Voice Over the Internet: Fad or Future?

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Program on Information Resources Policy

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Executive Summary

The challenge since the mid-1990s has been to conduct real-time communications over the Internet at a fraction of the price of a long-distance or international telephone call. As of 1997, an increasing number of companies have entered this arena and provided a variety of Internet-based real-time communications.

This report describes and analyses efforts to provide real-time communications over the Internet, in particular, voice over the Internet (VOI). There are three kinds of VOI, each with its own purpose and targeted to a different category of user. The first kind, PC [personal computer]-to-PC VOI, was made possible by computer software. Caller and called party, both with multimedia PCs and with VOI software, can call for the price of only the Internet hookup and a local telephone call. The second and third kinds of VOI, PC-to-phone and phone-to-phone, were made possible by gateway technologies. In PC-to-phone VOI, the gateway permits multimedia PC users to call ordinary telephone users. In phone-to-phone VOI, the gateway enables real-time voice conversation—local, long-distance, or international—through the Internet for users of ordinary telephones. The technological development of these kinds of VOI represents progress toward increasing simplicity, ease of use, and universal accessibility. PC-to-PC VOI shifted the targeted users from residential customers to businesses that demand such services as call centers or teleconferencing. Gateways broadened the targeted users from small business to larger businesses, Internet service providers (ISPs), and carriers.

Many attempts are being made to support real-time applications such as voice and video on the Internet, including work to make an integrated services Internet—an Internet with a range of qualities of service to support real-time and non-real-time applications. One fundamental problem being addressed is packet delay from network congestion—congestion of the Internet backbones and congestion of the public switched telephone network (PSTN). Real-time communications require speeding up the network to address the problem of network routing delay.

Technically, voice applications have been improving, and developers are trying forge a standard in order to promote interoperability. Latency, or delay in voice signal delivery, remains the biggest thorn on the VOI rose. If the architecture of the Internet moves from single-level, best-effort service to a more complex model with explicit options for quality of service (QoS) to support real-time applications such as video and audio, the quality of VOI can improve substantially.

Carriers, such as AT&T, MCI, and Sprint in the United States and NTT and KDD in Japan, are entering the Internet market and considering whether to prepare to offer VOI, which, they believe, will not replace the current telephone for some years but, rather, exist side by side with it. All carriers have already entered the ISP market and tried to increase their backbones. The three largest interexchange carriers (IXCs) have begun to provide integrated services—a call is initiated from the Internet but carried over the long-distance networks—and probably will eventually put most traffic on packet-switched backbone networks. The carriers, like the large ISPs, can also provide high-grade Intranets, and VOI will be used on Intranets because they are more reliable than the Internet. As of mid-1997, most ISPs were struggling financially, so some will try to use VOI to their advantage. They are eager to combine Internet and PSTN services and establish pricing for different levels of service. Most large ISPs began to offer high-guarantee Intranet service early in 1997. This prospect offers business users greater choice. Voice over frame relay (VoFR) and voice over asynchronous transfer mode (ATM) also are emerging. But which service is best remains an open question.

Whether VOI will replace the PSTN requires considering carriers' plans. VOI offers a price advantage over voice telephony, but whether this advantage will continue will depend on the prices of the PSTN and the Internet. Factors that may decrease VOI's price advantage in the future include cheaper provision of the PSTN and a higher price for use of the Internet along with price diversification for Internet applications, which will increase the price of VOI.

Both the United States and Japan are trying to promote the Internet. In the United States, regulation of the Internet and of telecommunications may change. The petition of the America's Carriers Telecommunications Association (ACTA) to the Federal Communications Commission (FCC) requesting regulation of VOI allowed the FCC to reconsider its categories of basic, enhanced, and information services. As of early 1997, the FCC tentatively decided to continue to exempt VOI from the access charge. The unfair competition between IXC resellers and phone-to-phone VOI service providers remains. For both Japan and the United States, the relevant actors in the telecommunications markets are not only the carriers but also the ISPs, computer manufacturing companies, and other companies with advanced private networks and "bypasses."

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The database for this report was closed as of mid-1997.

Chapter One

Introduction

Since early 1990, when commercial access to the Internet was first offered by such companies as PSI and AlterNet, methods of communication have been changing. By using the Internet, for example, and through it the World Wide Web (WWW), people can easily send and receive information. Before then, customers seeking information could call by telephone or send paper ("snail") mail, and the companies could return information by facsimile (fax) or direct mail (DM), methods that might mean a considerable wait for the information. Now, in the late 1990s, even knowing only the uniform resource locator (URL), a user or customer can readily access information at any time. This is true also for information providers: although they can send DM or faxes, they can more readily provide only a URL or need the customer's electronic mail (e-mail) address. Information providers can efficiently and economically send their information to the public or to particular customers by using the Internet (either the WWW or e-mail). "Non-electronic," "non-real-time" communications are now conducted over the Internet, and, through it, on the Web and by e-mail.

The challenge since the mid-1990s has been to conduct real-time communication over the Internet at a fraction of the price of a long-distance or international telephone call. As of 1997, an increasing number of companies entered this arena and provided a variety of Internet-based real-time communications.

This report presents the full scope of issues that need to be considered in a discussion of the future of voice over the Internet (VOI).

Part One is a description of efforts to provide real-time communication over the Internet, primarily VOI, with an analysis of their features, including the kinds of communications offered, how connections are made, signaling, directories, and universality. Each kind of VOI is shown to have its own purpose and to be targeted to different categories of user.

Part Two is a discussion of the status of VOI in the Internet and telecommunications markets, with a particular focus on the U.S. and Japanese markets, which have different tariffs, different competition structures, and different regulations. To date, most of the companies developing VOI applications have been American, and the differences between the U.S. and Japanese markets have automatically affected the influence of VOI.

In March of 1996, the America's Carriers Telecommunications Association (ACTA) asked the U.S. Federal Communications Commission (FCC) to exercise jurisdiction over companies, such as Internet service providers (ISPs) and Internet access providers (IAPs),

which provide real-time communication over the Internet. Up to that time, the FCC had not exercised such jurisdiction. ACTA pointed to unfair competition and insisted also on access charges. Interexchange carriers (IXCs) agreed about an access charge—a system for compensating local exchange carriers (LECs), which provide the "first and last mile" of interexchange links—but disagreed with ACTA on other issues. Even though both are categorized as telephone carriers, their demands were not always the same.

Most local telephone carriers, the regional Bell operating companies (RBOCs), provide some flat rates for unlimited calling, and many ISPs provide services for cheap, flat rates, so that in the United States customers may use the Internet for many hours at a time without worrying about cost. This situation has led to arguments among RBOCs about the congestion on telephone lines caused by use of the Internet. Eric Arnum explained the situation in the following way:

> Many of the rosy predictions of a mass market for Internet telephony are based on the fact that users currently get the service for almost no additional cost, and that equation will change as telecom carriers pass on the escalating costs of transmitting data traffic and upgrading their networks.[1]

In the U.S. telecommunications market, VOI has fueled a debate over whether the government ought to step in to regulate communications over the Internet. The following points need to be considered:

1. Competition and Regulation: Who is asking for which regulation? Who is against which regulation? VOI will require the FCC to reconsider its categorization of services, because VOI falls somewhere between basic and enhanced services.

2. Pricing of Internet Services: Will ISPs pay access charges? Will pricing for Internet services change from a flat-rate to a usage-based[2] or usage-sensitive[3] tariff?

In Japan, the telecommunications market was privatized in 1985, and since then new common carriers (NCCs) have entered the market and telephone rates have decreased by about one-third. Japanese telecommunications tariffs, however, remain expensive compared with those in the United States. If only this point were considered, then VOI might be expected to spread quickly in Japan, but because Japanese telecommunications tariffs are

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[1]Eric Arnum, "FCC's Levin Warns Stay Could Delay Access Reform," *TR Daily*, Oct. 24, 1996, 4.

[2]Usage-based means that the rates charged are based on expected use.

[3]Usage-sensitive means that the charges are for actual, rather than expected, use.

usage-based and because most Japanese Internet providers' services also are usage-based—and not cheap—people cannot obtain Internet service so easily as in the United States.[4]

But things have begun to change in the Internet market in Japan. Although telecommunications tariffs there have been based on usage and distance, since 1996 carriers have provided Internet-oriented services (for access to the Internet, a combined tariff: a flat rate for off-peak hours and a usage-based rate for peak times). At the end of 1996, some Japanese carriers announced special pricing for Internet access and for special Internet-oriented services, while some ISPs began to provide flat pricing for individual users. These changes will allow people easier access to the Internet than had been possible.

The Japanese telecommunications market also has begun to change, under the impact of competition. In October 1996, AT&T announced its entry into the Japanese telecommunications market as a call-back provider.[5] In 1997, an international public-private-public connection, or simple resale ("bypass"), will be allowed, and the law that has prohibited the entry of foreign companies will no longer be in effect. The Japanese telecommunications market will therefore change dramatically in the next few years.

Until recently, for Japanese carriers VOI was not an issue for debate. Most Japanese carriers have begun to look into VOI and are still trying to judge whether and when to enter this arena.

For both Japan and the United States, the relevant actors in the telecommunications markets are not only the carriers but also the ISPs, computer manufacturing companies, and other companies that have advanced private networks and that build "bypasses." *VOI will change both the ordinary telecommunications market and the Internet market, and its greatest impact may be on service prices and infrastructures.*

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[4]According to data from *Jouhou Ka Hakusyo 1995* (Tokyo: Nihon Jyouhou Syori Kaihatu Kyoukai, 1995), focusing on companies, the number of personal computers (PCs) per 1,000 employees is for the U.S., 551.4, and for Japan, 146.5, so that in the U.S. there number is 5 times that in Japan. The number of systems that connect to the Internet is for the U.S. 3,179,000, for Japan, 96,000, so that in the U.S. the number is 30 times that in Japan.

[5]Call-back service providers have found a niche in offering an international calling rate somewhere between the higher and lower tariffs of different countries. The targeted market of call-back service providers is people in countries with high telecommunications tariffs. The mechanism of call-back service is as follows: Callers in the countries with higher tariffs dial the number of the call-back service provider, hang up, then receive a call from the country that provides a second dial tone with an outbound calling capability. Callers with call-back adapters, such as large companies can instead dial in the ordinary way. AT&T announced that it will provide this service at a rate about 30 percent lower than that of Japanese international telecommunications carriers; see "AT&T Enters as a Call-Back Service Provider," *Nihon Keizai Shinbun* [Nippon Newspaper], Oct. 29, 1996, 3. After AT&T's announcement, Japanese international telecommunications companies lowered their rates; see "International Telephone Rate, KDD Decrease 5.1% from November 23, to Compete with Call-Back Providers," *Nihon Keizai Shinbun*, Nov. 15, 1996. Following these announcements, call-back service providers lowered their rates also; see "Call-Back Providers Decrease Their Rates to Compete with KDD," *Nihon Keizai Shinbun*, Nov. 18, 1996.

Part Three focuses on the future of VOI and discusses such issues involved in its wide use as new Internet architecture, regulation, stakeholders' activities, pricing, and customer needs. These issues are critical to whether voice over the Internet will prove to be either a fad, and therefore ephemeral, or indeed the future. Rather than offering the author's views, Part Three provides the views of the affected stakeholders and what decisionmakers will need to consider in relation to the possible future of VOI.

The database for the report essentially closed as of mid-1997. Many changes have occurred since then: for example, many new VOI products have appeared in the market; AT&T—contrary to earlier claims that it would not make this offering (see section **9.1.1**)—as of late 1998 provides phone-to-phone VOI; the relationship then existing between BT and MCI (see section **10.3**) has ended; and the FCC has decided to levy an access charge on Internet service providers (ISPs) on a case-by-case basis (see **Chapter Eight**).

Given its nature as a "snapshot in time," the report does not aim to provide the latest news flash but, rather, the context for a news flash, offering the reader a sense of the areas and issues that must be considered in order to understand VOI and its potential future.

Part One

The Internet: Issues for VOI

Chapter Two

The Internet

2.1 What is the Internet?

2.1.1 Formation of the Internet

The Internet is a network of networks. It was founded in 1968 by the Advanced Research Projects Agency (ARPA) of the U.S. Department of Defense (DOD), itself founded in 1957 for funded research on networking. By the late 1960s ARPA used a variety of electronic, computer, and communications technologies. By the late 1970s, when computer networking had begun to blossom, in an effort to connect computers to permit data transfers between networks, many companies and organizations began to install local area networks (LANs). Because LAN technology is easy to install, an individual department can purchase, install, and operate a LAN. Not all LAN technologies, however, are compatible: a given LAN technology may have been engineered to operate over a limited distance, and each technology has its own way of encoding information.[1]

Another form of computer networking, wide area networks (WANs), emerged in the 1960s and 1970s.

Many LAN and WAN technologies exist, most of them incompatible with one another. By the late 1970s, ARPA had several computer networks operating and had begun to pass technology on to the U.S. military. ARPA research examined ways to interconnect all the machines from a large central organization in an attempt to connect computers in different places so they could share information. ARPA projects included the ARPAnet.[2] A key idea of ARPA research was a new approach to interconnecting LANs and WANs that became known as an "internetwork," which was abbreviated to "Internet."

ARPA's Internet project was an effort to make networking more open and more efficient. It produced many innovations in its work to achieve this goal. By 1982, it had produced a smooth, apparently seamless software design. Particularly important were the innovative Internet Protocol (IP) software, which provides basic communications, and the Transmission Control Protocol (TCP) software, which provides additional facilities the

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[1]Much of the information in this paragraph and for this chapter was drawn from Douglas E. Comer, *The Internet Book: Everything You Need to Know About Computer Networking and How the Internet Works* (Englewood Cliffs, N.J.: Prentice-Hall, 1995). See also Robert Hobbes Zakon, "Hobbes' Internet Timeline v2.5" [On-line]. URL: <info.isoc.org/quest/zakon/Internet/History/HIT.html>

[2]ARPAnet was called the backbone network because it was the central WAN that tied researchers together.

applications require. IP and TCP work together to provide a reliable way to send data across the Internet.

2.1.2 TCP/IP

The Internet Protocol is the main reason for the Internet's high degree of interoperability. IP is a set of rules for what packets of information look like, how they are handled, and how different parts of the Internet know and relate to one another. IP software makes an interconnected set of networks and routers operate like a single, large network.

The current version of the IP is IPv4.[3] This protocol is sometimes referred to as a "thin layer" because of the small amount of functionality it provides. Its "best-effort" model of delivery does not guarantee whether, when, or how accurately packets will be delivered. For that reason, the best-effort delivery model is not good for real-time communication, which requires tight bounds on delay and packet loss. In other words, the Internet was not designed for real-time applications.

TCP was created in 1974 by Vinton Cerf and Robert Kahn, for whom high efficiency in transmitting data and the speed of getting data across the network were less important than the assurance that they would arrive eventually. TCP sacrifices speed for reliability. It makes the Internet reliable in the following ways:

1. If a router becomes overrun with datagrams, it must discard them. As a result, a datagram can be lost on its trip through the Internet. TCP automatically checks for lost datagrams and handles the problem.

2. Sometimes some datagrams can arrive at the destination in a different order from that in which they were sent. TCP automatically checks incoming datagrams and puts the data back into order.

In this way, IP provides a way to transfer a packet from its source to its destination but does not handle problems such as the loss of a datagram or delivery out of order. TCP handles problems IP cannot, and together they can provide a reliable way to send data across the Internet.

