. ADSL could be a source of new revenue for incumbent LECs (ILECs) as well as a solution to the congestion problem. But even LECs cannot guarantee the speed of ADSL—as is also the case of the 56-kbps modem over the PSTN; even with a modem connected, the initial speed cannot be guaranteed. This situation may be a reason that in 1997 ILECs like Ameritech limit the speed of ADSL services to 1.5 Mbps. In January 1998, the computer and telecommunications industries formed a working group, the Universal ADSL Working Group (UAWG), to propose "a simplified version of ADSL,"[37] called the "universal ADSL,"[38] based on an ITU standard, which is expected to reduce the cost of ADSL. The proposal also limits the downstream speed of ADSL to 1.5 Mbps.[39]

<www.pacbell.com/products/business/fastrak/adsl/adsl-faq> (Accessed 30 Dec. 1997.) GTE started providing ADSL services as a competitive LEC in 1997, while since 1996 it has continued trials as an ILEC. See GTE, "GTE Commercially Deploys Asymmetrical Digital Subscriber Line (ADSL) Service. High-speed Internet Access Service to Initially Benefit Multi-Tenant Property Owners and Residents of Southern California Apartment Complex," press release, 17 Nov. 1997, [On-line.] URL: <www.gte.com/g/news/adslonsite.html> (Accessed 12 Feb. 1998.)

[37]UAWG, "PC, Telecom, and Networking Industry Leaders Unite to Deliver Ultra-Fast Internet Access to the Home," press release, 26 Jan. 1998, [On-line.] URL: <www.uawg.org> (Accessed 2 Feb. 1998.)

[38]Ibid.

[39]See Jim Davis, "Intel, MS, Compaq Tell of DSL Plan," "CNET News.com," 26 Jan. 1998, [On-line.] URL: <www.news.com/News/Item/0,4,18466,00.html> (Accessed 2 Feb. 1998.)

Some ILECs reportedly are "concerned about [ADSL] cannibalizing their very profitable high-speed services for businesses."[40] Still, the possibility of high-speed data transmission at relatively affordable cost would be very attractive to Internet access users.

In Japan, Nippon Telegraph and Telephone (NTT), the major LEC, owns most of the subscriber lines for homes. NTT experimented with the possibility of using ADSL in Japan and in 1997 announced that it had found that ADSL did not interfere with existing services, either PSTN or ISDN. It also found that the actual speed of ADSL depended on the condition of the cable and that the speed could not be guaranteed. When NTT discovered that physical proximity of ISDN lines and ADSL interfered with the ADSL signal it decided to proceed to a field trial in order to study ways to use this technology in Japan.[41]

2.5 Satellite Communications

Satellite communication is used for Internet data distribution to homes. In the United States, DirecPC™, an Internet access service offered by Hughes Network Systems™, uses satellites. In 1997, its typical service was 200 kbps for Internet data downstream at a charge of $19.95 per month,[42] for unlimited use, except for weekday daytime usage from 6 A.M. to 6 P.M. Monday through Friday.[43] Users must purchase the satellite dish, tuner card, and access software, for a total price of $399.

Satellites can cover almost all homes without the need to build a surface subscriber network. Once satellites are in orbit, the construction of the subscriber network is complete. A data transmission speed of up to 200 kbps, as provided by DirecPC, is several times faster than the 56-kbps modem used with the PSTN, although the actual speed of satellite Internet may be less than 200 kbps because subscribers share bandwidth. Sometimes, users' apartments can physically obstruct satellite transmission, making location of the dish difficult, even impossible. The main feature of satellite Internet for homes, such as DirecPC, is that it requires an upstream data line, typically a PSTN line with a modem, to transmit a user's request, phrased as URL data, to the Web server. Responding to the request, the satellite Internet system sends the data by satellite. In short, satellites cannot be used independently for Internet access, but, as in the case of

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[40]Dean Takahashi and Stephanie N. Mehta, "Sprinting Behind Cable in Race to Offer Fast Data Access, Bell Back New Way," *The Wall Street Journal*, 21 Jan. 1998, B6. The article insists that a "lite" version of ADSL, such as up to 1.5 megabits per second (Mbps) downstream, could avoid the cannibalism.

[41]The ADSL modem is sensitive to noise caused, for example, by ISDN linese. See Hiromi Nakagawa, "ADSL modem, NTT-mou ni aku-eikyo nashi" [ADSL Modem Isn't Harmful to NTT Network], *Nikkei Communications*, 16 June 1997, 85. Also see NTT, xDSL Information, [On-line.] URL <www.info.ntt.co.jp/dlij/xDSL_J/xdsl.html> (Accessed 26 Feb. 1998.)

[42]It also provides 400 kbps service. See DirecPC, "Service and Pricing," [On-line.]URL: <www.direcpc.com/about/a34f.html> (Accessed 6 Nov. 1997.)

[43]These per-use charges are $0.50 per megabyte (MB). Ibid.

DirecPC, are what can be called a type of data broadcasting, rather than satellite communications, because the satellite is used for only one-way data distribution.

Because a DBS subscriber could be a prospective customer of satellite Internet, tie-up marketing of DBS services and satellite Internet services may be a good strategy for a satellite Internet provider.[44] For example, in 1997, Hughes Network Systems began to provide a satellite dish that can be used for both DBS and satellite Internet.[45] This double use could be an upgrade path for DBS subscribers who could thereby subscribe to a satellite Internet service easily.

The satellite used for satellite Internet is in geosynchronous earth orbit (GEO), 22,238 miles above the equator, where it appears stationary. Several satellites cover the full surface of the earth,[46] but because they are so far from the earth's surface, sending data to them requires a lot of power, which makes two-way data communication with a GEO satellite both complicated and expensive, and transmission delays occur. When the satellite is nearer to the surface, sending data requires less power and transmission delays are much smaller. Some low earth orbit (LEO) satellite communications are planned for two-way data communications. Teledesic, for example, plans to launch 288 satellites 435 miles above the surface and to provide 16-kbps to 64-Mbps data communications services beginning in 2002.[47] Each LEO satellite covers only a small portion of the surface, so many are needed to transmit communications among satellites to cover a large area. LEO requires satellite-to-satellite data transmission if no surface network is used as well. The LEO satellite system is expensive and its technology still has uncertainties, but its advantage is that it would bypass subscriber networks on the surface.[48]

In 1997 in Japan, satellite communications companies began to provide Internet access service for business users. In January 1998, Direct Internet™ started residential satellite Internet service, using the same system that DirecPC uses in the United States.[49] But satellite communications companies reportedly are concerned about the system's marketability in Japan. Whether satellite Internet for homes is broadcasting or communications in nature is currently

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[44]But bundling might cause some problems related to fair competition, especially if one service were bundled to another that dominated the market.

[45]See Hughes Network Systems, "DirecPC, DirecTV, and USSB Converge with Hughes' DirecDuo," press release, 15 July 1997, [On-line.] URL: <www.direcpc.com/about/pr-duo.html> (Accessed 31 Dec. 1997.) If DBS and satellite Internet service were provided through the same satellite, no special dish may be required.

[46]See John Montgomery, "The Orbiting Internet, Fiber in the Sky," *Byte* **22**, 11 (November 1997), 68.

[47]Ibid., 61.

[48]According to Montgomery, however, Russell Daggatt, president of Teledesic, said, "It's not going to replace the current phone network—the capacity isn't there." Ibid., 64.

[49]See "Kojinmuke eisei Internet, DIC ga 1gatsu kara service kaishi" [DIC Starts Satellite Internet Services for Personal Use in January], *Nikkei Communications*, 19 Jan. 1998, 224.

under discussion by the MPT, so whether or how residential satellite Internet access in Japan will be regulated remains unclear.[50] See **Table 2-6**.

Table 2-6

Satellite Communications Service: Examples from the United States and Japan, 1997

	United States: DirecPC	Japan: Direct Internet
Speed	200 kbps downstream only*	Up to 400 kbps downstream only
Residential Monthly Charge	$19.95 for unlimited time weekday nights and weekends	$55 (64 MB for downloading data)

*400 kbps service available for $39.95 per month

2.6 Cellular Phone and PCS

Cellular telephony and PCS are usually used for voice communication on the move, but they can also be used to transmit data. As notebook-type PCs came to be widely used, users began to use them to connect to the Internet outside offices or homes. A cellular phone or PCS is best used in this case. Using an analog cellular phone for Internet access requires an analog modem. For digital cellular or digital PCS, a cellular or PCS adapter is needed. As of 1997, the connection speed was ordinarily up to 14.4 kbps for cellular telephony and PCS; for the personal handy-phone system (PHS), a Japanese digital mobile phone system with a small cell size, used in a radius of several hundreds meters, the speed is 32 kbps (in practice, 29.2 kbps).[51]

Among mobile communications, PHS has a slight advantage in access speed and offers advantageous rates for data communications.[52] Of the total PHS traffic of NTT Chuo Personal, which covers the Tokyo area, 7 percent is reported to be data traffic.[53] NTT has reportedly developed a new data transmission protocol to realize 64 kbps (practically 58.4 kbps) over PHS, but its deployment is thought to be slow because the protocol requires upgrading the base station

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[50]See Masaaki Hujikawa and Jiro Yoshino, "Internet ha eisei de shinka suru" [The Internet Develops Using Satellites], *Nikkei Communications*, 1 Sept. 1997, 97.