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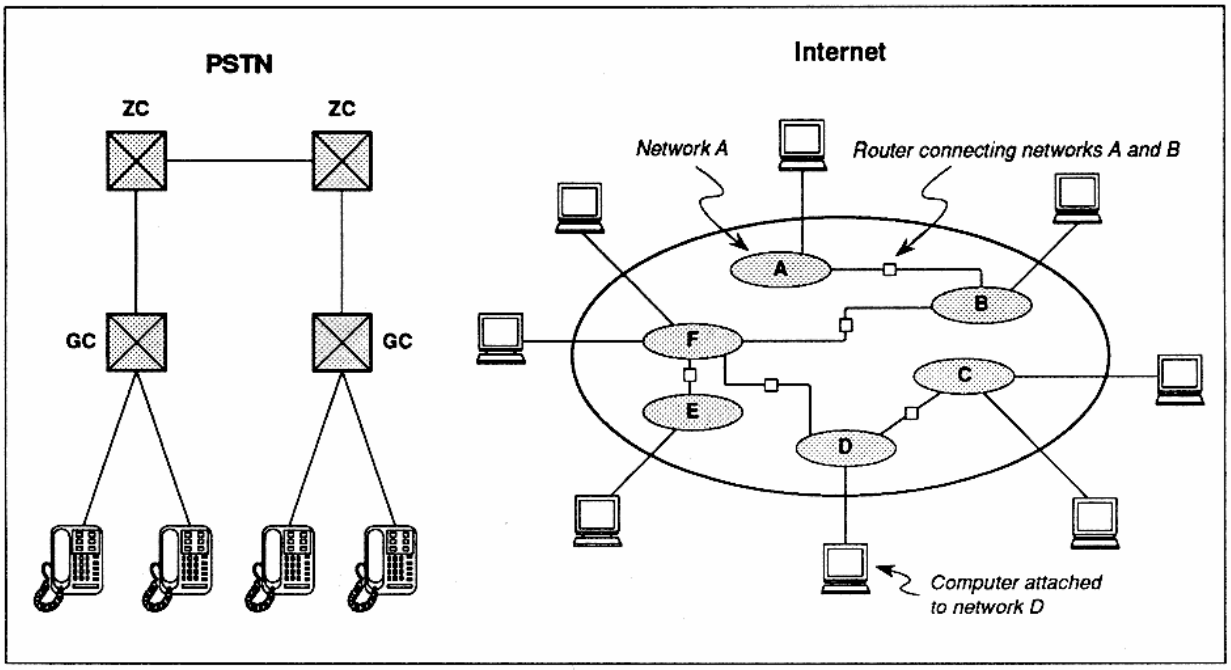
[3]The Internet has expanded considerably and is continuing to grow much faster than the original designers of the IP could have imagined, so the usefulness of the protocol as a primary enabler of interoperability is becoming limited. To address this problem and to support real-time applications, the Internet Engineering Task Force has begun work to make a new version of IP, IPng (IP next generation), formally known as IPv6. See section 7.1.1.

2.1.3 Technical Differences Between the Public Switched Telephone Network (PSTN) and the Internet

There are two main differences between the public switched telephone network and the Internet. One is network configuration. The PSTN has two or three levels of configuration, and expensive exchanges are used for connection. The Internet is a network of networks connected by routers (for a comparison of the configurations of the Internet and the PSTN, see **Figure 2-1**). Second, there is a fundamental difference in how the lines are used by the Internet and the PSTN. The Internet provides connectionless, packet-switched service, whereas telephone service is circuit-switched. Circuits must be set up before a call can begin, and a fixed share of network resources is reserved for the call—no other call can use those resources until the original connection has been closed. Packet-switching can share network resources with other (packet) traffic, and for this reason it is said to be more efficient than the PSTN.



GC = group unit center
ZC = zone center
PSTN = public switched telephone network

= exchange
= provider's network
= router

Source: Internet configuration adapted from Douglas E. Comer, *The Internet Book* (Englewood Cliffs, N.J.: Prentice-Hall, 1995), 110.

Figure 2-1

Comparison of the Configurations of the Internet and the PSTN

2.2 The Internet in the Late 1990s

2.2.1 Explosive Growth

In 1991, after the National Science Foundation (NSF) lifted restrictions on commercial use of the Internet, the Commercial Internet eXchange (CIX) Association was formed by several companies: General Atomics (CERFnet), Performance Systems International (PSInet), and UUnet Technologies (AlterNet). Once commercialized, the Internet grew explosively, from fewer than one million connections to PCs in 1985 to eighteen million by 1996, with the major increase occurring between 1993 and 1996.[4]

2.2.2 Intranets

Intranets are private networks, usually networks used for communications by a particular company. Such private networks may solve problems involved in service over the (public) Internet; they sometimes offer quality-of-service guarantees and better security against hackers. "An Intranet provides the same services [as the Internet] and is built on TCP/IP, but Intranet servers and corporate users are behind firewalls, with access limited to intra-company computers, employees, and selected outsiders."[5]

2.2.3 Many IP applications

In 1982, IP was neither a real-time nor a synchronizing application: for e-mail, file transfer protocol (FTP), and telnet, correct delivery is more important than real-time communication. But in the mid-1990s, a new class of IP applications that use multiple media (voice, video, and data) began to appear.

Real-time applications have been thought to suit the PSTN, but not the Internet, for the following reason. The PSTN is built on circuit-switching and can guarantee minimum delay, which is essential for real-time applications. Packet-switching does not guarantee the delay, because it permits "statistical multiplexing" on the communications lines, in which packets from many different sources can share a line, allowing efficient use of fixed capacity. Packets are generally accepted onto the network on a first-in-first-out (FIFO) basis, and if the network becomes overloaded, packets are delayed or dropped. Packets can be resent, although this does not work for real-time delivery requirements, such as voice.

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[4]Phil Leigh, *The Internet and the New Media Gold Rush* (St. Petersburg, Fla.: Raymond James & Associates, Industry Report, Feb. 13, 1997), 9.

[5]Jerry Lucas, "Ten Internet Predictions for 1997," *TeleStrategies Insight* (October 1996), 2.

In 1992 the Internet Engineering Task Force (IETF)'s Audio-Video Transport Working Group was chartered to explore ways to transmit real-time data over the Internet. The group thought the User Datagram Protocol (UDP), created in 1979 by Jonathan Postel as an alternative to TCP, might be used to carry time-sensitive data, such as telephone calls. Because UDP sends only single, small packets at a time, it skips the reassembly process required by TCP, which makes it simpler and faster than TCP but less reliable. Unlike TCP, UDP does not delay packets when confronted by congestion on the network. But the Group doubted that UDP would prove the best tool, concluding that "UDP transmission of audio and video is only sufficient for small-scale experiments over fast portions of the Internet." As the Internet grew, the T-1 (1.5 megabits per second [Mbps]) lines that had seemed fast became common, and using UDP for real-time transmission became more practical.[6]

Technological changes that made possible a transition from "best-effort" to real-time applications have fundamentally changed communication over the Internet. By 1990, some nonvoice communications had moved from telephone to fax, and by the mid-1990s some had moved from fax to e-mail via the Internet. For voice communications, the move has been small but steady away from the PSTN not only to VOI with multimedia PCs but also to VOI with ordinary telephones. Based on the IP, new technologies have made it possible to "talk" while exchanging photographic images and memos with multimedia PCs or to talk cheaply using an ordinary telephone.

In the late 1990s, the Internet is becoming integrated with the existing communications networks that most people use every day. Improvements in technology have resolved many earlier drawbacks to using packet data systems for voice and video transmissions, with the result that the Internet is becoming a seamless part of the world's voice, data, and video networks.[7]

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[6]Zachary M. Schrag, "The Achilles Heel of Internet Telephony, New Congestion Controls Could Raise the Price of Real-time Traffic," *TeleGeography 1996/97* (Washington, D.C.: TeleGeography, 1996), 37-40.

[7]"Lucent Announces Internet Products Venture," *Electronic Mail & Messaging Systems* **20**, 19 (Sept. 30, 1996), 8. See also "Lucent's Entry into Internet Telephony to Change Market," *Voice Technology and Service News* **15**, 20 (Oct. 1, 1996) [NEXIS].

Chapter Three

Voice Over the Internet (VOI)

VOI has been made possible by developments in PC software and gateway technologies. First, the analog voice signal must be converted into digital data; then, for transmission on the Internet, the data are transmitted as packets. Packet transmission is known as "best effort": in "best-effort" transmission, packets arrive one by one but not always in the correct order and sometimes with delay. For that reason, best effort is not useful for VOI. To solve this problem, software and gateways have been developed. The heart of any VOI product is its coder-decoder, or codec, the software that at one end compresses digitized voice data and at the other end decompresses them. See **Figure 3-1**.

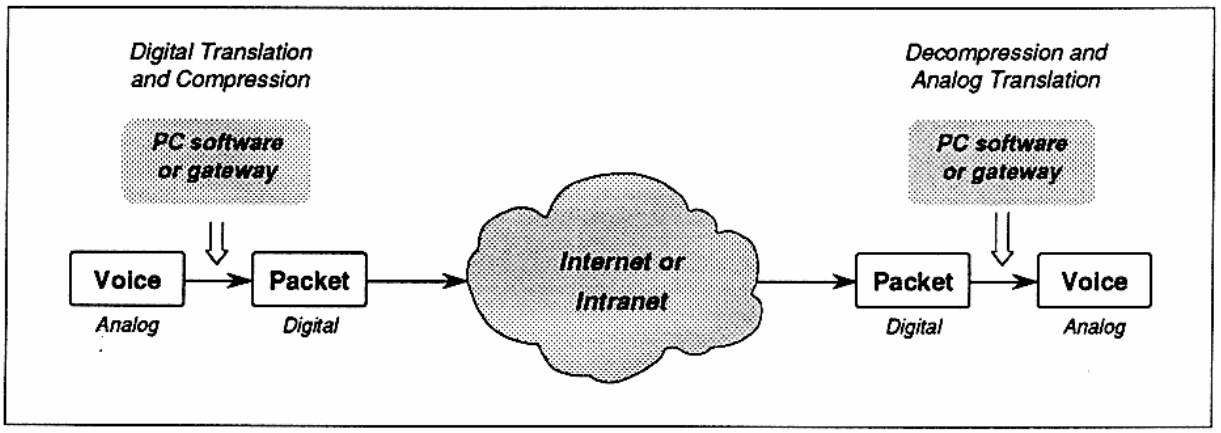
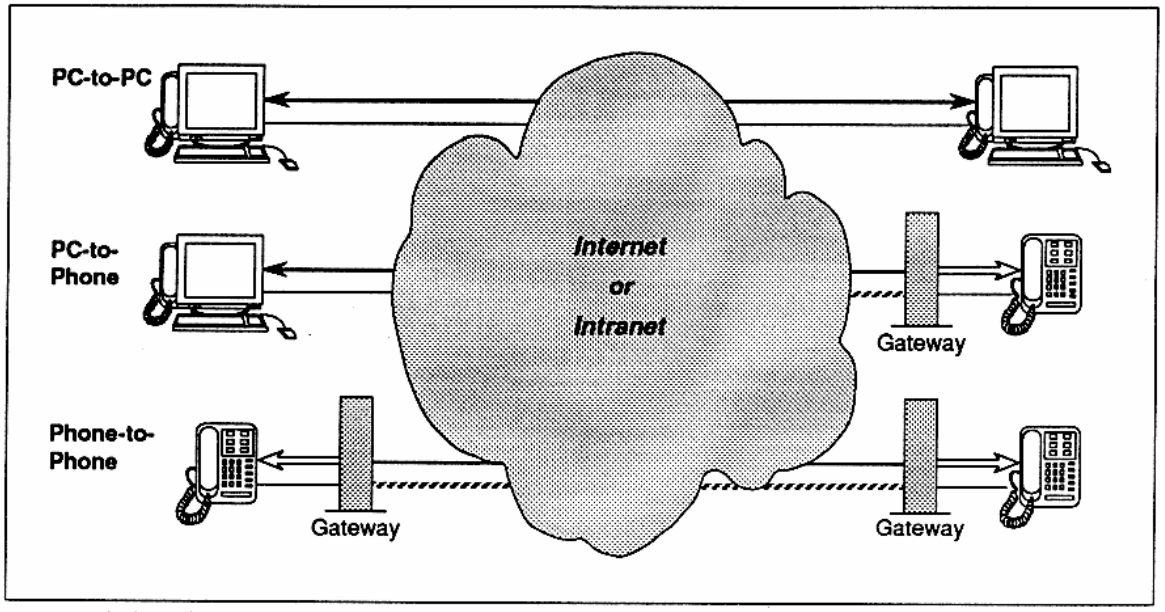


Figure 3-1

VOI

There are three kinds of VOI (see **Figure 3-2**): (1) PC-to-PC, (2) PC-to-phone, and (3) phone-to-phone. This chapter describes all three, including their distinguishing features, the types of communications each offers, and how each kind of VOI makes connections, and discusses the issues of signaling, directories, and universality. Problems of and improvements to each kind are mentioned, indicating changes in communications and the problems and improvements involved, as well as the progress from the first through to the third kind of VOI.



Source: Adapted from T. Kikuchi et al., "Power of VOI" (Internet Denwa no Iryoku), *Nikkei Communications* (Nov. 4, 1996), 95.

Figure 3-2

Three Types of VOI

3.1 PC-to-PC VOI

In 1993, the first VOI technologies were PC-to-PC. Its roots are in "shareware" tools, such as Maven (Mac AV ENabler) and Internet Voice Chat (IVC),[1] both of which have been widely distributed since 1993. After VocalTec introduced its Internet Phone (Iphone) in February 1995, other products by other companies were introduced in this arena. These are the result of the companies' efforts: companies working to resolve such problems as computer configurations, lost conversations, and broken speech have focussed on the issues of transmission delay and poor quality of voice and on developing new technologies for voice compression and a new protocol. For a timeline of VOI products and developments, see **Figure 3-3**.