[51]See Yasukazu Sugiyama, "Shin keitai denwa gijutsu, CDMA" [CDMA, the New Mobile Telephone Technology], *Nikkei Communications*, 21 July 1997, 131-132.

[52]For example, NTT Personal started a new discount for data communications over PHS in February 1998. It discounts ¥10 for every data communications call, which offers an advantage to short time applications, like receiving e-mail. NTT Personal cut the price of its fixed-rate plan for data communications by 34 percent at the same time. See Osamu Miki, "NTT Personal ga PHS no 32k data tsushin ryokin wo nesage" [NTT Personal Cuts the Price of 32 kbps Data Communications of PHS], *Mainichi Daily Mail Internet*, 25 Dec. 1997, [On-line.] E-mail: dm-info@mainichi.co.jp

[53]Which is higher than expected. See Tadao Kobayashi, "Data traffic ha sudeni 7 percent" [Data Traffic Has Reached 7 Percent of All PHS Traffic], *Nikkei Communications*, 5 Jan. 1998, 79.

for each cell.[54] Japanese consumer electronics manufacturers began to sell the personal digital assistant (PDA) with a PHS function in the Japanese market in 1997.[55] PHS is mainly used for e-mail; although the PDA has a primitive Web browser, its small monitor is not practical for browsing.[56]

To increase the speed of mobile data communications, by the end of 1999 a new International Telecommunications Union (ITU) standard will be in place, called international mobile telecommunication 2000 (IMT-2000), which will transmit data at a speed of 2 Mbps.[57] Some Japanese cellular phone companies plan to start new cellular phone services, as of 1998, which will be based on code division multiple access (CDMA) and may start a 64-kbps data service soon after deployment of the new standard. These companies persuaded members of the CDMA Development Group (CDG) to develop a 64-kbps data communications standard over CDMA and believe that in Japan CDMA-based cellular phone should be differentiated from other mobile phone services by its data speed.[58]

2.7 LMDS, MMDS

Wireless can be used for residential communications to connect homes to the Internet as if through a phone line but without a physical cable. The description "local multipoint distribution service" was coined by the FCC for "a terrestrial fixed-service cellular broadband technology using [the] Ka band (28 GHz and 31 GHz bands)."[59] LMDS transmits over a radius of 3 to 6 km (1.8 to 3.7 miles).[60] In the United States as of 1997, LMDS was provided only around New York City. The LMDS spectrum for other areas is expected to be auctioned in early 1998. The LMDS

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[54]See Noboru Kojima, "PHS 64 kbps data denso protocol wo NTT ga kaihatsu" [NTT Developed 64-kbps Data Transmission Protocol for PHS], *Mainichi Daily Mail Internet*, 19 Dec. 1997, [On-line.] E-mail: dm-info@mainichi.co.jp

[55]For example, see "Toshiba, Kosoku data tsushin taiou no PHS-denwa wo naizo shita pocket communicator 'GENIO' no hatsubai ni tsuite" [Toshiba Releases Pocket Communicator 'GENIO,' Which Includes the PHS High-Speed Data Communication Function], press release, 27 Feb. 1997, [On-line.] URL: <www.toshiba.co.jp/about/press/1997_02/pr_j2701.htm> (Accessed 18 Feb. 1998.)

[56]As for Internet TV, modifying the layout of Web pages to make them suitable for small screen size may improve this weak point.

[57]See Yasukazu Sugiyama, "Shin keitai denwa gijutsu, CDMA" [CDMA, the New Mobile Telephone Technology], *Nikkei Communications*, 21 July 1997, 141.

[58]Ibid., 143.

[59]Dick Bergen, "LMDS Wireless Multimedia," *Wireless Broadcasting Magazine* **5**, 5 (September–October 1997), 34.

[60]Abe, 352.

transmission speed is expected to be 1.5 Gbps downstream and 200 Mbps upstream, which is enough for simultaneous transmission of TV programs, teleconferences, and Internet access.[61]

As of 1997, in the United States CellularVision USA™ is the only provider of LMDS. It started with 500-kbps Internet access service for residential users at $49.95 per month. The ordinary basic installation charge is $199,[62] for installation in the home of a wireless receiver the size of a ping-pong paddle, a special modem, and a controller box.[63] LMDS is used only for downstream Internet data transmission. To send upstream data, users need an analog modem, as for satellite Internet.[64] The relatively small cell size means that the LMDS terminal requires less power than services with large cell size to transmit data to the base station. LMDS can be used for two-way data transmission without the PSTN. CellularVision USA may provide two-way services through LMDS in the near future.

LMDS installation offers some difficulty. Because it uses a high frequency, the LMDS signal can be weakened by rain and it requires a clear line of sight. Technological development could mitigate these difficulties, but more trials are needed.[65] Because LMDS has a small cell size, it needs many transmitters or receivers to cover the service area, even though it does not require a physical line, "the cost of an LMDS network is the physical equivalent of the last two miles of a local exchange network."[66]

Multichannel multipoint distribution services (MMDS) are a wireless broadband broadcasting service. One transmitter can provide service over a radius of 10 to 35 miles. Since the mid-1970s, two 6-megahertz (MHz) (analog TV) channels in the 2.1 GHz band have been used to distribute TV programs, in what is called multipoint distribution services (MDS). In the early 1980s, eight 6-MHz channels between 2.5 and 2.7 GHz were added. Twenty-three other channels between 2.5 and 2.7 GHz were originally designated for educational use, but MDS operators asked the educational license holders to lease their channels to them. As a result, MDS operators controlled thirty-three potential channels, thus becoming *multi*channel MDS operators. Although MMDS spectrum was auctioned in 1996, incumbent MMDS licensees continue to

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[61]See Video Information Provider Consulting, "LMDS: Answers to Frequently Asked Questions—4. Why Should I be Interested in LMDS? What Are Its Advantages?" [On-line.] URL: <www.ajs2.com/lmds/faq.htm#4> (Accessed 7 Jan. 1998.)

[62]See CellularVision USA, "CellularVision USA Begins Commercial Offering of Wireless High-Speed Internet Service," press release, 23 June 1997, [On-line.] URL: <www.cellularvision.com/pr/cvdnisdn.html> (Accessed 2 Nov. 1997.)

[63]Ibid., "How Does It Work," [On-line.] URL: <www.cellularvision.com/speed/HOME/howWorkCopy.htm> (Accessed 2 Dec. 1997.)

[64]Ibid.

[65]For the difficulty of LMDS installations, see Abe, 361-363.

[66]Bergen, 37.

operate. In 1996, the FCC ruled that MMDS operators could digitize their services. MMDS can deliver 100 to 200 channels of digitized TV programs and Internet access at a speed of up to 27 Mbps downstream, on the basis of current (1997) equipment. MMDS has more than a million customers in the United States, and many MMDS operators now provide Internet access.[67] For example, CAI Wireless Internet provides MMDS Internet in New York City and Rochester, in N.Y., Washington, D.C., and Boston, Mass., at a monthly charge of $49.95, and plans to expand to other areas.[68] See **Table 2-7**.

Table 2-7

LMDS and MMDS Services: Examples from New York City, 1997

	LMDS: CellularVision USA	MMDS: CAI Wireless Internet
Speed	500 kbps, downstream only	27 Mbps broadcast speed, downstream only*
Residential Monthly Charge	$49.95 for unlimited time	$49.95 for unlimited time

*Actual speed for downloading data is 1 to 2 MBps.

MMDS was provided mainly in rural areas, where building CATV networks were too expensive for the sparse population. MMDS is the least expensive infrastructure for broadcasting TV programs with local content.[69] According to George Abe, "Telephone companies...view microwave as a fast-start service to enter video distribution that can compete against cable and DBS."[70] For example, Pacific Bell Video Services™, a subsidiary of Pacific Telesis, began to provide MMDS in Los Angeles and Orange counties in 1997.[71]

As was the case with satellite Internet, MMDS can be used to transmit only downstream data, with other networks (for example, the PSTN) used for upstream transmission. In 1997, MMDS operators petitioned the FCC "to grant the industry the right to use MMDS spectrum for

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[67]For the features and histories of MMDS, see Jim Cahoon, "How does Wireless Cable Work?" [On-line.] URL: <www.wirelesscabl.com/How_It_Works.htm> (Accessed 8 Jan. 1998.)

[68]See CAI Wireless Internet, "How to Subscribe," [On-line.] URL: <www.caiwireless.net/sub.html> (Accessed 27 March 1998.); and "Frequently Asked Questions [FAQs]," [On-line.] URL: <www.caiwireless.net/faqs.html> (Accessed 27 March 1998.)

[69]Satellite can broadcast widely at low cost and CATV can broadcast local contents, but neither alone offers the combination of low-cost infrastructure and local contents, which MMDS can offer.

[70]Abe, 342.

[71]Ibid., 346. Also, see SBC Communications, "Pacific Bell Digital TV Begins Initial Rollout in Southern California," press release, 29 May 1997, [On-line.] URL: <www.pactel.com/cgi-bin/getrel?1565> (Accessed 9 Jan. 1998.)

two-way access."[72] Although there was opposition, the FCC proposed permitting such access.[73] But, according to Abe, MMDS "would not be practical without fragmenting the return path into smaller cells, such as by using digital cellular technology" to avoid congestion because of the large MMDS area covered,[74] which might spoil the cost effectiveness of MMDS.

In 1997, in Japan, neither LMDS nor MMDS has been installed, but in June 1997, an interim report by a study group of Ministry of Posts and Telecommunications (MPT) proposed quick deployment of the Advanced Radio Fixed Access (ARFA) system. ARFA is a general term for a wireless access system that connects homes and offices to the CO or a backbone network.[75] According to the MPT study group's proposal, a 6-Mbps system is expected to connect homes or small offices, using the 22-GHz and 26-GHz bands, to transmit data in the range of 0.3 to 1 km (1,000 to 3,300 feet). This system image is similar to that of LMDS in the United States.

2.8 Other Possibilities

Another type of Internet access is the high-altitude, long endurance platform (HALE):

> basically a solar-powered, lightweight airplane or lighter-than-air craft that hovers over an unmoving spot some 70,000 feet (21 km) above the earth's surface...[which is] right now primarily a research venture.[76]

For example, Sky Station International plans to use HALE to provide high-speed data transmission services in 2000. The company received FCC approval to use the 47 GHz frequency band in 1997.[77] It plans to provide a 2-Mbps two-way data transmission service at a cost of "a few cents per minute."[78] Angel Technologies plans to provide a similar service using aircraft flying at

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[72]See Cahoon.

[73]For example, WebCel Communications insisted that the two-way flexibility of MMDS "would scare lenders away from LMDS prospects and deter companies from bidding in the upcoming LMDS auction." See "FCC Proposal to Give Two-Way Data Flexibility to MDS Operators Creates Numerous Uncertainties," *Telecommunications Report* (20 Oct. 1997), 8-9.

[74]See Abe, 348.

[75]See MPT, "Jisedai no kanyusya-kei musen access system niyoru chiiki tsushin shijo no kasseika" [Local Wireless Access System of Next Generation Activates the Local Communications Market], press release, 3 June 1997, [On-line.] URL: <www.mpt.go.jp/pressrelease/japanese/denki/970603j601.html> (Accessed 8 Dec. 1997.)

[76]Montgomery, 68. For details on HALE, see Goren M. Djuknic and John Friedenfelds, "Establishing Wireless Communications Services via High-Altitude Aeronautical Platforms: A Concept Whose Time Has Come?" *IEEE Communications Magazine* (September 1997), 128-135.

[77]See Sky Station International, "FCC Creates New Frequency Allocation for Stratospheric Internet Service," press release, 6 May 1997, [On-line.] URL: <www.skystation.com/fcc.html> (Accessed 12 Jan. 1998.)

[78]Ibid., "Frequently Asked Questions—How Much Will Stratospheric Telecommunications Service Cost?" [On-line.] URL: <www.skystation.com/faq.html#cost> (Accessed 12 Jan. 1998.)

52,000-60,000 feet.[79] Japan's MPT plans to develop a radio-relay system that will use aircraft by 2002[80]; the plan is to have several aircraft cover all of Japan to make ultra-high-speed Internet service possible throughout the MPT's radio-relay system.

Electric power lines can transmit Internet data. For example, in 1997, United Utilities, in England, and Northern Telecom, of Canada, jointly developed a system to transmit more than 1 Mbps of data over existing power lines. The system was realized by a new signalling system. An experiment with the system was conducted in the United Kingdom, but this system is not economically feasible in the United States.[81] Northern Telecom plans to construct a new system for U.S. power companies.[82] Four Japanese consumer electronics manufacturers, Toshiba, Hitachi, Mitsubishi, and Matsushita, have formed a consortium to develop a system for transmitting data over electric power cable which would allow remote control of electric appliances in Japan. According to the consortium, the data speed will be up to 9.6 kbps, which, in the consortium's view, accords with Japan's Radio Law.[83] Electric power lines reach every home, though the switching signals are very noisy, but if data could be transmitted at the same speed as over CATV Internet, electric power lines might offer a convenient way for residential users to access the Internet.

2.9 Penetration

Table 2-8 indicates the penetration of residential connectivity for Internet access in the United States and Japan.

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[79]See Jeff Pelline, "Net Access from 52,000 Feet," *CNET News.com*, 12 Sept. 1997, [On-line.] URL: <www.news.com/News/Item/0,4,14184,00.html> (Accessed 7 Jan. 1998.) Also, see Angel Technologies, "HALO Network," [On-line.] URL: <www.angelcorp.com/halos/techpaper1.html> (Accessed 27 Jan. 1998.)

[80]See "Radio-Relay System to Use Unmanned Airship," *New Breeze* **9**, 4 (Autumn 1997) 21-22.

[81]According to a spokesperson of Northern Telecom, "a transformer in the United Kingdom typically provides power to 100 to 300 people, compared with just 8 to 12 in the United States." "The U.K.'s electric grid layout in [sic] makes the plan more economical than that of North American." Quoted in Jeff Pelline, "Electric Utilities Getting Wired," CNET News.com, 8 Oct. 1997, [On-line.] URL: <www.news.com/News/Item/D,4,150001,DO.html> (Accessed 27 March 1997.)

[82]See Gautam Naik, "Putting Telecom Services on Power Lines Could Spark Internet Usage in Europe," *The Wall Street Journal*, 9 Oct. 1997, B21.

[83]See Hiromi Nakagawa, "Denryoku-yo kaisen de kaden wo network ka" [Networking Electric Appliances with Electric Power Lines], *Nikkei Communications*, 5 Jan. 1998, 73.

Table 2-8

Penetration of Residential Connectivity for Internet Access, 1997

	United States	Japan
PSTN	Commonly used for Internet access Residential PSTN lines: 103,359,377[1]	Commonly used for Internet access Residential PSTN lines: 42,451,000[2]
ISDN	Less than 5 percent of Internet subscribers[3] Residential ISDN lines: 55,430[1] 0.05 percent of PSTN 1,319 percent since Dec. 1995[4]	24 percent of dial-up access[5] Residential ISDN lines: 188,000[2] 0.44 percent of PSTN 1,105 percent since March 1996
CATV	Internet users estimated at 110,000[6] Five top providers (number of users): • Time Warner Cable: 29,000 • MediaOne: 17,000 • Cox Communications: 15,000 • Rodgers Cablesystems: 11,000 • Comcast: 10,000	Too early to count subscribers
DSLs	Too early to count subscribers ILECs with commercial services[7] • U S West, Ameritech ILECs with trial services[7] • GTE, Bell Atlantic (NYNEX), BellSouth, • SBS Communications (Pacific Bell)	Field trial by NTT under way
Satellite	Number of Internet users not clear DBS subscribers are said to be more than 5 million and increasing rapidly[8]	Too early to count subscribers
Cellular, PCS	Not common	Number of Internet users not clear
LMDS, MMDS	Number of Internet users not clear LMDS: only in New York City; provided by CellularVision USA; 12,000 subscribers, some also using an Internet access service[9] MMDS: may have more than 1 million subscribers, but number of MMDS Internet users not clear[10]	NA

(1) As of December1996. Source: FCC, *Statistics of Communications Common Carriers 1996/1997 Edition*, Table 2.5 [On-line.] URL: <fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/SOCC/96socc.pdf> (Accessed 4 Feb. 1998.) (2) As of March 1997. Source: NTT, "Kakusyu service betsu keiyakusu" [The Number of Subscriptions to Each Service], 23 May 1997 [On-line.] URL: <1.nttinfo.ntt.jp/hqs/nttopen/network/contact/contact.html> (Accessed 27 Feb.1998.) (3) See Kevin Webach, "Digital Tornado: The Internet and Telecommunications Policy," FCC, March 1997 [On-line.] URL: <fcc.gov/Bureau/OPP/working_papers/oppwp29.pdf> (Accessed 10 Dec. 1997.) (4) Source for calculation of growth: FCC, *Statistics of Communications Common Carriers 1995/1996 Edition*, Table 2.5 [On-line.] URL: <fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/SOCC/95socc.pdf> (Accessed 27 Feb.1998.) (5) Source: "Cyber Space Japan, Hiki-tsuzuki ISDN-ka ga susumu" [ISDN Continues to Increase] [On-line.] URL: <csj.co.jp/www6/connect.html> (Accessed 4 Nov. 1997.) (6) Source: Kinetic Strategies, Inc., Cable Modem Market Stats and Projections [On-line.] URL: <cabledatacomnews.com/cmic16.htm> (Accessed 7 Jan. 1998.) (7) Source: ADSL Forum, ADSL Trials and Service Deployments [On-line.] URL: <adsl.com/trial_matrix.html> (Accessed 29 Dec.1997.) (8) Source: FCC, *Fourth Annual Report*, 13 Jan. 1998, CS Docket No. 97-141, Para. 55 [On-line.] URL: <fcc.gov/Bureaus/Cable/Reports/fcc97423.pdf> (Accessed 15 Jan. 1998.) (9) Source: Video Information Provider Consulting, "LMDS: Answers to Frequently Asked Questions—17. Is LMDS Currently Being Commercially Deployed Anywhere in the U.S.?" [On-line.] URL: <ajs2.com/lmds/faq.htm#17> (Accessed 7 Jan. 1998.) (10) Jim Cahoon, "How Does Wireless Cable Work?" [On-line.] URL: <www.wirelesscabl.com/How_It_Works.htm> (Accessed 8 Jan. 1998.)