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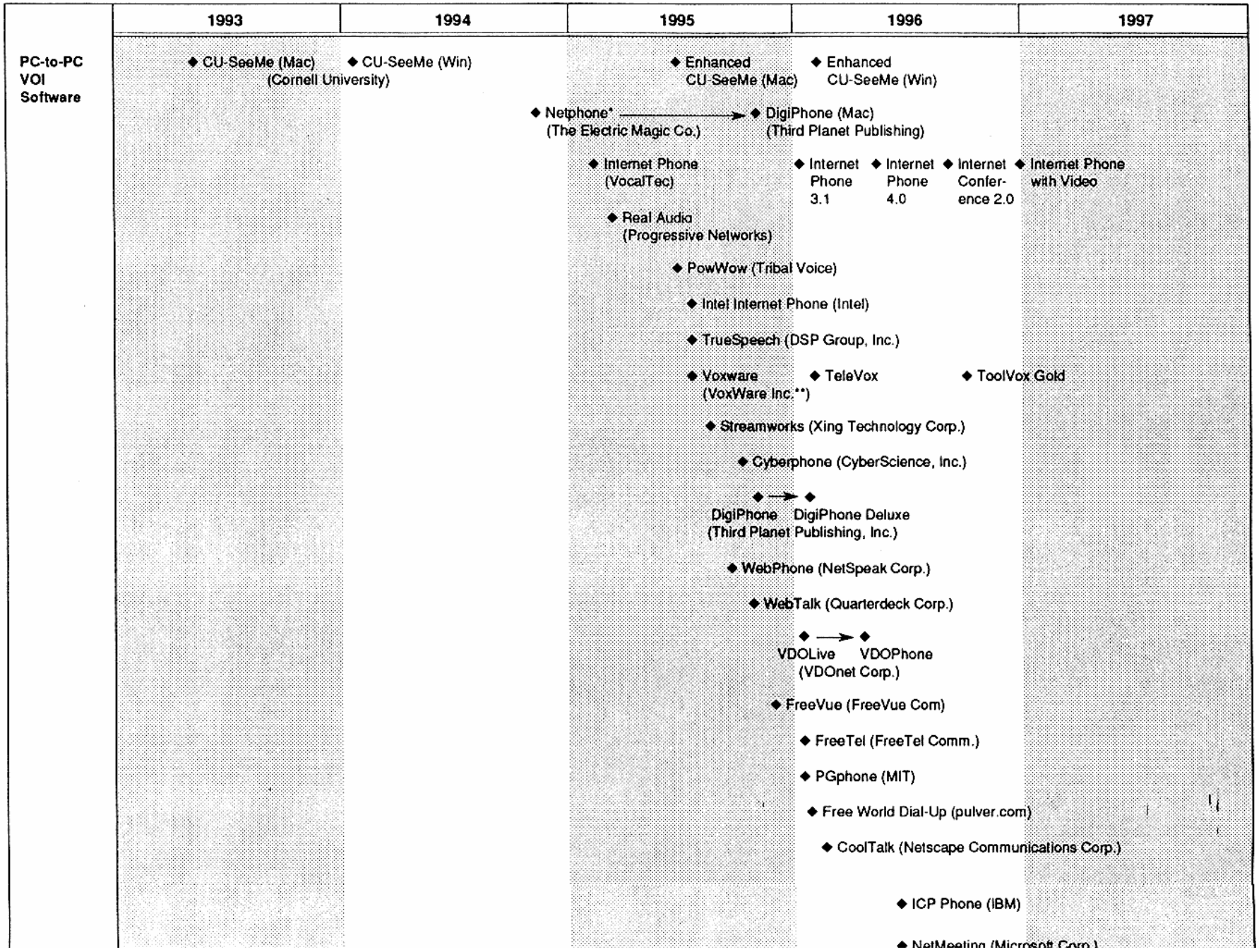
[1]Maven, written by Charley Kline, of the University of Illinois, "was the first person-to-person audio application to enjoy widespread use in the PC market. Using the [Macintosh computer's] built-in microphone and speaker, Maven allows walkie-talkie-style voice communication between two users, as long as both are trying to connect to each other at the same time. Users can also connect to a central reflector site and chat with whomever is logged on at the time. [IVC, created by Richard L. Ahrens, is for Microsoft Windows users and followed Maven.] IVC lets a sound-card-equipped-PC send 'bursts' of sound—roughly a sentence at a time—to another PC with an IP address." See "Telephones on the Internet," in *A2Z Consumer Guide* [On-line]. URL: <a2znet.com/page4.shtml>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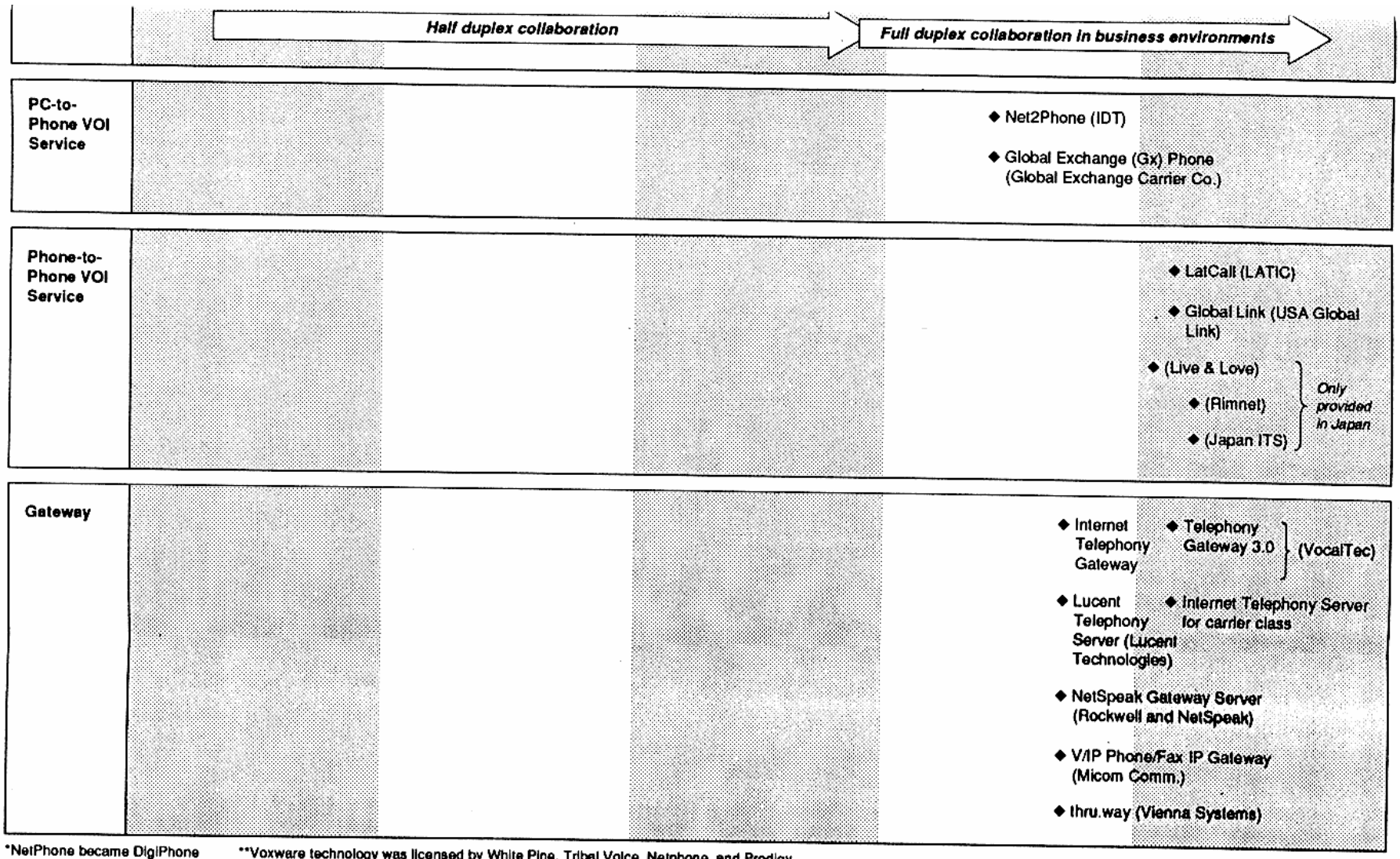
1996
1997
PC-to-PC VOI Software
◆ CU-SeeMe (Mac) (Cornell University)
◆ CU-SeeMe (Win)
◆ Enhanced CU-SeeMe (Mac)
◆ Enhanced CU-SeeMe (Win)
◆ Netphone* → ◆ DigiPhone (Mac) (The Electric Magic Co.) (Third Planet Publishing)
◆ Internet Phone (VocalTec)
◆ Internet Phone 3.1
◆ Internet Phone 4.0
◆ Internet Conference 2.0
◆ Internet Phone with Video
◆ Real Audio (Progressive Networks)
◆ PowWow (Tribal Voice)
◆ Intel Internet Phone (Intel)
◆ TrueSpeech (DSP Group, Inc.)
◆ Voxware (VoxWare Inc.**)
◆ TeleVox
◆ ToolVox Gold
◆ Streamworks (Xing Technology Corp.)
◆ Cyberphone (CyberScience, Inc.)
◆ → ◆ DigiPhone DigiPhone Deluxe (Third Planet Publishing, Inc.)
◆ WebPhone (NetSpeak Corp.)
◆ WebTalk (Quarterdeck Corp.)
◆ → ◆ VDOLive VDOPhone (VDOnet Corp.)
◆ FreeVue (FreeVue Com)
◆ FreeTel (FreeTel Comm.)
◆ PGphone (MIT)
◆ Free World Dial-Up (pulver.com)
◆ CoolTalk (Netscape Communications Corp.)
◆ ICP Phone (IBM)
◆ NetMeeting (Microsoft Corp.)



*NetPhone became DigiPhone **Voxware technology was licensed by White Pine, Tribal Voice, Netphone, and Prodigy.
IP = Internet protocol Mac = Apple Computer's Macintosh computer/operating system Win = Windows operating system

Figure 3-3

Timeline of Selected VOI Products and Services

3.1.1 VOI Software

Table 3-1 presents examples of PC-to-PC VOI software products, indicating manufacturers and vendors as well as features of the products. PC-to-PC VOI requires the user to purchase a multimedia PC (equipped with sound card, speakers, modem, and microphone) and VOI software (sold by a computer accessories vendor, a computer company, or sometimes made available on the Internet as "freeware" or shareware that the user can download).

Figure 3-4 shows how VOI software makes PC-to-PC communication possible by voice over the Internet. The calling party's PC uses VOI software to digitize the analog voice, significantly compressing it, packetizing it for the Internet using the IP, then routing it. The called party's PC uses VOI software to store packets that randomly arrive one by one in the buffer, then depacketizes, decompresses, and changes them into analog voice. The same procedure occurs in reverse as the called party speaks to the caller, and it continues back and forth for the duration of the conversation. The main functions are compression and decompression (code-decode, or codec) and play-back, the mechanism that stores packets in the buffer. All these work to control the transmission delay in the network so that the voice can be transmitted with better quality or less delay, or both.

The length of transmission delay is equal to the time required for computer management and for the transmission delay in the network. The first factor in transmission delay is the *delay needed for computer management*, which depends on the capability of the computer's CPU and improvements to it. Use of VOI software requires certain system capabilities (see Requirements, Table 3-1).

The second factor, *transmission delay in the network*, is controlled by the buffer in VOI software. During transmission, the packets are affected by network traffic, and they arrive one by one, sometimes with a delay. On the receiver side, the VOI software sets a buffer that stores a set of packets until the next packets arrive. But there are tradoffs: when the buffer waits for a long time to receive the next packets, the quality of voice will be better but the delay will be long. If, on the other hand, the buffer waits a shorter time and the delay is shorter, the quality of voice is diminished. Voice compression is related to control of the transmission delay in the network. If the voice is significantly compressed, the packet will be smaller, will need less bandwidth, and will be less affected by other packets during transmission.[2] The challenge is to shorten the period of delay and improve the quality of voice.[3]

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[2]Smaller packets suffer less serialization delay, but, in the absence of priority queuing, can still suffer as much queuing delay as large packets.

[3]Shortening delay is important, but shortening delay jitter is equally if not more important.

Ordinarily, VOI software enables reconstruction of voice, but network congestion sometimes degrades the quality of voice. To support transmission of real-time voice packets on the Internet, both technical control of network congestion and pricing control, which may help alleviate congestion, may be necessary (see **Chapters Seven** and **Twelve**).

PC-to-PC VOI software has been manufactured and sold by many companies (see Table 3-1), including Intel, Microsoft, FreeTel Communications, VocalTec, Netscape, Quarterdeck, and IBM, which fall into the following categories:

1. **Software companies**, such as VocalTec, NetSpeak, Quarterdeck, which sell VOI software on the Internet or in stores for about U.S. $50. Because the aim of these companies is to make money by selling their software, each company is eager to differentiate itself and its product from those of other companies and, to do so, some of them offer as a bonus a free second-user license.[4]

2. **Computer manufacturing companies**, for example, Intel,[5] provide the software at no cost on the Internet. They want to sell more high-end computers (CPUs equipped with the Pentium chip and more than 75 MHz) with which people can use VOI (because a lower capacity cannot be used for VOI). As these companies make greater demands on high-end computers, the demand for their products, such as chips, increases.

3. **Internet browser companies**, such as Microsoft and Netscape, provide their software free as a standard Web tool. They want to create attractive browsers and, hence, acquire an increasing number of Internet users.[6]

Some kinds of VOI allow users to exchange photographic images, share documents as well as work on them together, and browse the Internet while talking. Collaboration is a special feature of this kind of VOI (see Features in **Table 3-1**).

3.1.2 How PC-to-PC VOI Works

Figure 3-5 illustrates PC-to-PC VOI as of the end of 1996. First, the call needs to be prearranged. Both users must be at their PCs and logged on to the Internet at the same time.

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[4]Voxware provides its product free, probably because its codec technology has been licensed by WhitePine, Tribal Voice, Netiphone, and Prodigy.

[5]According to Intel, "Internet telephony is a vital tool to spread the PC market." *Shyukan Touyou Keizai*, Nov. 23, 1996, 48. (Translation by the author.) Intel recommends using CPUs equipped with Pentium 90 MHz capability in order to run its "Proshare" and "Videophone" software. Such recommendations are based on a strategy of offering moderately priced high-grade software and services that require users to upgrade CPUs and chips. See "Intel Runs," *Shyukan Touyou Keizai*, Nov. 23, 1996, 17.

[6]Microsoft and Netscape are in a "browser war," each trying to gain an advantage over the other. Both use VOI as one means to acquire new users. For example, when Netscape introduced a new version, it provided such collaborative tools such as telephony and whiteboard conferencing, and to use them, both ends must run Navigator 3.0. CoolTalk.

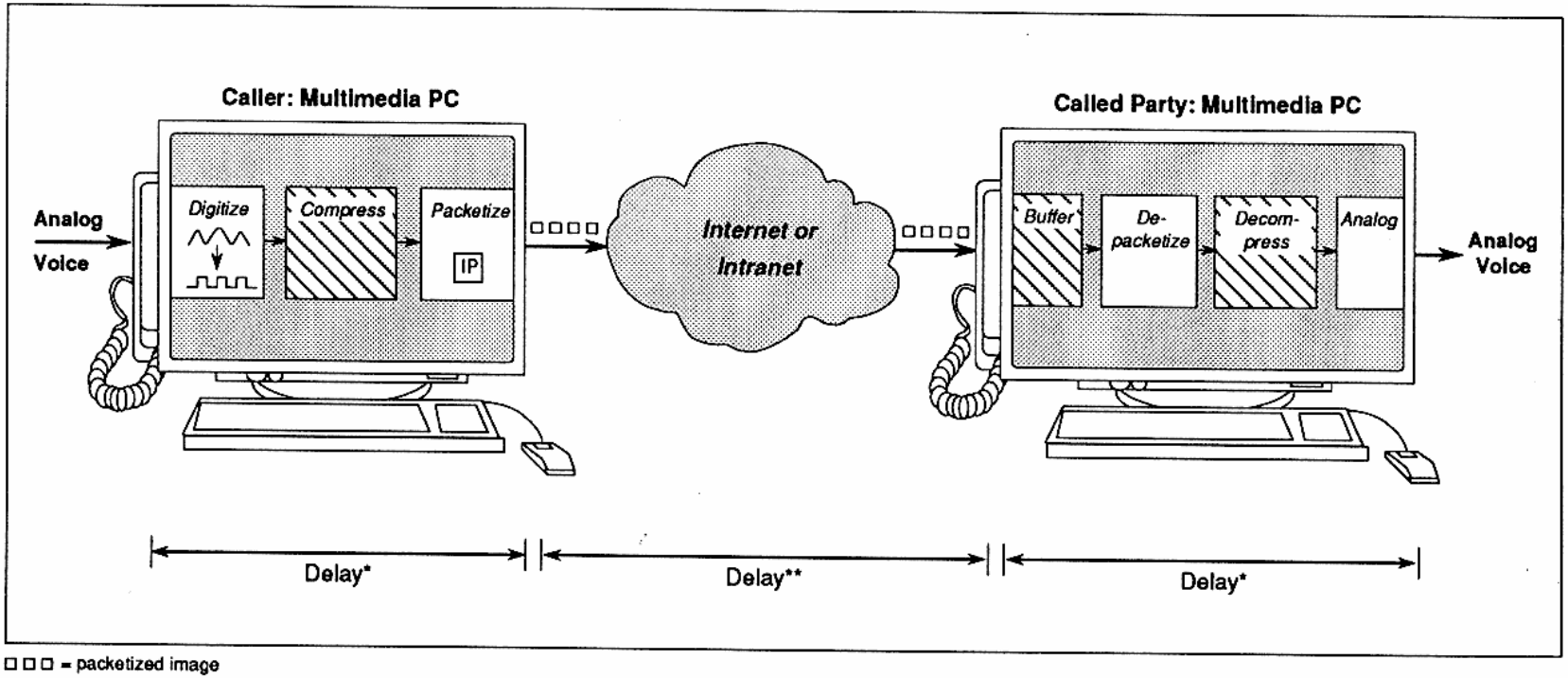
Table 3-1

Features of Selected PC-to-PC VOI Software Products

Product Features	Company and Vendor								
	Internet Phone 4.0: VocalTec	**TeleVox 2.0 Beta 3:** Voxware	**DigiPhone 1.03:** Third Planet Publishing	**WebPhone 2.01:** NetSpeak	**WebTalk 1.0:** Quarterdeck	**FreeTel 0.94:** FreeTel Communica-tions	**Intel Internet-Phone:** Intel	**CoolTalk:** Netscape Communications	**NetMeeting:** Microsoft
Requirements									
• OS	Windows, Macintosh	Windows	Windows, Macintosh	Windows	Windows	Windows	Windows	Windows, Unix, Macintosh	Windows
• CPU	486 PC (33MHz)	Pentium (75 MHz)	33 MHz Power PC	486DX (33 MHz); Pentium (75 MHz)	486 (50 MHz)	486 (50 MHz)	Pentium (90 MHz)	486 (50 MHz) Power PC	486 (66 MHz)
• Memory	8 MB	8 MB	1.5 MB	4 MB	8 MB	12 MB	16 MB	8 MB	8 Mb
Connection									
• Via direct dial	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes
• Via server log-on	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes
Codec	Proprietary (6.72k/7.7 kbps); TrueSpeech GSM	Proprietary (RT29HQ = 2.98 kbps), GSM (8 kbps)	Proprietary (from Voxware)	GSM TrueSpeech	TrueSpeech RT24 ADPCM Lernout & Hauspie a-Law, m-Law	Proprietary	G723.1 G729, etc.	GSM RT24	Lernout & Hauspie 4, 8, 11, 16, and 32 kbps
Future Features:									
• File transfer	Yes	Yes	No	No	No	Yes		No	Yes
• Text chat	Yes	Yes	No	No	Yes	Yes		Yes	Yes
• Special features	Speed-dial buttons; system configuration test	Voice sound effects; call-blocking; event log	Voice encryption; call notifica-tion via e-mail	Voice mail; assignable outgoing messages	None	Microphone test; event log		Whiteboard; voicemail; photo	Whiteboard
Price	$49.95	Free	$59.95	$49.95	$50	Free	Free	Free	Free
How to Acquire	URL	URL	URL or store	URL or store	URL or store	URL	URL	URL	URL