Chapter Three

Relationship Between Kinds of Connectivity as of 1997

3.1 Competitive Relationships or Links in the Form of Internet Access Services

3.1.1 United States

PSTN, ISDN, and xDSL all use the same twisted-pair copper cable, and the ILECs that own the cables to homes provide or plan to provide these services. Competitive local exchange carriers (CLECs) can also provide them by using either unbundled network elements or simple resale. CATV Internet access is provided through CATV cables. Both this kind of cable and twisted-pair copper cable are used for connecting to homes in the United States. For high-speed Internet access, both kinds of cable will necessarily compete against each other. In 1997, satellite Internet access requires other lines for upstream data transmission, typically the PSTN, which may make it difficult for satellite to compete directly with the two other kinds of connectivity. But because satellite covers wide areas, including rural areas that are of less interest to other connectivity providers, satellite may become the sole choice for users there. LMDS or MMDS can provide wide-bandwidth wireless Internet access for homes as well as video programming distribution. Some ILECs are operating MMDS in areas where ILECs have an interest in entering the video distribution market.

ILECs may have good reason to acquire CATV companies that cover areas outside their PSTN territories.[1] Because CATV networks can provide Internet access, ILECs that acquire one can expand the territory where they provide high-speed Internet access. The U S West Media Group acquired Continental Cablevision in 1996 and asserted that its strategy is to provide data services more widely than in its original PSTN territory as well as to provide video and telephone services.[2] In 1997, U S West decided to separate the CATV segment from its telephone segment. According to Richard D. McCormick, chairman and chief executive officer (CEO) of U S West, "Recent developments in technology, markets and regulation will provide strategic competitive opportunities for both businesses that overweigh the benefits of remaining together."[3] ADSL

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[1]The Telecommunications Act of 1996 prohibits "an LEC from acquiring more than a 10 percent financial or management interest in an existing cable operator providing cable service within the LEC's local telephone service area." FCC, *Third Annual Report*, 2 Jan. 1997, CS Docket No.96-133, Para. 68, [On-line.] URL: <www.fcc.gov/Bureaus/Cable/Reports/fcc96496.txt> (Accessed 26 Feb. 1998.)

[2]See U S West Media Group, "U S West Media Group Announces Continental Cablevision Has Agreed to a Merger, Creating a World Leader in Cable Communications," press release, 27 Feb. 1996, [On-line.] URL: <www.uswest.com/media/news/022796> (Accessed 5 Jan. 1998.)

[3]U S West Media Group, "U S West, Inc., Plans to Split U S West Media Group, U S West Communications Group into Separate Public Companies," press release, 27 Oct. 1997, [On-line.]URL: <www.uswest.com/media/news/102797m> (5 Jan. 1998).

technology is said to "allow for more efficient video and data transmission over twisted-pair wires," and this separation will "make it easier for each unit to form alliances with other industry players."[4] It remains to be seen which is more efficient, CATV or ADSL.[5]

Carriers using wireless networks can connect homes to the Internet without using any cable, new or existing. LMDS in particular is expected to enhance competition in the local communications market, because it is capable of two-way communication. In 1997, after six years of dispute about the appropriateness of using the Ka band spectrum for LMDS, previously thought reserved for satellite communications,[6] the FCC decided to auction spectrum for LMDS. In a press release concerning the LMDS auction, the FCC said it hoped that its

> decision [to hold the auction] will open the door for a new broadband wireless service that will provide meaningful competition to cable and local exchange services.[7]

For the first three years

> ...the FCC will not permit incumbent local exchange carriers (LECs) and cable systems to obtain Block A licenses in any BTA (Basic Trading Area) where ten percent or more of the BTA's population is within the LEC or cable service area.[8]

The ILECs insisted that they should participate in the auction "because they could efficiently provide such services and because open market entry ensures the best use of spectrum."[9] They further asserted that competition between LECs and cable companies was expected by Congress and that LMDS was a good method for LECs to use to provide video services competitively with cable television.[10] The ILECs petitioned the U.S. Court of Appeals to

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[4]"U S West's Plan to Split Company Hinge on 'Divergence' of Cable TV, Telco Industries," *Telecommunications Report* (3 Nov. 1997), 11.

[5]For LECs' moves in the CATV market, see FCC, *Fourth Annual Report*, 13 Jan. 1998, CS Docket No. 97-141, Para. 112-115, [On-line.] URL: <www.fcc.gov/Bureaus/Cable/Reports/fcc97423.pdf> (Accessed 15 Jan. 1998.)

[6]See Video Information Provider Consulting, "LMDS: Answers to Frequently Asked Questions—20. Why LMDS Now?" [On-line.] URL: <www.ajs2.com/lmds/faq.htm#20> (Accessed 7 Jan. 1998.)

[7]FCC, "FCC Adopts Service and Auction Rules for LMDS," press release, 11 March 1997, [On-line.] URL: <www.fcc.gov/wtb/auctions/lmds/nr970011.txt> (Accessed 8 Jan. 1998.)

[8]Robert J. Rini, "LMDS Offers the Promise of Competition," *Wireless Broadcasting Magazine* **5**, 5 (September–October 1997), 39. According to this article, Block A signifies a part of LMDS spectrum that covers 1,150 MHz and can be used for two-way broadband communications, while block B covers only 150 MHz (38). Basic Trading Areas (BTAs) are units for which wireless licenses are given.

[9]Ibid.

[10]Ibid.

overturn the ruling that excluded them from the auction, but in early February 1998 their petition was denied.[11] The LMDS auction began in February 1998.

3.1.2 Japan

Although the PSTN is ordinarily provided over twisted-pair copper cable, in 1998, NTT will begin to install a new subscriber-line system called the "New Optical Access System," which will include an optical fiber cable network to be constructed close to each home and to be shared by as many as ten homes. Twisted-pair copper cable is used only for the segment of several hundred feet from each home to the optical fiber terminal point. NTT insists that this hybrid system will enable it to replace existing copper cable economically with optical fiber. A director of NTT anticipates that this new system will be installed for 50 percent of the subscriber lines in Japan by 2010.[12] In an accelerated plan that the Japanese government has considered to stimulate the economy, a low-interest rate fund would be offered to LECs and optical-fiber subscriber networks would be constructed by 2005.[13] There would be no change in PSTN service itself, even when the new system was installed. The only change would be that the physical subscriber line, other than the last several hundred feet, would be optical fiber, rather than twisted-pair copper. Whether NTT has a concrete plan to provide high-speed Internet access for residential users at a low price using this system has not yet been announced.[14]

In the Totsuka area in Yokohama, NTT and the Town Television Yokohama CATV company (known as Townty) are cooperating in constructing a network of fiber to the home (FTTH).[15] Townty began business in July 1997 but still does not have its own cable network. Instead, it uses NTT's optical fiber network. In this cooperative trial, NTT installs both the optical fiber line to the home and the optical network unit (ONU) for Townty's subscribers. Subscribers are expected to use NTT's PSTN or ISDN service over the optical fiber line, instead of the existing copper cable. The cost of NTT's FTTH is covered in the monthly charge for the CATV company and the subscriber's monthly charge for the PSTN or ISDN. NTT charges the CATV companies around ¥1,500 ($15) per line, which is about 40 percent of the CATV basic service

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[11]See United States Court of Appeals for the District of Columbia Circuit, *Melcher, et al. v. FCC, et al.*, No. 93-1110, 6 Feb. 1998, [On-line.] URL: <www.fcc.gov/wtb/auctions/lmds/melcher.pdf> (Accessed 27 Feb. 1998.)

[12]See Masaaki Yoneda and Hiroyasu Mizuno, "Hikari-fiber, nokisaki-ni semaru" [Optical Fiber, Along the Eaves], *Nikkei Communications*, 2 Sept. 1996, 71.

[13]See "Katei made hikari fiber mou, 5nen maedaoshi 2005nen jitsugen" [Optical Fiber Network to Homes, Realized by 2005, Five Years Earlier], *Nihon Keizai Shinbun*, 6 Nov. 1997, 1 [American Edition.]

[14]With this system, NTT plans to start a new 1.5 Mbps dedicated-line service for ¥100,000 to ¥130,000 ($1,000 to $1,300) per month, which, although 30 to 40 percent of the price of the old services, is still too expensive for residential users. See "Network kyoka sakusen" [Strategy to Reinforce the Private Network], *Nikkei Communications*, 5 Jan. 1998, 87.

[15]See Hiroyasu Mizuno, "Hikari-fiber ga wagaya-nimo" [Optical Fiber, to My Home, Too], *Nikkei Communications*, 15 Sept. 1997, 160-163.

subscription charge, ¥3,500 ($35) per month. NTT also charges residential subscribers ¥1,750 ($17) for the PSTN or ¥2,830 ($28) for ISDN, which are the same as the prices as for copper cable. When subscribers to CATV do not use the PSTN or ISDN over optical fiber, Townty will pay NTT ¥2,600 ($26) per line.

Given the low penetration of Japanese CATV networks—about 25 percent of homes as of 1995[16]—cooperation between LECs and CATV companies may be effective for constructing optical fiber subscriber networks there, especially because NTT, the major LEC, is prohibited from operating CATV. For users, the advantages of FTTH are not yet clear, because FTTH provides services—ordinary CATV and either PSTN or ISDN, or both—already available and at the same prices as existing copper cable.[17] Further, the question of who will provide broadband Internet access service has not been answered, although NTT's ONU has a slot for an interface card for NTT's 128-kbps Internet access service, known as the Open Computer Network (OCN). NTT has not yet announced its plan or prices for high-speed Internet access over residential FTTH.

The incumbent Japanese CATV companies strongly oppose cooperation between the LECs and CATV companies. CATV companies reportedly plan to provide communications services and are fearful of total dependence on the LEC network for communications services.[18] In February 1998, the MPT Study Group's report suggested that permits to CATV services for use of the LECs' FTTH should be issued with two conditions: (1) that service should start only after 2001 in areas where an incumbent CATV company provides CATV service using its own network; and (2) that the LECs' FTTH should be provided fairly to CATV companies.[19] Incumbent CATV companies insist that permission should be delayed until after 2006 in their current service areas.[20] The MPT reportedly seems not to have a distinct policy on how new access networks should be constructed, whether through competition between LECs and CATV companies or only through FTTH NTT, the major LEC.[21]

Some users have requested that carriers provide "mega-bps to the home now," not "fiber to the home in the future."[22] By conducting a field trial of ADSL, NTT is in a sense accepting that

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[16]See *Joho media hakusyo 97* [White Paper of Information and Media 97] (Tokyo: Dentsu Soken, 1997), 80.

[17]See Mizuno, "Hikari-fiber ga wagaya-nimo" [Optical Fiber, to My Home, Too], 163.

[18]See Hiroyasu Mizuno, "NTT no FTTH, housouriyo ha 2000nen iko" [After 2000, FTTH of NTT Can Be Used for Broadcasting], *Nikkei Communications*, 19 Jan. 1998, 88.

[19]"Tsushin jigyosya no hikari fiber mou, CATV ni 2001nen zenmen kaiho" [LEC's Optical Fiber Network Will Be Totally Open for CATV in 2001], *Nihon Keizai Shinbun*, 10 Feb. 1998, 7 [American Edition].

[20]Ibid.

[21]See Mizuno, "NTT no FTTH, housouriyo ha 2000nen iko," 88.

[22]See Yoneda and Mizuno, "Hikari-fiber, nokisaki-ni semaru" [Optical Fiber, Along the Eaves], 75.

request. But in 1998 NTT will also begin to install its New Optical Access System, an installation program that the government plans to accelerate.[23] ADSL thus seems to be "filler" until the optical system is installed. With little threat from CATV Internet, because CATV has such low penetration, NTT may not need to hasten deployment of DSLs. The new common carriers (NCC) in Japan have begun to request that NTT provide unbundled twisted-pair copper subscriber lines,[24] which NTT does not intend to provide. The MPT has decided on the rules governing interconnection among carriers in line with Japan's revised Telecommunications Act of 1997. Although these rules oblige NTT to connect its network with those of other carriers, the MPT did not order NTT to provide a connection through physical twisted-pair copper subscriber lines. The MPT is reported to have considered the possibility that the ADSL modem could interfere with existing services, such as the PSTN or ISDN.[25]

In the area of high-speed wireless access, ARFA "is expected to become an effective means to accelerate competition in the local [Japanese] market, familiarize [users with] multimedia applications, and enhance local communications networks in rural areas,"[26] as with LMDS in the United States. The MPT's policy will reportedly license this service to NCCs, excluding NTT except in rural areas.[27] Japan Telecom, a long-distance NCC, has started to experiment with the ARFA system.[28]

3.2 Bundling Practices and Pressures for Unbundling

For both PSTN and ISDN services, bundling is not offered with Internet access. Users can select an Internet service provider which they access through the PSTN or ISDN. On the other hand, CATV data transmission usually comes with a specific ISP, usually the CATV company

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[23]See "Katei made hikari fiber mou, 5nen maedaoshi 2005nen jitsugen" [Optical Fiber Network to Realized by 2005, Five Years Earlier.]

[24]Taro Sasaki, Director of Japan Telecom, was reported to have said that physical twisted-pair copper cable should be provided for use by other carriers. See "Unbundle-nara dry-copper wo mitomeyo" [If You Say It Is Unbundled, Dry-Copper Should Be Admitted], *Nikkei Communications*, 3 Nov. 1997, 97.

[25]See Hiroyasu Mizuno, "Dry-copper, Yuseisyo ga gimu-ka miokuri" [Dry Copper, MPT Decided not to Oblige It], *Nikkei Communications*, 10 Oct. 1997, 103. NTT's experiment (in 1996–97) in its research center indicated that ADSL does not interfere with existing services, yet in 1997–98 it will conduct a field trial using real subscriber lines. The MPT may plan to wait for the results. See section 2.4.

[26]MPT, "Technical Requirements for ARF Access System to Be Established," *MPT News* **8**, 11 (25 Aug. 1997), 2.

[27]See Harumi Yasui, "Mietekita local musen-mou" [Wireless Local Loop Within Sight], *Nikkei Communications*, 15 Sept. 1997, 142-143.

[28]Ibid., 144.

itself or its own subsidiary company[29]—but cannot select, for example, AOL as their ISP.[30] Incumbent ISPs are not necessarily eager to invest in new technology for connectivity when it is still in the early stages; only after a technology is somewhat widely deployed and becomes a major technology will ISPs begin to use it. Then, connectivity providers equipped with the new technology, such as CATV Internet, may face pressure in the form of requests not to exclude other ISPs from using this technology for connectivity. One pressure of this kind may be to unbundle Internet access services from providing connectivity (or pipe).

In the United States, the FCC sets policy to enhance competition in the local telephone market. One regulation is that twisted-pair copper cables must be unbundled and provided to CLECs, for whom constructing their own networks to cover many of the COs in their service areas might be too expensive. And the price of the unbundled elements of physical cables has sometimes been criticized also as too expensive.[31] CLECs can provide ADSL services by using the ILECs' physical twisted-pair copper cables, but it not clear whether under the Telecommunications Act 1996 ILECs have to provide unbundled elements of services with a new technology, like ADSL, to the CLECs.[32] For other kinds of connectivity, which do not use telephone cables, the incumbent service providers are not required to provide unbundled network elements.

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[29]As of 1997, MediaOne itself provides CATV Internet. Time Warner provides it under the brand name of Road Runner; see Time Warner, "Time Warner's Road Runner Launches in Akron/Canton Area," press release, 10 Sept. 1996, [On-line.] URL: <www.pathfinder.com/rdrun/news/launch> (Accessed 30 Jan. 1998.) TCI.NET, a subsidiary of Tele-Communications, provides CATV Internet services, @Home, to TCI customers; see TCI.NET, "TCI Internet Services, Inc. Changes Its Name to TCI.NET," press release, 4 March 1997, [On-line.] URL: <www.tci.com/press/030497b> (Accessed 30 Jan. 1998.)

[30]AOL has two faces, that of ISP and that of contents provider. AOL can be accessed through the Internet, and its contents can be provided this way, if the user has an AOL account.

[31]For example, in November 1997, regarding entering New York's local market, MCI criticized "Bell Atlantic's unbundled loop rates and nonrecurring charges as excessive to the point of forestalling competition." See "Bell Atlantic Asks New York Regulators to Support Its Entry into InterLATA Markets," *Telecommunications Reports*, 10 Nov. 1997, 9.

[32]According to one opinion, unbundling requirements for new services such as ADSL would delay the deployment of new technology by ILECs because of the risk of new investment and little reward. For a detailed discussion, see Debra Aron, Ken Dunmore, and Frank Pampush, "The Impact of Unbundled Network Elements and the Internet on Telecommunications Access Infrastructure," 4 Dec. 1997, [On-line.] URL: <www.ksg.harvard.edu/iip/iicompol/Papers/Pampush> (Accessed 24 Dec. 1997.)

Chapter Four

Contents That Require High-Speed Internet Access

Why do home users need high-speed Internet access? What kinds of contents require it?

4.1 Streaming Video and Audio Contents

Digital data transmitted on the Internet occur as text, image, audio, and video. Current (1997) browser program displays these contents little by little, as the contents are downloaded. For both audio and video, the speed with which data are transferred on the Internet is essential to the quality of display and interactivity. When music is played as streaming audio contents, for example, the contents can be halted or seriously impeded by low transmission speed. If users request high quality in streaming audio or video contents, all elements of the transmission must be suitable—the servers that distribute them, the backbone networks of the Internet that transfer data, and access lines that connect users to the Internet.

In 1997, AOL, for example, first provided contents called "AOL Slideshows."[1] Users can see slide pictures and simultaneously listen to narration. Also that year, ABC News became part of the AOL's news menu. When playing back the slideshow, the user can pause, rewind, and fast-forward. The quality of the sound is not very good—monaural and somewhat noisy, like listening to AM radio. The pictures, or slides, are very small (about 270 dots x 160 dots), and they change every 5 to 10 seconds. The presentation is a slide show, not video. AOL says users do not need fast modems for the slide show, that the 9.6-kbps modem is sufficient.[2] If, however, AOL's video system were adapted to high-speed access, as in ADSL or CATV Internet, users would enjoy something like video on-demand. In 1997, most AOL users access AOL's service by analog modem, which may be a reason AOL limits the quality of its service to slide shows.[3]

RealPlayer™, by RealNetworks, is a very popular program for playing streaming video and audio contents on the Internet that features the pause, rewind, and fast-forward functions of streaming contents. The software can be downloaded free from the Internet. According to RealNetworks, "there are more than 85,000 Web pages using RealAudio and RealVideo and more than 100,000 hours of live RealAudio and RealVideo programming available each week"; further,

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[1]See America Online, "Welcome to AOL Slideshows," announcement, 3 Jan. 1997, [On-line.] "Slideshows" area accessed 13 Jan. 1998.

[2]Ibid.