CPU = central processing unit (computer) MB = megabyte MHz = megahertz OS = operating system URL = uniform resource locator

Source: Data from Kikuchi and Ando, *Nikkei Communications* (November 1996), 99-101; and the Web home pages of the companies named. Products evaluated by testing are discussed in Gus Venditto, *Internet World* (June 1996), 40-52; and Jon Hill, Jan Ozer, and Thomas Mace, *PC Magazine* 15, 17 (Oct. 8, 1996), 102-158;. Evaluations based on user surveys can be found in the "Internet Phone Survey" (Aug. 20, 1996) [On-line]. URL: <treetel.com/survey1.htm> and The Pulver Report (Dec. 1996) [On-line]. URL: <von.com/1996vonvote.htm>



□□□ = packetized image

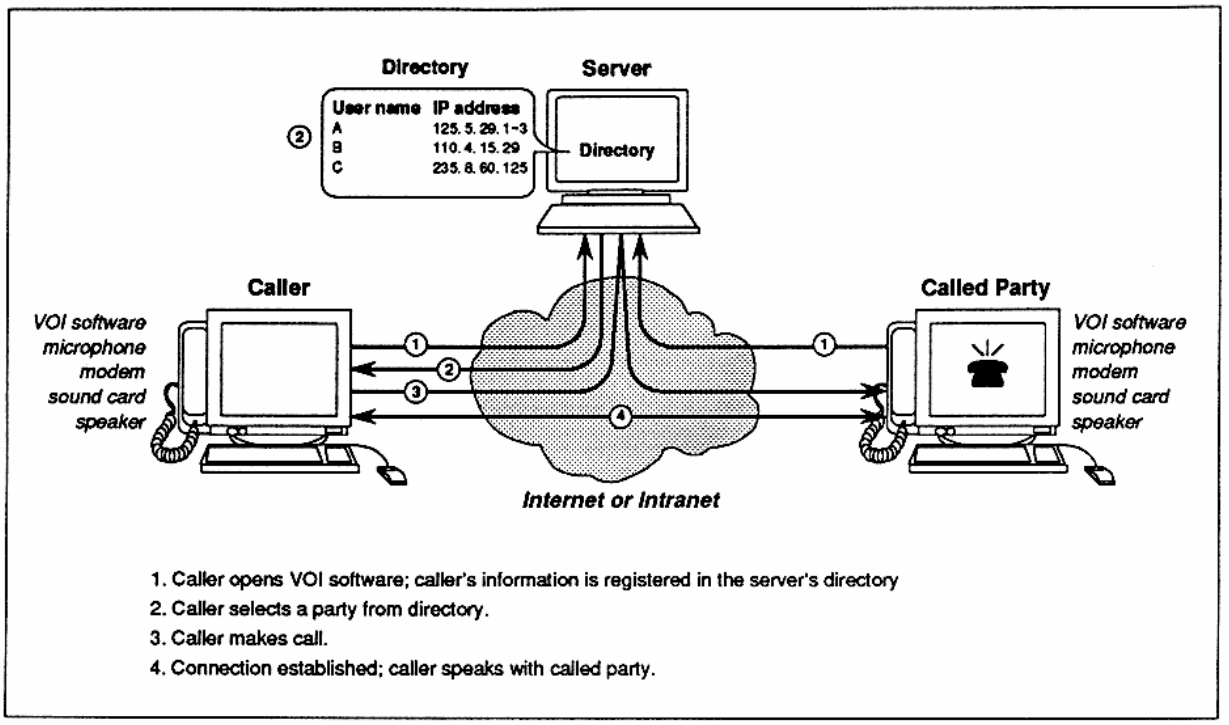
*Delay controlled by CPU (ex. 90 MHz).

**Delay controlled by high compression and buffer.

Source: Adapted from T. Hoshi et al., "Call over the Internet" (Internet de Denwa wo Kakeru), "Process of Voice Stream" (Onsei Stream Syori), *Nikkei Communications*, April 25, 1996), 80. (Permission pending.)

Figure 3-4

PC-to-PC VOI Software Process



IP = Internet Protocol
*VOI software directory provides an up-to-date list of all on-line users running VOI software.

Source: Adapted from T. Kikuchi et al., "Power of VOI" (Internet Denwa no Iryoku), *Nikkei Communications* (Nov. 4, 1996), 98.

Figure 3-5

PC-to-PC VOI Indirect Connection

Second, both computers must be high-end and have VOI software installed. Third, callers can call without paying additional charges above the price of access to the Internet—that is, each user pays only the cost of the Internet hookup and nothing more (even if the parties talk, the price remains the same as for data transmission).

There are two ways to make the connection. The first way is by *indirect connection*, using directory service, as shown in **Figure 3-5**. In this method, the caller queries a remote public server that lists people active on the service. Using VOI software, the caller can access the software on the server, which provides an up-to-date list of users running VOI software and can be called, then the caller chooses the person to be called, and then they talk.

The second is by *direct connection*. If the caller knows the IP address of the party being called, a direct connection can be established. For the dedicated connection user, the IP address is "static" (fixed). The dial-up user's IP address is "dynamic" (not fixed), and a new IP address must be assigned each time that caller dials up. When both parties are dial-up

users, the party wishing to place the call can be notified of this IP address in advance, by telephone call or e-mail from the called party, so that the caller can call directly.

PC-to-PC VOI lacks universality. Unlike telephony, this kind of VOI cannot be used to call anyone anywhere in the world at any time. Until very recently, it could not be used to talk to a PC with different VOI software. PC-to-PC VOI may not replace ordinary telephone but, instead, may be a new communications medium. As shown in **Table 3-1**, most VOI software offers collaboration functions. One developer, Microsoft, aims to provide Computer Telephony Integration (CTI)[7] over the Internet, which can be used in the call center by looking at a Web page on the PC screen to communicate with customers using a "whiteboard" while talking.[8] In this case, users would not need two telephone lines, one to access the Internet, the other for ordinary use.

3.1.3 Changing Targets

Developers of PC-to-PC VOI software are changing their targets, from individuals to businesses. Major developers, manufacturers, and vendors, such as Lucent Technologies, Northern Telecom, and Motorola, are deeply involved in VOI initiatives. In 1997, Motorola enlisted the help of VocalTec in developing VOI technologies for mainstream use.[9]

In line with that change of direction, developers of VOI software are also changing their target and becoming increasingly concerned about business use.[10] VOI products offer new functions, such as whiteboard and identification of speaking partners.[11]

By 1997, many companies were developing hardware and software for communication between business and customers, or for CTI, for example, Rockwell and Netspeak; Lucent

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[7]CTI: The practice of using computers to control one or more telephone and communications functions.

[8]According to Douglas Comer, whiteboard "is a service that permits a group of users to establish a session that permits all of them to see and modify the same display. The display can begin blank or can start with a document. Whenever a participant modifies the display by adding text or graphics, all other users see the changes immediately. A whiteboard service is usually combined with an audio teleconferencing service." See Comer, *The Internet Book*, 305.

[9]Motorola is expected to announce a plan to license and sell software from VoalTec that will link corporate switchboards to the Internet. See William M. Bulkeley, "Motorola to Sell VocalTec Software for Calls via Internet," *The Wall Street Journal*, March 3, 1997, B6.

[10]"The latest generations of voice over the Internet software focus on business customers, introducing features such as document sharing, voice mail and white-boarding that make Internet telephony not only less expensive than traditional long-distance service but, for businesses, more versatile as well." See Chris Bucholtz, "From Basement to Business Tool; Voice over the Internet," *Telephony* **231**, 7 (Aug. 12, 1996), 22 [NEXIS].

[11]This identification appears to resemble "caller ID," but it differs in that no information (such as a phone number) is given automatically; instead, the information is made available by a customer and may include a variety of personal data (which may include a phone number).

Technologies; Telecom Finland and VocalTec. Rockwell and NetSpeak teamed up to let call-center operators embed in a Web page the capability for making Internet calls to the call center. A user who has not installed Web telephony software can click on the call icon and will be given the option of downloading WebPhone.

3.1.4 Standardization

Most software developers have manufactured products on the assumption that both callers use the same software. If not, people would not be able to communicate with each other. To promote interoperability, a number of international bodies are discussing standardization.[12] Three points must be considered: call control protocol; voice compression; and a shared directory.

The International Telecommunication Union (ITU) has recommended call control protocol H.323.[13] In March 1996, about 120 computer software companies, including Intel, Microsoft, and Netscape, agreed to use H.323 to secure interconnectability. Intel's Internet phone was the first VOI software developed following this agreement; Microsoft's NetMeeting has used H.323 since October 1996. As more VOI software uses H.323 to promote interoperability, the third standardization factor, the common directory, will become more important.

To develop and promote standards for Internet telephony, a group called Voice over Internet Protocol (VoIP) was "founded in 1996 by Cisco, Microsoft, Dialogic, US Robotics, Vocaltec, and several other leading firms."[14] Under the name VoIP Forum, it has become a working group of the International Multimedia Teleconferencing Consortium (IMTC),

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[12]The International Telecommunications Union is the body of the United Nations that focuses on developing standards. One branch of the ITU, the Telecommunications Standardization Sector (ITU-T), is concerned solely with developing telephony standards. There are other standard bodies: the IETF, the primary working body to develop new Internet standards, the Enterprise Computer Telephony Forum (ECTF), the primary working body to develop computer telephony standards, founded by Dialogic, Ericsson, Hewlett-Packard, Nortel, and Dialogic Equipment Corporation (ECTF now thirty-six principal members, including Sun Microsystems, IBM, and AT&T), and the International Multimedia Teleconferencing Consortium (IMTC), a nonprofit organization dedicated to developing and promoting standards for audio graphics and video conferencing. See "Standards Organizations," "Standards," Dialogic World View [On-line]. URL: <dialogic.com/stds2.htm>

[13]"This standard covers technical requirements for narrowband visual telephone (or audiographics) services. H.323 covers the elements needed for a visual telephone call, including: video codecs, audio codecs, shared applications (T.120), call control, and system control." "Standards," Dialogic WorldView [On-line]. URL: <dialogic.com/solution/ internet/stds2.htm>

[14]Ibid.

working to ensure and promote industrywide interoperability of Internet voice communications products.[15]

The second standardization factor, voice compression, is the means companies can use to differentiate their VOI software from others'. The heart of the VOI products is the coder-decoder, or codec. Key technical requirements for coders include low bandwidth, high quality of voice, low latency (waiting time), and the ability to reconstruct lost packets.[16] Each product varies in the number of codecs designed to handle modem connection speeds between 2,400 bps and 28.8 kilobits per second (kbps). The quality of transmitted sound is closely tied to the codec.[17] The codec emerging as popular is G. 723, which has 8 kilohertz (kHz) sampling rates, an algorithm for compressed digital audio over telephone lines. The company that can develop a superior system of voice compression can distinguish its VOI software above others, and for this reason companies, in particular software companies such as Voxware, prefer to maintain unique modes of voice compression.[18] Most companies use both their proprietary voice compression and ITU-T G.723.1 or the global system for mobile communications (GSM)[19] as standard.

The third standardization factor, the common directory, helps a caller find another party. Each VOI software has its own directory, rather than sharing a common directory. In August 1996, five directory service companies, such as Big Foot Partners and InfoSpace,[20] began to provide a common user location service (ULS), which Microsoft proposed that the IETF

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[15]"Dialogic Licenses G.t23.1 Technology from the Digital Signal Processor (DSP) Group; Accelerates Availability of Internet Telephony, Video Conferencing Applications," Dialogic WorldView [On-line]. URL: <dialogic.com/company/pressroom/pressrel/G723.htm>

[16]"Internet Telephony Basics" [On-line]. URL: <dialogic.com/solution/Internet/howdo.htm>

[17]"Among the best were Codec 723, used in Intel Internet Phone; the Lernout & Hauspie codecs used in Microsoft NetMeeting; and the Digital Signal Processor (DSP) Group's TrueSpeech codec, used in Internet Phone, WebTalk, and WebPhone. All of these codecs require a relatively fast modem connection. [To the very slow modem,] the ultrahigh-compression RT24 codec used in TeleVox and others may be [the] only option. [In a test,] the high-compression codecs needed for slower connections were the ones most likely to suffer from severe delays, annoying distortion, or total breakup of the data stream." Jon Hill, Jan Ozer, Thomas Mace, "Real-Time Communications: Connecting," *PC Magazine* **15**, 17 (Oct. 8, 1996), 105.

[18]According to Lior Haramary, Technical Marketing Director of VocalTec: "Nevertheless, standards don't totally level the market's playing field.... H.321 was expected to enable interoperation between competing systems...and eliminate the major differences between systems (hardly). In fact, the market chose the best performing system (using proprietary technology) at competitive prices." "The Future and Promise of Internet Telephony," *Telecommunications* (January 1997), 48.

[19]The acronym "GSM" derives from Group Spécial Mobile.

[20]On Sept. 24, 1996, "InfoSpace Inc. and NetSpeak Corporation announced a strategic partnership agreement. Under this agreement, InfoSpace's most popular people directory and dynamic maps [will be integrated] with NetSpeak's WebPhone.... InfoSpace also announced partnerships with Microsoft and Intel to integrate InfoSpace directories with their Internet telephony products." See "Financial News," PR Newswire, Sept. 24, 1996 [NEXIS].

adopt as the standard. Other companies, however, disagreed. In mid-1996, Netscape and Microsoft then endorsed the Light-weight Directory Access Protocol (LDAP),[21] the current leader for on-line directory service governed by IETF Request for Comments (RFC) 1777.

3.2 PC-to-Phone VOI

PC-to-phone VOI requires that the caller has a high-quality multimedia PC, Internet access, and VOI software, while the called party need have only an ordinary telephone. It requires VOI software and, in addition, gateway technologies (PC-to-PC VOI requires VOI software, and phone-to-phone VOI requires gateway technologies but not VOI PC software). Gateway technologies enable calls to be connected between the Internet and the PSTN. PC-to-phone communication VOI through the gateway enables callers to combine the low cost of an Internet connection with calls initiated from PCs, and the ability to communicate over the PSTN with anyone who has an ordinary telephone.