[3]Other reasons might be the server and the network capacity.

this software was downloaded by "more than 20 million end-users,"[4] which means there are up to 20 million potential users. RealNetworks claims that its RealPlayer Version 5.0 plays "near VHS quality video at 300 kbps."[5] In 1997, with a 56-kbps modem, the program plays video contents at only 4 to 7 frames per second[6] in a very small screen (about 190 dots x 150 dots). The software has a switch with which to change the connection's bandwidth, for example, from a 56-kbps modem to T1 (1.5 Mbps) or local area network (LAN). Users can enjoy high-quality video contents with high-speed Internet access such as ADSL or CATV Internet, if the high-quality contents are available on the server and if there is enough bandwidth both on the line connecting the server to the backbone network and on the network itself.

Streaming video contents require servers and backbone networks with high capacity. The number of servers can be increased to reduce the load on individual servers, a necessary increase as the audience for high-speed streaming video grows. Servers must be located directly on the backbone network in order to avoid congestion on the line connecting the two. Inefficiency will increase on the backbone as the number of users of streaming video increases. Because servers distribute the same video contents to various users, the backbone network must carry many streams of the same contents, and if the video contents gain a large audience, the backbone network may be full of the same data. Backbone inefficiency, or congestion, can be avoided by having the video contents delivered to many servers at different access points on the Internet and then distributed from those points to individual users. The so-called MBone or IP[7] Multicast was the earliest trial of this function.[8] In 1997, RealNetworks and MCI began a service to provide streaming contents to 50,000 users simultaneously or daily to 10 to 15 million users.[9] RealNetworks and MCI installed many servers on the backbone network. Live contents are relayed to the servers and distributed from each to end users. On-demand contents are duplicated for the servers and distributed to end users. Servers are located at suitable points, like network access points (NAPs), where ISPs connect their networks to one another[10]—indeed, the best way

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[4]RealNetworks, "RealNetworks Introduces RealSystem 5.0 Delivering Breakthrough Innovations in One Complete Streaming Media System," press release, 6 Oct. 1997, [On-line.] URL: <www.real.com/corporate/pressroom/pr/5.0release.html> (Accessed 12 Jan. 1998.)

[5] Ibid.

[6]By contrast, ordinary TV, in both Japan and the U.S., is about 30 frames per second.

[7]Internet Protocol.

[8]For details of MBone, see Vinay Kumar, "What is MBone (or IP Multicast)?" [On-line.] URL: <www.mbone.com/mbone/what-is-mbone.html> (Accessed 12 Jan. 1998.); also, Vinay Kumar, "The MBone FAQ," [On-line.] URL: <www.mbone.com/mbone/mbone.faq.html> (Accessed 12 Jan. 1998.)

[9]See RealNetworks, "MCI and Progressive Networks [now RealNetworks] Launch First Internet Broadcast Network Designed to Reach Large-Scale Audiences," press release, 5 Aug. 1997, [On-line.] URL: <www.real.com/corporate/pressroom/pr/rn/index.html> (Accessed 12 Jan. 1998.)

[10]For details of this system, see RealNetworks, "RBN Technical Whitepaper," [On-line.] URL: <www.real.com/rbn/techpaper.html> (Accessed 14 Jan. 1998.)

to cope with the backbone problem may be to locate servers for streaming contents at every access point for Internet users. This notion is similar to interactive video service or video on demand, but a significant problem with it is who will pay to build the system.

Even if servers and backbone networks were sufficient to provide high-speed streaming contents, such as 300-kbps RealPlayer contents, users could not enjoy those contents without high-speed access. Neither the 56-kbps modem or nor 128-kbps ISDN access with two B channels can be used for 300-kbps streaming contents. For end users desiring high-speed streaming contents, the speed of Internet access is critical. As of 1997, only a few 300-kbps streaming contents are available on the Internet.[11] Considering that for ordinary residential users there are few options for high-speed access over 300 kbps at this time, this situation is natural. As high-speed Internet access by ADSL or CATV Internet becomes more common, the number of users of high-quality streaming contents such as 300-kbps video ("near VHS quality") could grow.[12] The wish to access high-quality streaming contents could be the main reason residential users of the Internet will want and need high-speed Internet access in the future. With the user audience for streaming video contents expected to grow enormously, contents providers will want to distribute such contents on the Internet, and advertisers will be attracted by that enormous audience. Advertisers may be crucial to funding the system for streaming contents on the Internet.

If streaming contents are provided on Web pages, users will only need to click on the links to contents they want to see to have particular video or audio programs stream out of the server. If they do not like the contents, they can stop that video or audio software and try another right away. Detailed explanations or supplementary information about the streaming contents are usually on the same Web page. Links to other servers that contain other information related to streaming contents also are presented on that page. A Web page with streaming video contents is itself like a complex video program, with explanations of video and links to related information accessible at a click on the browser screen.

These features of streaming contents on the Internet somewhat resemble an interactive or electronic program guide (EPG) for CATV or DBS. Most CATV or DBS companies provide their own program guides on one or more of their channels. Users see the guide on the TV screen and can move the cursor on the screen and click on a program name either to see what they want to see or to change the channel to the selected contents. This method of selection often requires upstream data transmission, as for Internet access, and the major difference between TV programs with an interactive program guide and Internet streaming contents is that users cannot select

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[11]In 1997, one example of a provider of 300-kbps contents was New England Cable News (available at URL <www.necnews.com>), which provides 300-kbps contents mainly for CATV Internet as well as less than 40-kbps contents for analog modem users. See section 5.1.

[12]Such high-quality streaming video contents are usually provided by TV, CATV, and DBS, so that the competition is potentially between the Internet and the media that distribute these contents.

previously broadcast programs with EPG or CATV (which only broadcast in real time).[13] The quality of Internet streaming contents in 1997 is not yet comparable to CATV or DBS but a sort of video-on-demand contents that everyone can use through the Internet.

4.2 Software Files

Software files can be delivered through several different media. Usually they are delivered on floppy disks and other magnetic media, on CD-ROM (compact disk–read-only memory) and other optical disks, and on a network. As the Internet became the major network on which everyone can exchange information electronically, many software files began to be provided there, including freeware and shareware available on Internet servers. Newly updated files for programs distributed by CD-ROM are also available on the Internet. For example, Microsoft provides amended files for Windows 95™ through its Web servers. With fast access speed on the Internet, large-size files can be downloaded quickly. A Web page may include software files that can be executed on the user's PC to enhance the look of the Web page or to offer functions, such as calculating the total on an order page; such software files are deleted from the memory of the user's PC once the user quits that Web page for another. Web pages with these kinds of embedded programs and functions require high-speed Internet access.

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[13]Streaming contents, audio or video, are either live or on-demand. Users cannot control the time of live contents. Once the contents are stored as data files, however, they are on-demand contents, and the user can access them at will. Users can control the timing of access to Internet streaming contents, by, for example, selecting yesterday's news report and playing it back whenever they wish and pausing when they need to leave the room.

Chapter Five

Choosing an Internet Access Service

As ways to access the Internet become available, users' choices widen. A variety of high-speed Internet access services are available (see **Chapter Two**), including telephone cable, CATV cable, satellite, and wireless transmission. To select the service they prefer, users must check actual availability, price, and quality (including speed, reliability, support). This chapter discuses other factors that affect choice of service, such as contents, "user friendliness" of the interface guide (the opening screen or start menu from which the user chooses services), and devices that the user will need to access the Internet.

5.1 Contents

Streaming contents and downloadable program files available on the Internet both require high-speed Internet access (see **Chapter Four**), and providers sometimes promote such contents to attract customers to their services.

In September 1997, MediaOne, a CATV company that provides CATV Internet, began to offer MediaOne Streamcast™, "an integrated software and hardware package that automatically encodes and compresses standard analog video for use via the Web...developed to take advantage of the bandwidth available via MediaOne Express, the advanced Broadband Internet access service of MediaOne."[1] The company also announced that New England Cable News (NECN), 50 percent-owned by MediaOne, had started a news-on-demand service on the Internet. NECN makes streaming videos of its CATV news programming and provides contents for 300-kbps access as well as for users with lower speed access. To view high-quality video contents at 300-kbps access, users need high-speed Internet access such as the one CATV Internet service MediaOne provides. NECN news-on-demand is optimized particularly for users of the MediaOne Internet service, although any dial-up Internet user can access it.[2] Nonsubscribers to MediaOne may not be able to enjoy the full quality of its streaming videos, however, even with high-speed Internet access, because other points, such as backbone network interconnections, may be congested. Network congestion is one good reason for users wanting to view high-speed streaming video contents with high quality to choose MediaOne as their ISP.

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[1]MediaOne, "MediaOne Unveils Streamcast Video Stream Publishing System to Enable Efficient and Economic Web-Based Video," press release, 29 Sept. 1997, [On-line.] URL: <www.mediaone.com/cgi-bin/x20/x$webnews.show_news?in_news_id=412> (Accessed 20 Jan. 1998.)

[2]Ibid. NECN news-on-demand is available at URL: <www.necnews.com>

In Japan in 1996, NTT began to provide a distribution system for streaming video and audio contents which it had developed as SoftwareVision™.[3] The following year NTT constructed an experimental Web site to distribute personal videos using this SoftwareVision system. As part of the experiment, users with access to the Internet are permitted to upload their own video contents at the site, and these contents can be seen by other Internet users using the client software of SoftwareVision, available at the site as freeware. NTT said it wanted to examine and consider possible new video communications services[4] that may in effect promote high-speed Internet access.

An ISP that, like MediaOne, can offer popular contents, especially streaming video contents, on an exclusive basis has an advantage in attracting customers to its high-speed access service.