The interface with the PSTN, or the gateway, allows the second type of VOI, PC-to-phone, to address the problem of "lack of accessibility," which has beset the first type, PC-to-PC VOI. With the gateway, callers can call anyone anywhere at any time; calls do not need to be prearranged. **Figure 3-6** illustrates the function of the gateway in PC-to-phone VOI.

Providers of PC-to-phone VOI can be divided into service providers (see section **3.2.1** and manufacturers (see section **3.3.1**), such as ISPs which provide PC-to-phone service using gateways in their networks.

3.2.1 Services

Internet Discount Telecommunications (IDT), a global exchange company (GXC), began to provide PC-to-phone service in August 1996. Their calling method resembles the call-back mechanism (see **Figure 3-7**). IDT provides Net2Phone, software that allows an international call to be routed over the Internet to IDT's centralized switching infrastructure, then to the PSTN from the gateway in the United States. Net2Phone is distributed free on the Web, and users are charged on a per-minute basis. The price depends on the PSTN fee, which is based on the distance between the gateway and the called party (see **Figure 3-8**). When gateway service first started, the gateway was set up only in the United States, thus lowering the price of calls to the U.S. from outside. Using Net2Phone, users can make international calls at 95

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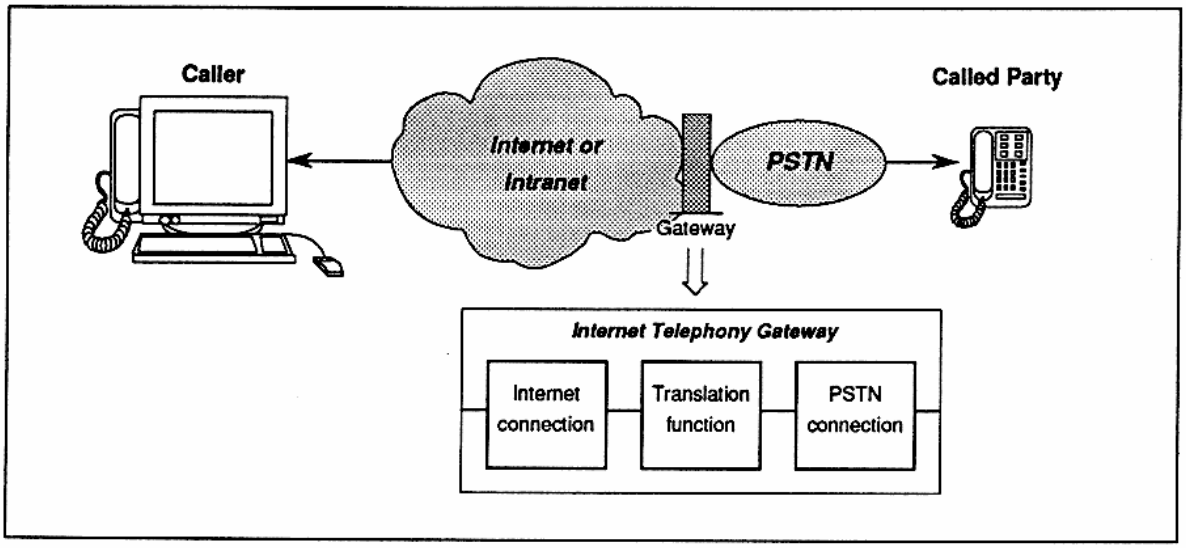
[21]For further information on LDAP, see IETF RFC 1777. For information on Netscape Directory Service Features, see "LDAP Spec Poised to Ease Directory Woes," *Web Week* (Aug. 5, 1996), 37. In April 1996, Netscape Communications selected LDAP as the foundation for its directory services server.



PSTN = public switched telephone network

Source: Diagram of Internet Telephony Gateway adapted from Web page of Dialogic WorldView [On-line]. URL: <dialogic.com/solution/internet/howdo.htm>

Figure 3-6

Internet Gateway

percent below the rates charged by international phone carriers, and payment is handled by IDT's debit card billing platform.[22] **Table 3-2** lists PC-to-phone VOI services.

3.3 Phone-to-Phone VOI

Phone-to-phone VOI enables customers to use their existing telephones for Internet-based communication. It addresses the problems of "equipment that is too expensive" and "lack of accessibility," which affect the first type of VOI, PC-to-PC communication. In this kind of VOI, both parties can communicate with each other using ordinary telephones, that is, without needing multimedia PCs. Further, this type of VOI potentially offers universality (callers can call anyone anywhere) and accessibility (the called party uses an ordinary telephone and the call does not need to be prearranged).

The gateway makes phone-to-phone VOI possible, because it enables real-time voice conversation for ordinary telephone users through the Internet to other local, long-distance, or international telephone users. It provides the connection between the Internet and the PSTN. The cost of a call is limited to the telephone charge incurred at both ends of the connection when linking to the Internet plus the standard Internet connectivity charge.

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[22]"IDT Releases Net2Phone Commercial Version Three Months Ahead of Schedule," PR Newswire, Aug. 5, 1996 [NEXIS].

Table 3-2

PC-to-Phone VOI Services

Company	Service	Software	Compression	Fee per Minute	Comments
IDT	Net2 Phone	Net2 Phone (free download)	10.4kbps	to U.S.: 10¢ U.K.: 18¢ France: 25¢ Japan: 29¢ Germany: 26¢	Exchange for call-back
Global Exchange Carrier (GXC) **Company**	Global Exchange (Gx) Phone	Gx-Phone (free download) VocalTec Internet Phone (above v 3.2)		to U.S. 19¢ U.K.* 27¢ France* 28¢ Japan* 34¢ Germany* 28¢	120 nations and regions (User must register)

*After the gateway is set the tariff will decrease to 25¢.

Source: Data from T. Kikuchi et al., "Power of VOI" (Internet Denwa no Iryoku), *Nikkei Communications* (Nov. 4, 1996), 107.

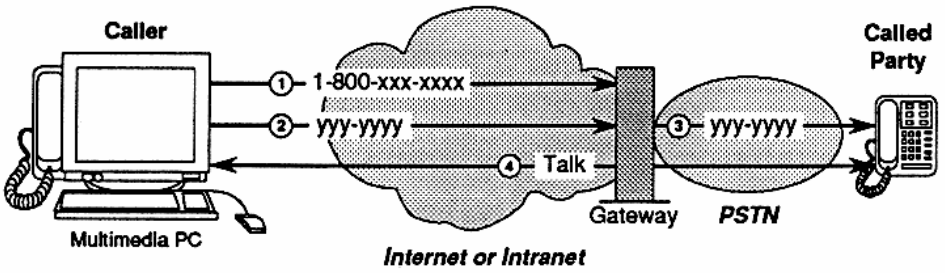
The gateway has several functions, as shown in **Figure 3-9**:

1. Its most important function is to bridge the traditional circuit-switched telephony world with the Internet; and

2. its codec, packetizing, call-control, and control over transmission delays, which are also functions of PC-to-PC VOI software. The gateway takes the standard telephone signal, digitizes it (if it is not already digital), significantly compresses it, packetizes it for the Internet using IP, and routes it to a destination over the Internet. The gateway reverses this operation for packets coming in from the network and going out to the phone.

3. The gateway has other functions, such as routing, network monitoring, and billing.

Providers of this kind of VOI fall into two categories. One type builds the network by itself, using the gateway, and acts like a telecommunications carrier: these providers sell their customers Internet-based voice communications services but not Internet telephony products. The calling method they offers resembles the call-back, as shown in **Figure 3-10**. The second type of provider sells the gateway to a company that builds its own "Intranet" and to ISPs, which provide phone-to-phone Internet-based service.



1. Caller dials 1-800-xxx-xxxx: access to gateway
2. Caller dials called party's telephone number (displayed on monitor) using a mouse or keyboard
3. Gateway calls the called party
4. Connection established, parties talk

Source: Adapted from T. Kikuchi et al., "Power of VOI" (Internet Denwa no Iryoku), *Nikkei Communications* (Nov. 4, 1996), 106.

Figure 3-7

PC-to-Phone VOI Connection

Among the first type of provider, those that build a network using the gateway and act like a telecommunications carrier, are AlphaNet Telecom, LATIC, USA Global Link, and IDT. As already mentioned, the running cost of providing phone-to-phone VOI consists of the cost of telephone calls at the local end, which is based on a per-minute charge at a level customers are willing to pay.

In July 1996, AlphaNet Telecom announced that it would provide phone-to-phone communications services in North America, Australia, Taiwan, and Korea at the beginning of 1997 under the name "Mondial."[23] The service was intended to provide for a call to the United States from anywhere in the world at U.S. 10¢ per minute using a gateway to have been set up in the U.S. **Figure 3-11**[24] illustrates the configuration of the intended service.

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[23]"Telephone to Telephone Voice over Internet Networks Demonstrated by Alpha Net," Canada Newswire (Toronto), July 23, 1996 [NEXIS]. See also Chris Bucholtz, "A Grand Compromise; Newcomer Uses IP and Data Networks for International Calls," *Telephony* (Oct. 14, 1996), 48; and Rivka Tadjer, "Internet Telephony Gets Easier—Businesses Evaluate Phone-to-Phone Net Gateway Services and Systems," *Information Week* (Oct. 21, 1996), 68 [NEXIS].

[24]AlphaNet's commercial VOI service did not materialize. It had planned to use the Global One network, because the public network is insecure and unreliable for voice traffic. It built its Intranet using the Global One network and tested it for Mondial service. But it then stopped using IP to transmit voice, deciding instead to use voice over frame relay (VoFR). According to Michael Reichmann, vice-president for business development at AlphaNet, VoFR is preferable, because it does not have the large size header that makes IP inefficient. Reichmann pointed out that AlphaNet offers three cost advantages: (1) for voice transmission, it uses a data network, not a voice network; (2) high compression: 6.4 kHz, that is, 10:1; and (3) even if Mondial service is international, AlphaNet does not need to pay an accounting rate, because it uses only one company's network, EQUANT's worldwide digital frame relay.

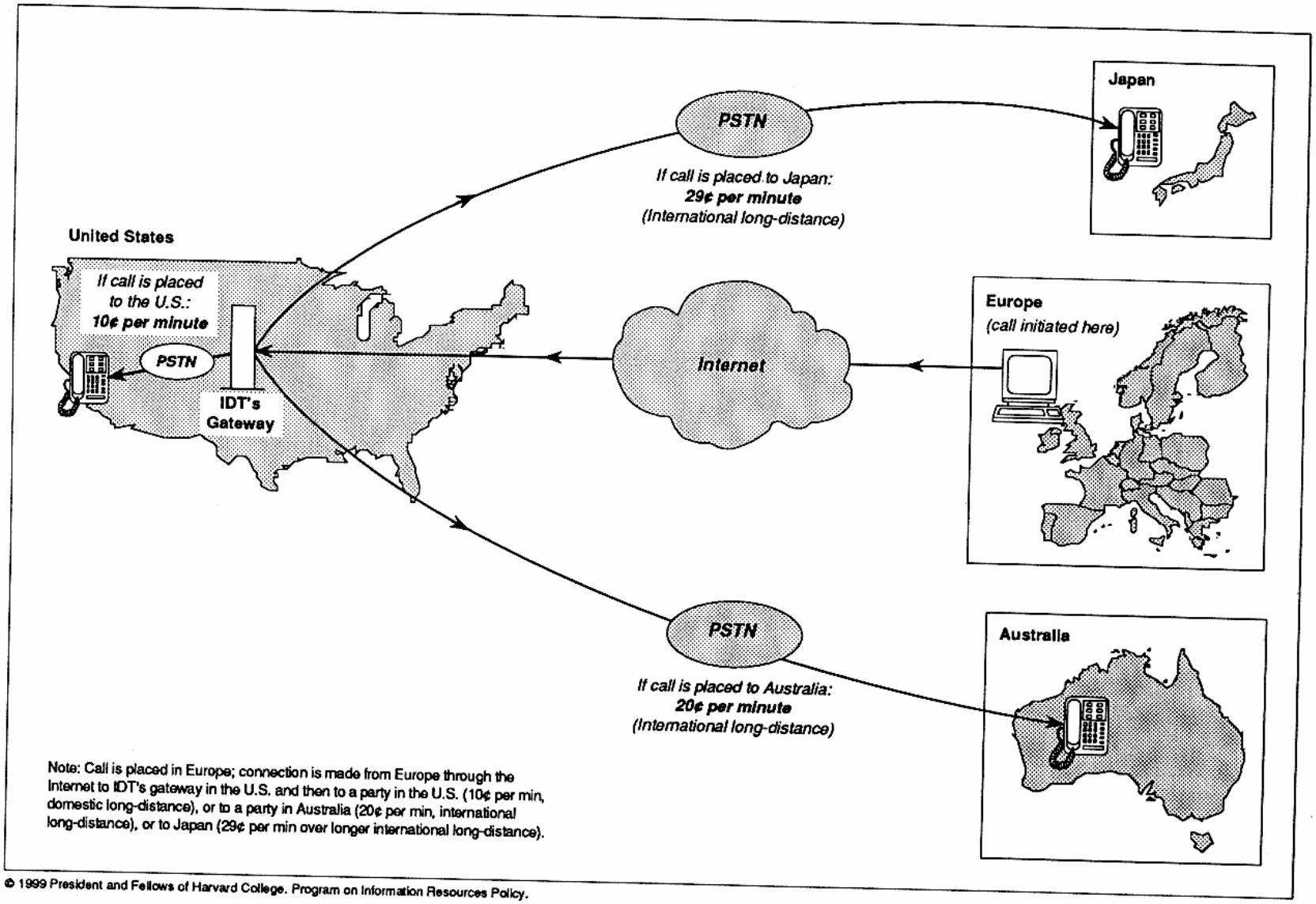
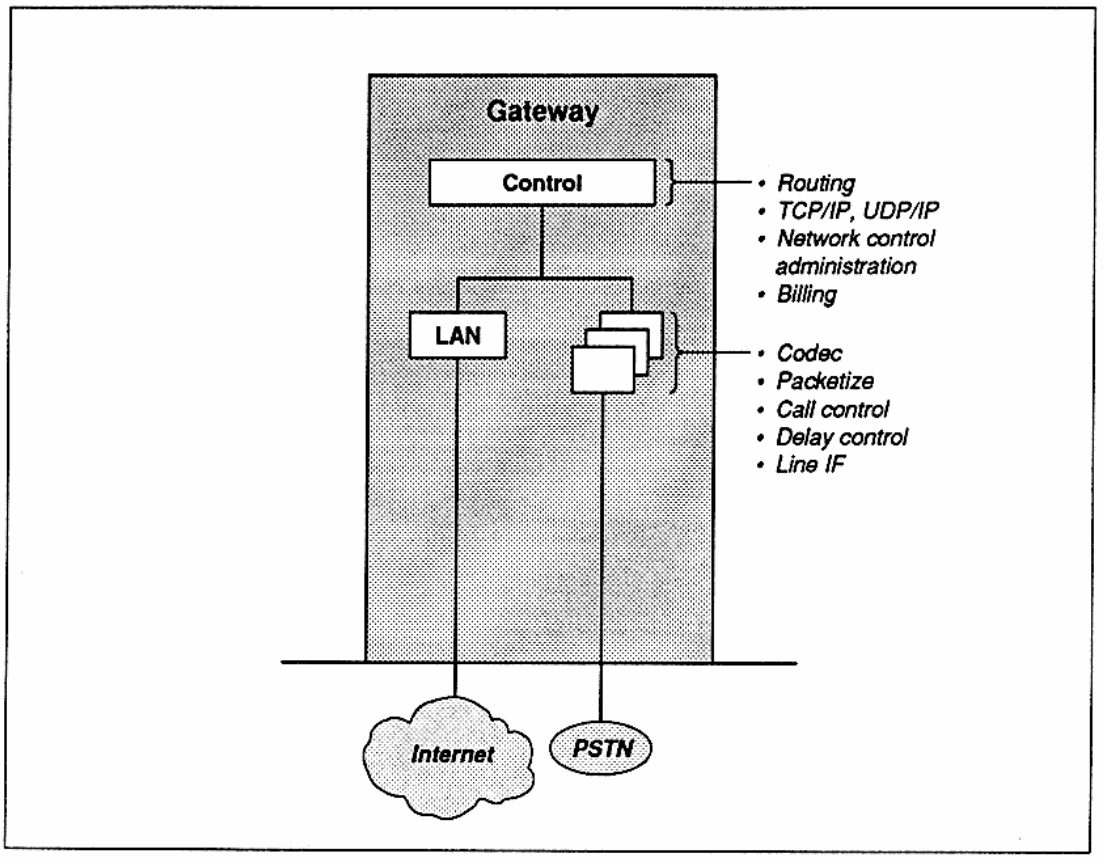