5.2 Guide

Users access the Internet to search for information or to look through the enormous number of sites now available for something interesting to view. Yet the number of sites can be confusing, because users may find it difficult to locate exactly the particular information or contents they are seeking amid oceans of what is available. Users therefore ordinarily use search engines or a directory service(or services) to locate what they are seeking.

As of December 1997, the most popular Web site was the navigation service Yahoo!™. The top ten sites include five navigation services: AltaVista™, Excite™, Infoseek™, Lycos™, as well as Yahoo!.[5] See **Table 5-1**. Users generally go first to a navigation service, then go to sites that it recommends. The Internet access service is itself a pipe that transmits information. If the pipe is wide enough and of good enough quality, then users require ease of use ("friendliness") to obtain information through the pipe. For example, in January 1998 Yahoo! and MCI announced that they would offer an on-line service combining MCI's Internet service and Yahoo!'s contents, including "news, stock quotes, travel, entertainment, and weather," to provide "subscribers with a complete, integrated, easy-to-use online service."[6] Yahoo! planned to "create a customized Web page and

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[3]See NTT, "Internet-jo deno kouhinshitsu-na eizo wo haishinsuru gijutsu no teikyo ni tsuite" [NTT Provides the Technology for Distributing High-Quality Video on the Internet], press release, 10 May 1996, [On-line.] URL: <www.info.ntt.co.jp/dlij/NR_J/9605/960510B.html> (Accessed 21 Jan. 1998.)

[4]See NTT, "Internet-jou ni 'Kojin Eizo Hasshin Jikkenkyoku' wo kaisetsu" [NTT Opens an 'Experimental WWW Site for Distributing Personal Videos' on the Internet], press release, 11 Sept. 1997, [On-line.] URL: <www.info.ntt.co.jp/dlij/NR_J/9709/970911b.html> (Accessed 20 Jan. 1998.)

[5]In December 1997, about 17 million "Unique Visitors" ("a statistic similar to cumulative audience in television ratings," according to this source) visited Yahoo!. See RelevantKnowledge, "RelevantKnowledge First to Release Top Twenty-Five Web Site Lists for the Month of December," press release, 12 Jan. 1998, [On-line.] URL: <www.relevantknowledge.com/rk/press/release/1_12_98_1.html> (Accessed 22 Jan. 1998.)

[6]Yahoo!, "Yahoo! and MCI Unveil New Internet Online Service; Yahoo! Online Powered by MCI Internet," press

Table 5-1

Top Five Internet Navigation Services, 1997

Navigation Services	"Unique Visitors," December 1997
Yahoo.com	16,769,000
Excite.com	9,215,000
Infoseek.com	6,842,000
Lycos.com	5,576,000
Altavista.digital.com	4,693,000

Source: RelevantKnowledge, Inc., "RelevantKnowledge First to Release Top Twenty-Five Web Site Lists for the Month of December," press release, 12 Jan. 1998 [On-line.] URL: <relevantknowledge.com/rk/press/release/1_12_98_1.html> (Accessed 22 Jan. 1998.)

some content features that will be exclusive to the new service."[7] The initial screen, or start page, was expected to offer a good menu to help users navigate.

Other ISPs, such as MindSpring Enterprises™ and EarthLink Network™, already offer connection software that combines "ease-of-use and content into an attractive package that makes customers want to return again and again."[8] Prodigy™ has given up on "creating its own content for its Internet users" and instead "links its users to the contents of Excite, Inc., a Web directory that already provides such information at no charge to anyone with Internet access."[9] Prodigy offers its own contents as one of its on-line services, but for its Internet service, it employs the contents of Excite, the second biggest navigation service. In the "early days"—the mid-1990s—ISPs offered only the pipe to connect to the Internet and began in 1997 to provide start-menu pages with ease-of-use interfaces to help users navigate on the Internet.

Once users become accustomed to a particular start-menu page, they can easily obtain information through its user interface. On AOL's opening menu screen, the icon for AOL's news service is always the same shape and color and located at the same place on the screen, thus becoming for users an ease-of-use feature. Users are not likely to change to another ISP for only the same quality of service. A friendly interface can have significant effect on retaining users.[10]

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release, 12 Jan. 1998, [On-line.] URL: <www.yahoo.com/docs/pr/release140.html> (Accessed 22 Jan. 1998.)

[7]Don Clark, "Yahoo! and MCI Team Up to Launch Co-Branded Internet Online Service," *The Wall Street Journal*, 13 Jan. 1998, B18.

[8]Randy Barrett, "ISPs Emulate AOL—Sort of," *Inter@ctive Week* (22 Sept. 1997), 41.

[9]Thomas E. Weber, "Prodigy Will Stop Creating Content for Internet and Will Link to Excite," *The Wall Street Journal*, 22 Jan. 1998, B10.

[10]The default menu on most PCs is the desktop screen of Microsoft Windows™, which includes the icon for Microsoft's Internet Explorer 4.0™, a Web browser that guides users to contents on the Web. Access to contents on the

5.3 Device

With the growth in the popularity of the Internet came devices to enable Internet access through TV. In the United States, given the penetration of TVs into homes, it was reasonable to believe that people might want access to the Internet through their TVs without needing to buy PCs. Some devices are external, such as the set-top box for CATV; others are TVs with features that allow users to access and view Internet contents. Unlike PCs, as of 1997 these devices are usually only for PSTN Internet access.

WebTV™ is a popular set-top box for Internet access through television built and commercially distributed by two electronics manufacturers, Sony and Philips, and designed by WebTV Networks, which was bought by Microsoft in 1997. WebTV Networks claims it has 250,000 subscribers,[11] even though it has only PSTN connectivity.[12] In Japan, the consumer electronics manufacturers Sharp, Mitsubishi, and Sanyo began to sell Internet TV in 1996, and their Internet TV sets too are only for PSTN connectivity.[13] Users of Internet TV sets cannot, for example, use CATV Internet. Providers of Internet connectivity other than the PSTN often offer PC users dedicated interface cards, for use, for example, with DirecPC, and sometimes the user can use an ordinary LAN card to connect a PC to a network terminal. To use TVs to access the Internet, providers of connectivity other than the PSTN must themselves provide or have another entity provide Internet TV devices suitable to their connectivity. CATV companies plan to provide digital set-top boxes with the Internet access feature.[14] When a particular kind of Internet access connectivity becomes popular, manufacturers are eager to provide the appropriate devices.

Microsoft's Internet Explorer 4.0™, a Web browser that guides users to contents on the Web. Access to contents on the Net is only a click away from activating this icon, and once the "active desktop" has been started, icons for certain contents providers appear on the default desktop, giving the Microsoft Corp. considerable control over contents providers.

[11]See WebTV Networks, "Backgrounder," [On-line.] URL: <www.webtv.com/ns/about/backgrounder.html> (Accessed 26 Jan. 1998.)

[12]Ibid., "Features/Specs," [On-line.] URL: <www.webtv.com/ns/corporate/features/index.html> (Accessed 23 Jan. 1998.)

[13]Very few Internet TV sets have been sold. The manufacturers (for example, Sharp and Sanyo) admit there were stringent limitations on their products, such as browsers that functioned poorly, insufficient memory (typically 2 MB), and slow modems (14.4 to 28.8 kbps). Still, they are eager to attract Internet users. In Japan, Matsushita and NEC began to provide Internet TV in 1997, with improved browser functions and increases in both memory (6 to 8 MB) and modem speed (33.6 kbps). They expect the future to hold interactive TV, a convergence of digital TV broadcasting, data broadcasting, and the Internet. See Hironori Watanabe, "Internet TV, ishi no ue nimo 3 nen, digital housou no oikaze wo matsu" [Internet TV, Patience Wins the Day, Waiting for the Favorable Wind of Digital Broadcasting], *Nikkei Multimedia* (November 1997), 94-99.

[14]For example, Tele-Communications, Inc., the biggest CATV company in the United States, plans to start commercial shipment early in 1999. See David Bank, "TCI in Talks over New Cable-TV Boxes," *The Wall Street Journal*, 15 Dec. 1997, A3.

So, the connectivity of TV-based Internet access devices may affect the user's choice of Internet access.[15] **Table 5-2** presents a sample of devices as of 1997.[16]

Table 5-2

Internet TV Devices, 1997

U.S.: Devices*	Japan: Internet TV Sets**
• WebTV (Sony, Philips) • NetChannel (RCA) • WorldGate (CATV set-top box)	Released since October 1996: • Network Vision (Sharp) • Internet Televi (Mitsubishi) Interneter (Sanyo) Released since September 1997: • Cyber Media (Matsushita) • Inter-Raku-TV (NEC)

*Source: Suzanne Galante, "Net TVs May Get Boxed In," *CNET NEWS.COM*, 17 Nov. 1997 [On-line.] URL: <news.com/SpecialFeatures/0,5,16401,00.html> (Accessed 23 Jan. 19 .98). Kurt Oeler, "Start-up Technology Rivals WebTV," *CNET NEWS.COM*, 12 Sept. 1997 [On-line.] URL: <news.com/News/Item/0,4,14157,00.html> (Accessed 23 Jan. 1998.)

**Source: Hironori Watanabe, "Internet TV, ishino ue nimo 3 nen, digital housou no oikaze wo matsu" [Internet TV, Patience Wins the Day, Waiting for the Favorable Wind of Digital Broadcasting], *Nikkei Multimedia* (November 1997), 94-99.