Figure 3-8

PC-to-Phone VOI Service Through IDT's Gateway in the United States



Codec = code(-er)–decode(-er)
IF = intermediate frequency
LAN = local area network
PSTN = public switched telephone network
UDP/IP = User Datagram Protocol/Internet Protocol
TCP/IP = Transmission Control Protocol/Internet Protocol

Figure 3-9

Detail of Gateway Functions

LATIC announced that it had "cracked the code on Internet-based phone-to-phone calling and is ready to begin offering a new long-distance service called LatCall."[25] By February 1997, the service was operational between Washington, D.C., and Tokyo and between Washington and San Jose, California.[26] LATIC initially expected to deliver rates of between U.S. 5¢ and 8¢ per minute for calls to domestic destinations and dramatically low rates to international destinations without disrupting a user's calling patterns. The service is expected to be rolled out eventually in fifty U.S. cities. According to Jerry Lin, president and CEO of LATIC:

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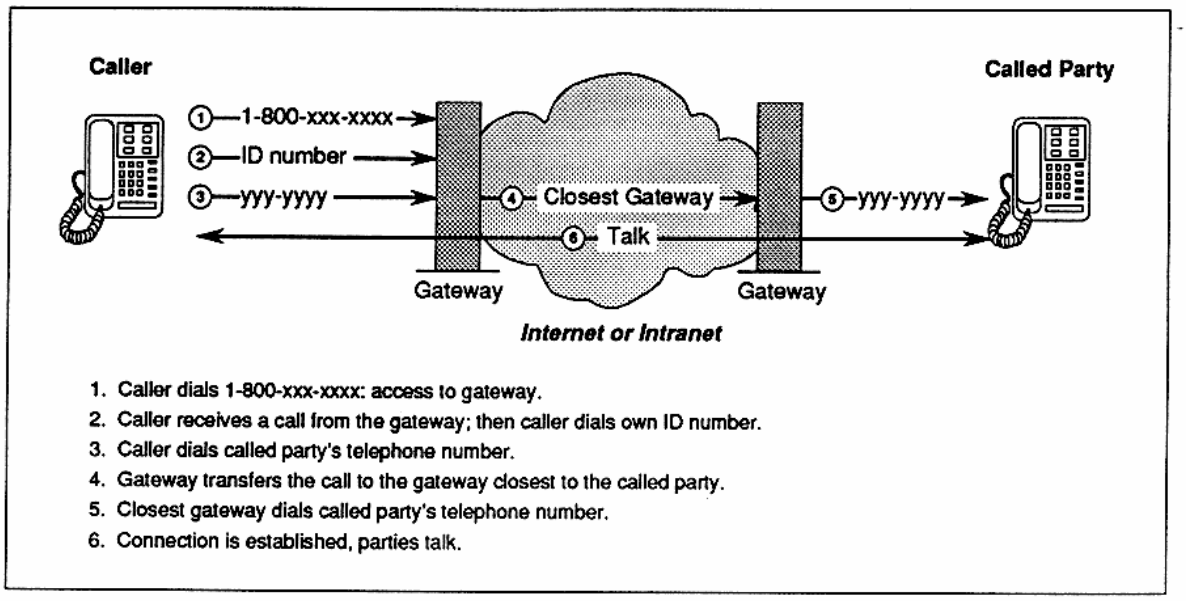
[25]"New Service Makes Inexpensive, High-Quality Phone to Phone Calling via the Internet a Reality," PR Newswire, Aug. 1, 1996 [NEXIS].

[26]"Maryland Company Begins Internet Voice Operations," *Telecommunications Reports* (Feb. 3, 1997), 14.



Source: Adapted from T. Kikuchi et al., "Power of VOI" (Internet Denwa no Iryoku), *Nikkei Communications* (Nov. 4, 1996), 107.

Figure 3-10

Phone-to-Phone VOI Connection

> LATIC's LatCall service will be very simple to use. LATIC customers will simply dial a five-digit access code from their home or office phone followed by the number of the person they are calling. There is no need for special equipment or changes in calling behavior.[27]

USA Global Link announced that it would offer "an advanced global Internet telephony system.... Exact calling rates are yet to be determined, but it is anticipated that rates will be 80–90% less than conventional international calling, and 20–40% less than callback."[28]

The first type of provision of phone-to-phone VOI is identical to provision by telephone carriers, IXCs, and simple resellers (SRs). If voice quality improves, users will be able to communicate using ordinary telephones, without regard for whether the call is made via the Internet instead of the PSTN, and they will be able to enjoy surprisingly cheap rates. For these reasons, in the United States, for this type of provision, the problem of the access charge and unfair competition between VOI and PSTN will loom larger (see **Chapters Five** and **Eight**).

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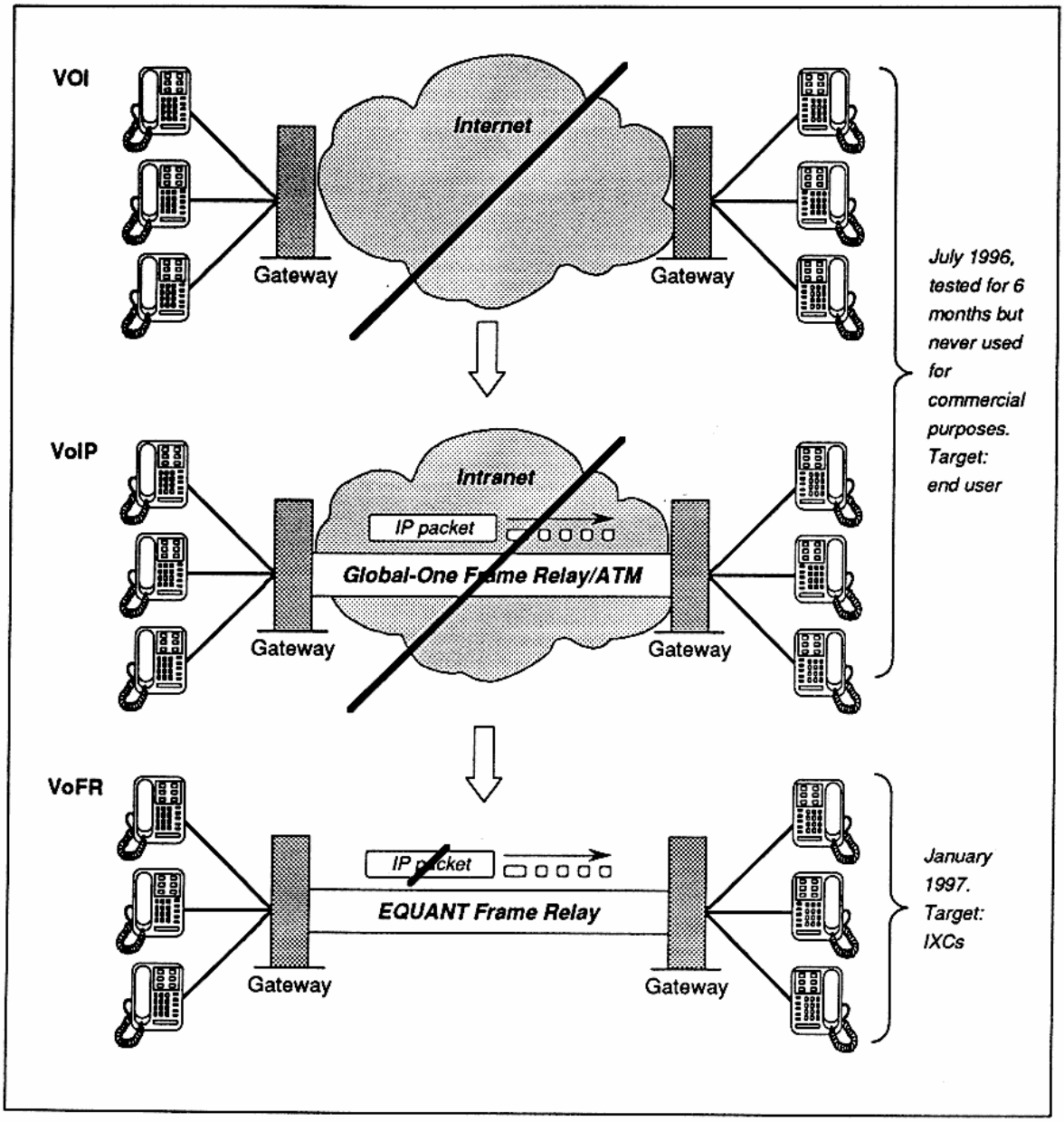
[27]"New Service Makes Inexpensive, High-Quality Phone to Phone Calling via the Internet a Reality."

[28]"Telephone-to-Telephone Internet Service Unveiled," *TR Daily*, March 25, 1997 [NEXIS]. Also, "Global Internetwork: An Introduction," USA Global Link [On-line]. URL: <usag1.com/Internetwork/index.htm>



ATM = asynchronous transfer mode
IP = Internet Protocol
IXCs = Interexchange carriers
VoFR = Voice over Frame Relay
VOI = Voice Over the Internet
VoIP = Voice over Internet Protocol

Figure 3-11

Technological Decisionmaking Behind a Commercial Offering: AlphaNet Telecom's "Mondial" Service

3.3.1 Products

For the second type of provision, in which vendors sells gateway products that enable Internet-based voice communication, the gateway makes worldwide voice, data, and video networks seamless. Providers include VocalTec together with Dialogic; Lucent Technologies; and Audio Codes. On September 17, 1996, Lucent Technologies introduced the Internet Telephony Server, which allows businesses to route telephone calls, fax transmissions, and voicemail over the Internet, instead of by more costly public and private networks.[29]

Additional products include Vienna.way (thru.way), produced by Vienna Systems, and V/IP, produced by Micom Communications. According to Vienna Systems, if the network is congested and 35 percent of the packets is lost, users will still manage to hear voice. To address the problem of network delay, Micom Communications uses the Resource ReServation Protocol (RSVP) (see **Chapter Seven**).

At first, developers of gateway technology targeted mainly (small) businesses, and only later larger businesses and ISPs, until, finally, Lucent Technologies developed a gateway for carriers.

3.3.2 Other Technologies: Internet-Initiated Telephony Solutions

Internet-initiated telephony uses the Internet to initiate signaling and the PSTN as the path for high-quality voice transmission. At the end of 1996, WebCentric Communications developed innovative solutions based on the user-friendly Web for initiating conference calls, dial-on-demand, international calling, and call-center services. Summa Four, "a leading provider of open, programmable switching platforms that enable telecommunications service providers worldwide to build intelligent, flexible networks that support the rapid deployment of new wireline and wireless services," added Internet voice capability on their open programmable switches, using WebCentric Communications' solutions.[30]

3.4 Summary of VOI Technologies

As described in sections **3.1-3.3**, VOI has been made possible by PC software or by gateways. **Table 3-3** presents a summary of the features of each kind of VOI.

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[29]See "Natural Micro Systems Internet Telephony Platform Embraced by Lucent Technologies, Inter-Tel and Netiphone," Business Wire, Dec. 9, 1996 [NEXIS].

[30]"Summa Four Invests in WebCentric Communications; WebCentric Is a Leading Developer of Internet-Initiative Telephony Solutions," PR Newswire, Dec. 3, 1996 [NEXIS].

The first kind of VOI, PC-to-PC VOI, was made possible by computer software. The caller and the called party both must have multimedia PCs with VOI software, but they can call for the price of only the Internet hookup and a local telephone call. The second and third kinds of VOI, PC-to-phone and phone-to-phone, were made possible by gateway technologies. In PC-to-phone VOI, the gateway permits multimedia-PC users to call ordinary telephone users. In phone-to-phone VOI, the gateway enables real-time voice conversation through the Internet for users of ordinary telephones, whether local, long-distance, or international telephone users.

Table 3-3

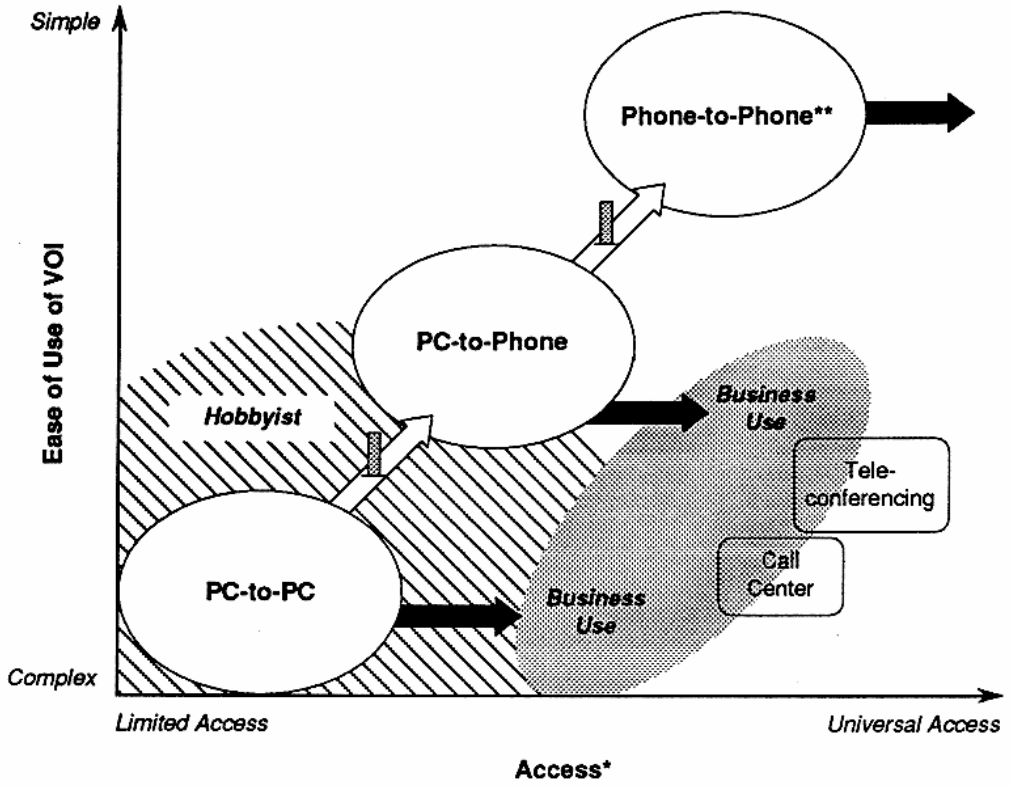
Features of Each Kind of VOI

Kind of VOI	Codec		Call Pre-Arranged	Cost		
	Compression	Decompression		Hardware	Software	Tariff
PC-to-PC	PC software	PC software	Necessary	Both parties: multimedia PC	Both parties: $50 or free	Same as for the Internet: no extra charge
PC-to-Phone	PC software	Gateway	Not necessary	One party: multimedia PC	One party: $50 or free	Extra tariff, e.g., 10¢/min (debit card)
Phone-to-Phone	Gateway	Gateway	Not necessary	Both parties: ordinary phone	Free	Extra tariff, e.g., 10¢/min (debit card)

Note: If a company's Intranet had its own gateway, tariffs would not apply.

The technological development of these kinds of VOI, from PC-to-PC, to PC-to-phone, to phone-to-phone, is a progress toward increasing simplicity, ease of use, and universal accessibility (see **Figure 3-12**). PC-to-PC VOI shifted the targeted users from residential customers to businesses that demand such services as call centers or teleconferencing. Gateways have broadened the targeted users from small businesses to larger businesses, ISPs, and carriers.

Thanks to the gateway, the Internet can be integrated with the PSTN. Everyone, whether equipped with only ordinary telephone, multimedia PC, gateway, is now a potential user of VOI (see **Figure 3-13**). Users with multimedia PCs on which VOI software has been installed can save money by paying for only a hookup to the Internet. Businesses that set up a gateway on an Intranet can use not only data but also voice. Even people who have neither a



*Standardization will increase accessibility and interoperability.
**Gateways have broadened targeted users of phone-to-phone VOI from small businesses to larger businesses, ISPs, and carriers.

Gateway

Standardization

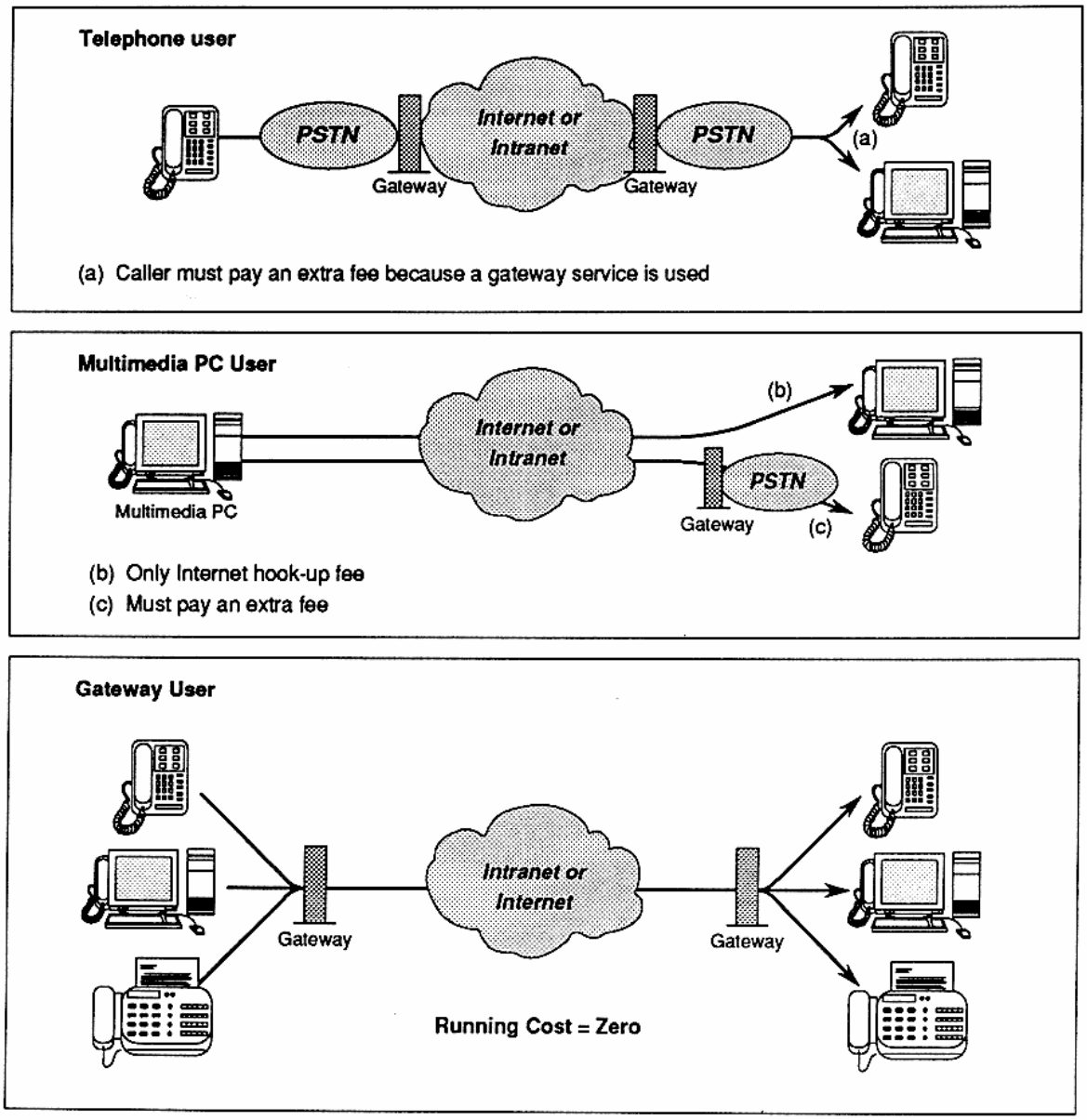
Figure 3-12

Progress of VOI: Toward Ease of Use, Accessibility, and Business Use

multimedia PC nor a gateway can use the Internet-based phone-to-phone telephony service provided by ISPs; as of mid-1997, this service is much cheaper than common carrier service.

For developers, the challenge involved in achieving good voice quality has been to control network delays, for example, by using codecs, buffers, or networks other than the Internet (AlphaNet), by using RSVP (Micom Systems) or—still in the planning stages—the real-time protocol (RTP) in the next version due from Vienna Systems.

To make these technologies interoperate, working groups are now working toward standardization.



PC = personal computer
PSTN = public switched telephone network

Figure 3-13

User Options for VOI

3.5 Evaluations and Opinions of VOI

VOI will permit users to have real-time communication for the price of access to the Internet, or on a per-minute basis, but either way the price of VOI will be les than for PSTN.

3.5.1 Estimates of Use of and Revenue from VOI

"The use of the Internet to make phone calls is in its infancy. An estimated 15 million to 20 million Internet users have the equipment to use an Internet phone product. Worldwide, there are 690 million traditional phones."[31]

The International Data Corporation (IDC) estimated the number of VOI users as follows: end of 1996, about 2 million users; by the year 1999, about 16 million users. IDC estimated that by the turn of the century VOI users will grow mainly among business users (see **Figure 3-14**).[32]

As for the revenue of software vendors: end of 1996, U.S. $70 million; by 1999, U.S. $560 million.[33]

Peter Sommerer, president and chief executive officer of the Newbridge Networks Corporation (Canada), forecast that by the year 2010 VOI will account for 28 percent of all voice communication.[34] A 1996 study by Killen & Associates forecast that global voice/Internet services revenues will top [U.S.] $63 billion by the year 2002, from $741 million in 1997.[35] Approximately 48 percent of the revenues by 2002 will be generated in North America, while 33 percent will come from Europe.[36]

According to *Telephony* magazine, Microsoft has joined with U S West Interactive Service to purchase 20 percent of VDOnet, whose VDOwave compression technology is used to make full use of available network bandwidth. According to Michael Heylin, a senior associate at the San Francisco-based company Creative Strategies Consulting, "It's clear that they're building toward offering a full line of voice-over-Internet products. And if they can address the quality issues with the number of Microsoft operation systems out there, they could really spur the market."[37]

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[31]Julie Schmit, "VocalTec Helps People Phone via the Internet," *USA Today*, March 8, 1996 (Final Edition), 2B.

[32]"Internet Telephone Technology Making Strides," Agence France Presse, Nov. 21, 1996.

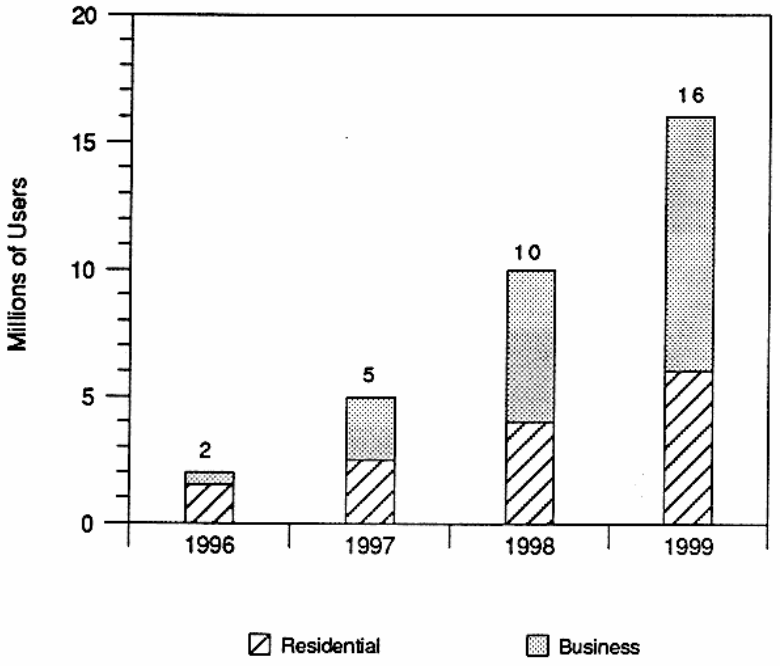
[33]Ibid.

[34]"Internet Voice Services Market to Reach $63 Billion by 2002," Business Wire, Jan. 29, 1997 [NEXIS]. See also Peter Sommerer, "The Impact of the Internet on the Phone Industry: Facts and Visions," the keynote address delivered at the "Interop" conference, Frankfurt, Germany, June 12, 1996 [On-line]. URL: <newbridge.com/coverstories/VOI.Pres/slide3.33.html>

[35]"Internet Voice: Services Market to Reach $63 Billion by 2002," Business Wire, Jan. 29, 1997 [NEXIS].

[36]Ibid.

[37]Chris Bucholtz, "Embracing Internet Telephony," *Telephony* **231**, 24 (Dec. 9, 1996), 40.



Note: There are approximately 690 million users in the traditional telephone market.
Source: Data from International Data Corporation, 1996.

Figure 3-14

VOI User Estimates: Residential and Business Markets

3.5.2 Evaluations of VOI

Even though many people foresee a rosy future for VOI, Jerry Lucas forecast that VOI will not negatively impact long-distance revenues in twelve months or even twelve years, for the following ten reasons:[38]

1. High price of equipment
2. The absence of standards
3. Transmission delay
4. Codec compatibility requirements
5. Lack of accessibility
6. Too few subscribers (of 6 billion people in the world, 40+ million use the Internet)
7. Lack of privacy
8. Security problems
9. Traffic jams (network congestion)
10. Reliability

---

[38]Jerry Lucas, "Ten Internet Predictions 1997," *Telestrategies Insight* (October 1996), 1-2.

Lucas probably considered only the first kind of VOI, PC-to-PC. Had he included the other kinds, PC-to-phone and phone-to-phone VOI, points 1, 2, 4, and 5 would have been less meaningful. For PC-to-phone communication, callers can call anyone anywhere at any time, and the call need not be prearranged. Thus, the second kind of VOI addresses Lucas's reasons 2, 4, and 5. Phone-to-phone VOI services address reasons 1, 2, 4, and 5: in this kind of VOI, the parties can communicate with each other using ordinary telephones, so that expensive terminal equipment is not needed; this kind of VOI also offers universality (callers can call anyone anywhere) and accessibility (the called party uses an ordinary telephone and the call does not need to be prearranged).

Regarding reasons 2 and 4, several international bodies are already working on issues of standardization (see section **3.1.4**). Developers are eager both to achieve a standard and to retain proprietary features, giving the user options.

Regarding Lucas's reason 3, many improvements have been and continue to be made to deal with the problem of transmission delay. When networks are less congested, the quality of VOI is now tolerable.[39] To address this problem within the network itself, IETF (and other groups) are working to develop a new Internet architecture and protocols; and as backbone and bandwidth have increased, so, too, methods of high-speed access have emerged (see **Chapter Seven**).

Regarding reason 6, as of early 1997, VOI is still in its infancy. Initially considered something for computer hobbyists, this situation has been changing: software for PC-to-PC VOI has improved (full duplex, better codec). Moreover, two large Internet browsers, Netscape and Microsoft, now provide VOI software as part of their standard versions, enabling Internet users to use VOI more easily. If the third kind of VOI, phone-to-phone, begins to provide for commercial use, in the future not only ISPs but also corporations may begin to provide phone-to-phone VOI service through their own Intranets. If that happens, then providers will advertise more widely. More and more people know about VOI, and as they learn that they can communicate much more cheaply than by common carrier or call backs, and that they can do so very easily, they may begin to use VOI. If phone-to-phone VOI eliminates two-stage dialling, that would soon be an important turning point (further discussion of this subject is beyond the scope of this report).

For reasons 7 and 8, the Internet may not be up to the job. The same protocols that provide easy access to legitimate customers also provide hackers an easy means of attack. In

[39]But improvements to VOI software alone cannot improve the quality of voice, which is affected by transmission delays when the network is congested.

the current environment, access and security seem mutually exclusive.[40] But according to Sommerer, in spite of known (or unknown) problems, VOI "should not be ignored." Although the quality of the Internet and its capacity both need improvement, the Internet has the "potential to dwarf all other applications."[41] Sommerer believes that these factors will influence the future of both the Internet and the telephone industry.

For reason 9, the following passage from *The Economist* describes the situation very well:

> Thanks to the wonders of the World Wide Web, the multimedia part of the Net, people are using the network to transmit telephone calls, films clips and other capacity-guzzling applications. The upshot is that the Net still resembles a congested city street; because users pay only their car and its fuel, rather than for the inconvenience their presence on the road imposes on others, they have no incentive to limit the use of their car in order to avoid traffic jams.
>
> *Congestion is made worse by the absence of a satisfactory way for firms running the Net to charge for carrying each other's traffic.*[42]

To address the sentence in italic, local exchange carriers (LECs) and IXCs have claimed that ISPs also should pay the access charge. Congestion, from "traffic jams" (reason 9) and from problems of reliability (reason 10) that those jams create, occurs not only at the Internet hookup but also within the network. Neither technical control nor pricing control is considered an appropriate mechanism for dealing with such congestion; see **Chapters Eight** and **Twelve**.

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[40]"Is the Internet Collapsing under Its Own Weight?" *Electronic Mail & Messaging Systems* (Sept. 30, 1996), 4.

[41]"The Impact of the Internet on the Phone Industry: Facts and Visions," slide 7.

[42]"Why the Net Should Grow Up," *The Economist* (Oct. 19, 1996), 17. (Emphasis added.)

Part Two

VOI Today

Chapter Four

VOI in the United States

4.1 The Internet Market in the United States

4.1.1 Service Pricing

Connections to regional and other service providers typically have been sold at a flat monthly rate based on access speed. Flat-rate pricing has been one of the conditions that allowed the Internet to flourish, because even if people used the service more and more, they have not needed to pay charges above the flat rate. Flat pricing is said to encouraged use, while usage pricing discourages it.

The many different Internet service providers (ISPs) have different schedules of services and fees, and customers have been able to choose according to their needs. For example, people who use access to the Internet for long periods can choose flat-rate services, which generally costs $20[1] a month for unlimited time on-line. If people need less time on-line, they can choose a service like Microsoft's, at $7 a month for five hours, with a surcharge of $2.50 for each additional hour. The big on-line services, such as America Online (AOL) or Prodigy, have started to offer flat fees, to match the ISPs.

Since 1996, LECs and IXCs also have jumped into the ISP market.[2] They provide Internet access service as "one-stop shopping"[3]: they provide Internet access to their customers more cheaply than others. For example, AT&T WorldNet offers AT&T's long-distance customers five free hours of Internet access a month, charging them $2.50 an hour above that. To non-AT&T customers, AT&T WorldNet offers access at $5 for three hours and $2.50 for each additional hour. For heavy users, it offers unlimited access for $20 a month to its own customers and to noncustomers for $25. See **Table 4-1**, which shows major ISPs and their tariffs.

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[1]All amounts cited in this report have been rounded off to the nearest U.S. dollar.

[2]Long-distance carriers such as AT&T and Sprint have rolled out Internet service businesses. See: "AT&T Offers Customers Internet Access," *Telecommunications Reports* **62**, 9 (March 4, 1996), 23; "Sprint Unveils Consumer Internet Access," *TR Daily*, Aug. 20, 1996 [n.p.]. GTE and other major LECs have also joined the Internet bandwagon. See: "BellSouth Joins internet Access Bandwagon," *Telecommunications Reports* **62**, 35 (Sept. 2, 1996), 30; "Pacific Telesis Unveils Consumer Internet Service, Access Pact with America Online," *TR Daily*, May 28, 1996 [n.p.].