5.4 Hooking Up Homes

In 1997, the race to hook up homes with high-speed Internet access had just begun. Because connectivity through the PSTN sets limits on the speed of data transmission, the various kinds of connectivity are in competition. Predicting which will be the winner is beyond the scope or intention of this report. Users choosing a method of access to the Internet must consider such factors as availability, price, quality (speed, reliability, support) and the ease of use (or friendliness) of the interface or start menu offered with a particular kind of connectivity.

Users in a particular locality may find that high-speed Internet access is not available to them, because, for example, local connectivity providers have little interest in it. In the United States, the Telecommunication Act of 1996 directs "the [FCC] and other regulatory bodies to take

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[15]Internet TV devices often work with the ISP's caching system, to improve the speed of data transmission by reducing actual access to congested Web servers. The system also modifies the layout of Web pages for viewing on TV screens, which have lower resolution than PC monitors. For example, "WebTV caches, transcodes, and reorganizes Web data and more efficiently utilizes the telephone line." See WebTV, "FAQs—30. How do WebTV's Internet Terminal and the WebTV Plus Receiver Compare to a PC?" [On-line.] URL: <www.webtv.com/ns/tune/faq.html> (Accessed 23 Jan. 1998.)

[16]Internet TV devices enable TV sets to access the Internet. RealPlayer™ (see Chapter Four) enables the Internet to distribute video programs. Internet TV devices can contain both Real Player and a Web browser, and the convergence may create a kind of integration of TV programs and Internet contents.

specific actions in order to make advanced telecommunications technology widely available."[17] If they are not "deployed in a reasonable and timely manner, the Commission is directed to take "immediate action" to remove barriers to such deployment,"[18] although what the actual action would be is not clear. Schools and libraries can expect discounts of telecommunications services.[19] In Japan, Shunpei Kumon, executive director of the Center for Global Communications at the International University of Japan, has proposed a Community Area Network (CAN). In 1997, Kumon started a project to build community LANs that would include shopping centers, apartment complexes, schools, hospitals, business offices, and local government offices. The LANs are expected to reach all members of the community and to form a CAN that will enable members of the community to collaborate in many aspects of life and business.[20] Who actually will build the CAN remains unclear, but in January 1998 the MPT started a similar trial, of "local intranets," using CATV Internet. Local government and other local organizations, such as medical associations and the Board of Education in the areas, will be expected to participate in the trials of local intranets.[21] The MPT trial uses CATV Internet, but the concept of a "local intranet" allows for any kind of connectivity. This might be another approach to hooking up homes in local areas, a community-oriented approach rather than a market-oriented one.

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[17]Kevin Werbach, *Digital Tornado: The Internet and Telecommunications Policy* (Washington, D.C.: FCC, March 1997), 79, [On-line.] URL: <www.fcc.gov/Bureaus/OPP/working_papers/oppwp29.pdf> (Accessed 10 Dec. 1997.)

[18]Ibid., 80.

[19]Ibid.

[20]See Shunpei Kumon, "Multimedia syakai ni denwamou ha huyo, nippon kakuchi ni LAN wo hiromerubekida" [The Multimedia Society Does Not Need the Telephone Network, LAN Should Prevail Anywhere in Japan], *Nikkei Multimedia* (October 1997), 148. Also, see CAN Forum, "About CAN Forum," [On-line.] URL: <www.can.or.jp/menu-e/about.html> (Accessed 28 Jan. 1998.)

[21] See Ministry of Post and Telecommunications in Japan, "CATV Internet wo tsukatta chiiki intranet model kouchiku" [Making a Model of Local Intranet with CATV Internet Services], press release, 22 Jan. 1998, [On-line.] URL: <www.mpt.go.jp/pressrelease/japanese/new/980122j502.html> (Accessed 28 Jan. 1998.)

Chapter Six

Summary

This report presents a snapshot of residential electrical connectivity for Internet access as of 1997.

- The PSTN is currently the main kind of residential Internet access. With a 56-kbps modem, actual downstream speed is around 40 to 50 kbps; upstream speed is up to 33.6 kbps. These are the upper limits on speed for a PSTN line. Most ISPs offer many access points to support the 56-kbps modem.

- ISDN uses the ordinary PSTN line. With ISDN terminal equipment, ISDN provides up to a 128-kbps path to access the Internet. In Japan, prior to the appearance of the 56-kbps modem for the PSTN, ISDN became popular for Internet access, although in the United States it is not yet popular.

- CATV networks also are used for Internet access, with a CATV modem. Data speed is usually 27 Mbps downstream and 768 k to 10 Mbps upstream, but users must share bandwidth. The actual speed of CATV Internet access services could be far less than these. For two-way data transmission, CATV networks need to use HFC, which requires some investment by the CATV companies. This is one reason that areas where CATV Internet is available are limited. In the United States, however, thanks to the high penetration of CATV networks, this kind of Internet access may prove to be a major high-speed path for residential connection. In Japan, however, the low penetration of CATV networks limits the availability of CATV Internet.

- DSLs use the ordinary PSTN line and provide higher speed data transmission than ISDN. There are several types of DSL, according to speed and the distance between the CO and the subscriber. ADSL for Internet access, at 1.5 to 8 Mbps downstream and 16 k to 1 Mbps upstream, has attracted attention, although the actual data transmission speed depends on conditions on the line. Several ILECs have begun ADSL service in the United States; in Japan NTT, the major LEC, has begun a trial. With the ordinary telephone line, ADSL may offer quick deployment of high-speed residential Internet access.

- Satellites can transmit high-speed data and provide Internet access service, and they can cover a wide area of the earth's surface without needing a subscriber network on the ground. In the United States, satellite Internet access is available at a speed of up to 400 kbps, but only for downstream data transmission. Other networks must be used for upstream data transmission. The downstream bandwidth is shared by users, as in the case of CATV Internet. Plans to launch LEO satellites to provide high-speed, two-way satellite Internet are under way. If successful, this kind of system could completely bypass surface subscriber networks.

- Cellular phone and PCS, which offer mobile communications, can also transmit Internet data using an analog modem or cellular adapter, although at a slower speed than that of a 56-kbps modem for the PSTN. Cellular and PCS companies plan to provide high-speed data transmission service up to 2 Mbps, called IMT-2000.

• LMDS and MMDS are wireless services that can transmit high-speed data. LMDS uses the 28-GHz and 31-GHz band to transmit data, for example, at 1.5 Gbps downstream and 200 Mbps upstream, enough to transmit, simultaneously, TV programs, teleconferences, and to provide Internet access. In the United States, spectrum is to be auctioned in 1998, which is expected to enhance competition in the local communications market. There are difficulties in installation of LMDS, because it requires a clear line of sight and rain can weaken the signal. MMDS, using the 2-GHz band, was originally used to distribute analog TV programs. MMDS is in the process of digitization; the FCC has proposed using MMDS for both downstream and upstream. Thus, like LMDS, it could be used for high-speed Internet access. One MMDS transmitter has wider coverage than LMDS. It is reported to be the least expensive infrastructure for broadcasting TV programs with local content, but to avoid congestion the return path must be fragmented into smaller cells, which could make constructing two-way networks costly.

• Wireless high-speed data transmission is planned for use also with lighter airplanes and "lighter-than-air craft." Experiments are also under way using electric power lines to transmit data.

• To some extent in the present and assuredly in the future, users' responses to certain kinds of contents, menus, and devices can affect their choice of Internet access service. For example, one important kind of contents that require high-speed Internet access is streaming video or audio. Browser software shows part of these contents as they are downloaded. If bandwidth is insufficient, the quality of the contents will be poor. Streaming video contents for 300-kbps, near-VHS quality will not play well with Internet access by either 56-kbps PSTN or 128-kbps ISDN. The availability of these streaming contents on an exclusive basis can affect the users choice of Internet access service. Most ISPs now provide initial screens with start-menu pages to guide users to what they want to see. Internet TV devices have come into use.

Acronyms

ADSL	asymmetrical DSL
AOL	America Online
ARFA	advanced radio fixed access
BTA	basic trading area
CATV	community access TV
CD-ROM	compact disk–read-only memory
CDG	CDMA Development Group
CDMA	code division multiple access
CEO	chief executive officer
CLECs	competitive local exchange carriers
CO	central office
DBS	direct broadcast satellite
DSL	digital subscriber line
e-mail	electronic mail
EPG	electronic program guide
FCC	Federal Communications Commission
FTTH	fiber to the home
GEO	geosynchronous orbit
GHz	gigahertz
HALE	high-altitude, long-endurance platforms
HDSL	high bit rate DSL
HFC	hybrid fiber coax (optical fiber and coaxial cable)
ILECs	incumbent LECs
IMT	international mobile telecommunications [standard]
IP	Internet Protocol
ISDN	integrated services digital network
ISP	Internet service provider
ITU	International Telecommunications Union
km	kilometer
LAN	local area network
LEC	local exchange carrier
LEO	low earth orbit

LMDS	local multipoint distribution services
MB	megabyte
Mbps	megabits per second
MDS	multipoint distribution services
MHz	megahertz
MMDS	multichannel multipoint distribution services
MPT	Ministry of Posts and Telecommunications
NTT	Nippon Telegraph and Telephone
OCN	Open Computer Network
ONU	optical network unit
PC	personal computer
PCS	personal communications services
PDA	personal digital assistant
PHS	personal handy-phone system
PSTN	public switched telephone network
TV	television
UAWG	Universal ADSL Working Group
URL	uniform resource location
VDSL	very high bit rate DSL
WWW	World Wide Web