[3]For example, according to *The Wall Street Journal*, MCI is offering business customers in thirteen cities a package of diverse telecommunications services including local and long-distance phone service, paging, cellular, and Internet access. Customers buying more than one service get discounts on "a single, simplified bill." See "MCI Offers Internet Phone, Paging Package to Business Customers," *The Wall Street Journal*, Sept. 13, 1996, B6.

Table 4-1

ISP Tariffs In the United States: Dial-up Connection

Name	Price per Month (for unlimited use unless specified)
America Online	$19.95
AT&T WorldNet	$24.95*
CompuServe	$9.95/5hours, $2.95 for each additional hour Or $24.95/20 hours, $1.95 for each additional hour
Concentric Network	$19.95. Or $7.95/5 hours, $1.95 for each additional hour
Earthlink Network	$19.95, $25 set-up fee
GTE Internet Solutions	$19.95 Or $8.95/5 hours, $1.95 for each additional hour
IBM Internet Connection	$19.95
MCI Internet	$19.95 Or $3/3 hours, $1.80 for each additional hour
Microsoft Network	$19.95 Or $6.95/5 hours, $2.50 for each additional hour
MindSpring	$19.95, $25 set-up fee
Netcom	$19.95**
Prodigy Internet	$19.95 Or $9.95/10 hours; $2.50 for each additional hour
Spring Internet Passport	$19.95 or $1.50 per hour
SpryNet	$19.95
WebTV	$19.95***

* $19.95 for AT&T long-distance customers.

** Netcom announced it will stop offering this price plan late February 1997; those already signed up can keep the plan.

*** No computer needed, but requires a television appliance made by Sony or Philips/Magnavox. Wireless keboard optional.

Source: Adapted from "By the Numbers: A Guide to Prices" (Table), in Leslie Miller, "Shopping for Web Access in Shadow of Giant AOL," *USA Today*, Feb. 3, 1997, 8D.

4.1.2 Size of the Market

Use of interstate information services, and in particular the Internet and other interactive computer networks, has increased dramatically in recent years. *Electronic Mail & Messaging Systems* reported early in 1997 that there may be fifty million users in the United States[4]: "According to a study by Find/SVP and Jupiter Communications, the number of U.S. households with Internet access more than doubled in the past year to 14.7 million, and roughly 38.7 million Americans over the age of eighteen have accessed the Internet at least once."[5]

4.1.3 Political Support for the Internet

The federal government has promoted the Internet, and some states have offered favorable treatment for Internet access providers, such as tax exemptions.[6]

According to *Computing Research News*, President Clinton, in a speech on science and technology given on October 10, 1996, at Oak Ridge, Tenn., referring to the rapid growth of the Internet, said, "the day is coming when every home will be connected to it, and it will be just as normal a part of our life as a telephone and television. It is becoming our new town square, changing the way we relate to one another, the way we send mail, the way we hear news, the way we play."[7] In the same speech, he announced three new initiatives aimed at improving and expanding education and public access to the Internet[8] and talked about the importance of research in general as well as the way in which computers and networking were

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[4]"Internet Now Growing at a 70% Annual Rate," *Electronic Mail & Messaging Systems*, Feb. 24, 1997, 3.

[5]FCC 96-488 I.B, NPRM, citing Jared Sandberg, "U.S. Households with Internet Access Doubled to 14.7 Million in Past Year," *The Wall Street Journal*, Oct. 21, 1996, B11.

[6]According to *Telecommunications Reports*, Internet access providers no longer are subject to a 6 percent telecoms service tax in Tacoma, Wash., where, on Sept. 4 , 1996, the city council voted to exempt Internet access services from a tax imposed in March 1996 by the Tax and License Department. See "Tacoma Exempts Internet Access Providers from Tax," *Telecommunications Reports* **62**, 36 (Sept. 9, 1996), 7. See also "ITAA Welcomes Tacoma Move to Turn Off Internet Tax," Business Wire (Sept. 4, 1996) [NEXIS]. On the other hand, the Interactive Services Association (ISA) commissioned a study of the taxation of on-line and Internet services by state and local governments; see "ISA Announces Study of Internet Taxation," *TR Daily*, Aug 5, 1996 [n.p.].

[7]Fred W. Weingarten, "Clinton Announces Special Internet Initiatives," *Computing Research News* **8**, 5 (November 1996), 1.

[8]Ibid. The initiative, to combine research and research infrastructure elements, has three goals: (1) to connect at least a hundred university and national laboratories at speeds at least a hundred times that now available in the current Internet and to connect a smaller number at speeds ten times greater than now available; (2) to experiment with the next generation of network technologies, such as high-quality videoconferencing, multicasting, and the ability to reserve bandwidth for applications with special requirements; and (3) to demonstrate new applications that meet important national goals and missions, such as distance education and health care.

transforming society. The President also announced a $100 million investment (Fiscal Year 1998) for a "Next-Generation Internet."[9]

The FCC recognized the importance of the Internet by requiring schools to offer access to it under the Telecommunications of 1996, which represents a policy statement that can be viewed as extending the definition of universal service.[10]

4.1.4 Regulation

As of spring 1997, the FCC does not regulate ISPs or VOI providers. According to FCC 96-488, § VIII.B, Treatment of Interstate Information Services:

> ...it is the policy of the United States "to preserve the vibrant and competitive free market that presently exists for the Internet and other interactive computer services, unfettered by Federal or State regulation," and we have long sought to avoid unnecessary regulation of information services.[11]

Beginning with the proceedings of the Second Computer Inquiry (*Computer II*) in the 1970s, the FCC has distinguished between basic and enhanced communications services.[12] It categorizes ISPs as enhanced service providers and exempts them from paying access charges.[13] Enhanced services are defined in § 64.702(a):

> ...the term *enhanced services* shall refer to services, offered over common carrier transmission facilities used in interstate communications, which employ computer processing applications that act on the format, content, code, protocol, or similar aspects of the subscriber's transmitted information; provide the subscriber additional different, or restructured information; or involve subscriber interaction with stored information." In the 1983 *Access Charge Reconsideration*

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[9]Ibid.

[10]See FCC Docet cc No. 96-45, Federal State Joint Board Report to Congress on Universal Service.

[11]Hereafter cited as FCC 96-488, with section or paragraph number.

[12]See "Amendment of Section 64.702 of the Commission's Rules and Regulations" (Second Computer Inquiry), Docket No. 20828, Final Decision, 77 FCC 2d 384, 417 (*Computer II*).

[13]"At one time, the FCC considered imposing access charges on use of the public network by enhanced service providers, but the proposal was decried as a 'modem tax' and defeated, in part by a letter-writing campaign of bulletin board operators and users. While the tax would have served the ideal universal service for the network, it would have worked against the leveraging of the new computer services from the voice network, and it would have further raised barriers to public access to the Internet. The arguments made against the modem tax were not that the transactions were of the such social value that access fees should not be imposed. The arguments were that use of computers and related technology should be encouraged as a matter of national technology policy." See Brian Kahin, "The Internet and the National Information Infrastructure," in *Public Access to the Internet*, edited by Brian Kahin and James Keller (Cambridge, Mass.: Massachusetts Institute of Technology [MIT] Press, 1995), 14.

> *Order*, we [the FCC] decided that, although enhanced service providers (ESPs) may use incumbent LEC facilities to originate and terminate interstate calls, ESPs should not be required to pay interstate access charges.

On the other hand, the FCC Commission's Third Computer Inquiry rules allow telcos to offer Internet "enhanced" services on an unregulated basis. In return, telcos must provide unaffiliated ESPs access to the basic services that "constitute the building blocks of the offering."[14]

4.2 VOI

4.2.1 Fuel for Debate: VOI vs. PSTN

The following discussion focuses on the examples of (1) an ordinary telephone holder, (2) a multimedia-PC holder who has already used the Internet, and (3) a gateway holder. **Figure 4-1** shows the price advantage of VOI when people call from the United States to Japan.

A person who already has a multimedia PC and who has already used the Internet, as in (2), even if this person uses the Internet for voice communication with that multimedia PC, does not have to pay an extra charge. If a company already uses an Intranet, with a gateway, the company, as in (3), does not have to pay extra or, if it does, it pays at most only the telephone charges incurred when linking to the Internet on either end. Even a person who has only an ordinary telephone, as in (1), can use Internet-based telephone services from an ISP and still can call cheaply.

In a comparison of VOI and IXCs, from the user's side the method of use does not seem greatly different, but the difference in pricing between VOI and IXCs is great. One reason IXCs must demand higher prices is the access charges they must pay LECs on a per-minute basis (see **Figure 4-2**). IXCs have pointed out that this regulation is unfair in that it gives VOI providers a pricing advantage. VOI has fueled debate in the United States on whether government ought to step in to regulate communications over the Internet.

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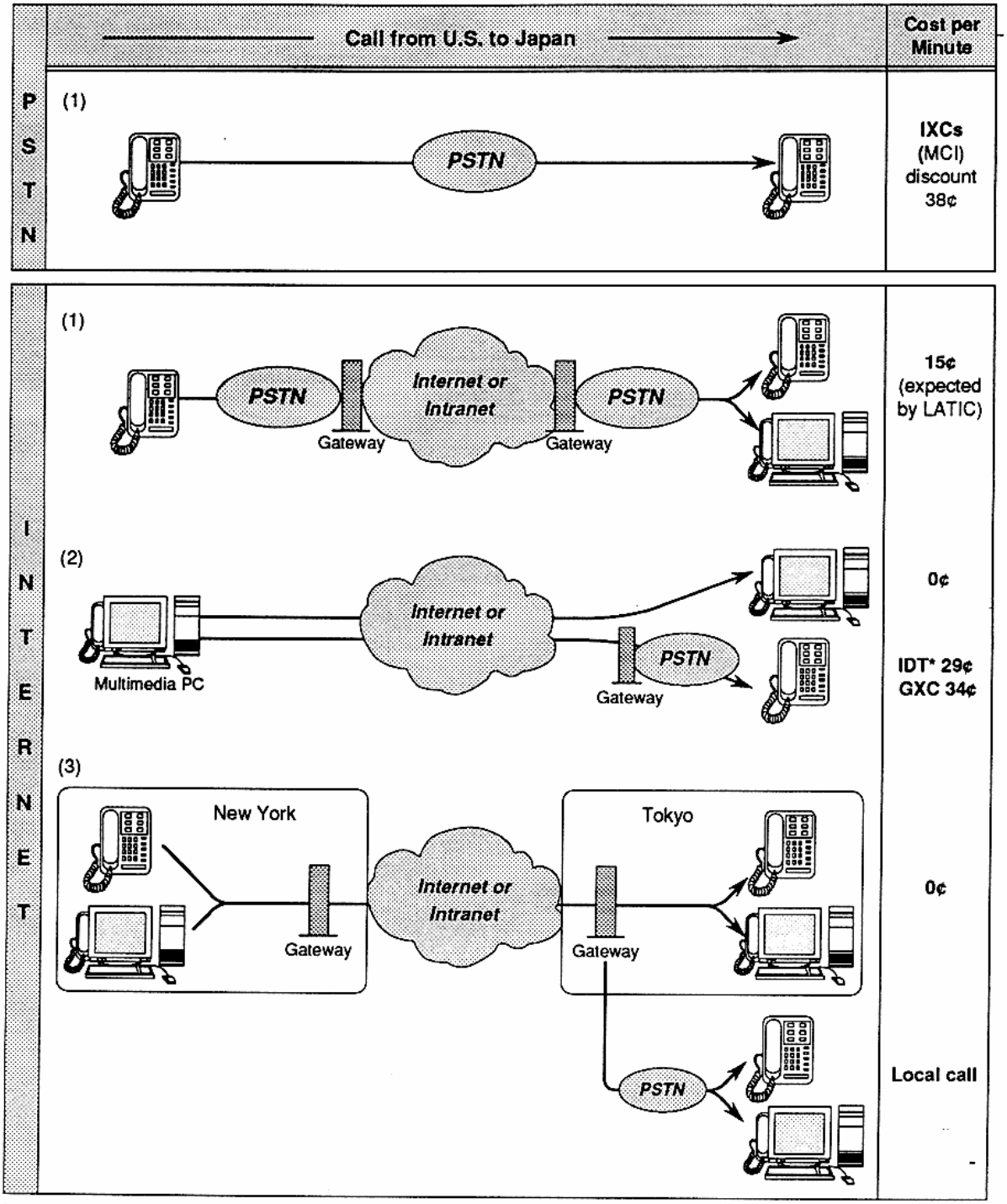
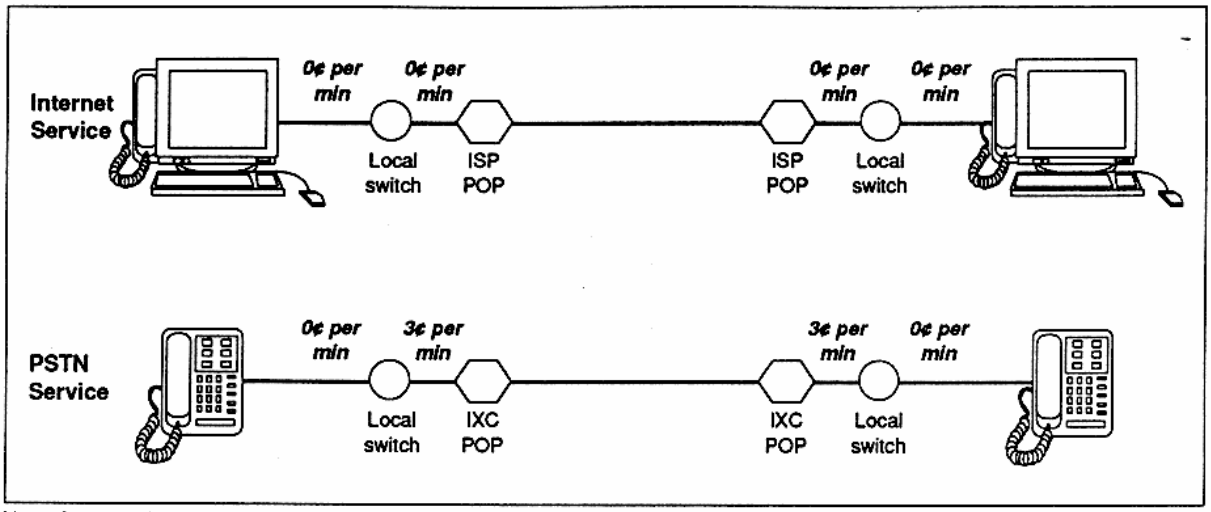
[14]"Bell Atlantic's CEI Plan for Internet Access OK'd," *Telecommunications Reports* (June 10, 1996), 27.



Note: Multimedia PCs are equipped with VOI software
*IDT Net2Phone service
PC = personal computer
PSTN = public switched telephone network

Figure 4-1

Comparison of Tariffs: VOI's Advantage



Note: Current pricing structure allows VOI providers to charge an effective usage charge of zero, while long-distance carriers must pass on roughly a 6¢-per-minute access charge for interstate calls.

ISP = Internet service provider
IXC = intereXchange carrier
POP = point of presence
PSTN = public switched telephone network

Source: Kevin Werbach, "Digital Tornado: The Internet and Telecommunications Policy," (March 1997) Figure 6, FCC Office of Plans and Policy, OPP Working Paper No. 29, 37; also [On-line]. URL: <fcc.gov>

Figure 4-2

Comparison of Pricing Structure: The Internet and PSTN

4.3 Arguments Regarding VOI

VOI has sparked a number of arguments in which the main issues have been unfair competition, regulation, access charges, and the universal fund. The America's Carriers Telecommunications Association (ACTA) fueled the arguments by filing a petition with the FCC. To counter ACTA, coalitions such as the Voice on the Net (VON) Coalition and the Digital Affordable Telecommunications Access (DATA) Coalition have appeared before the FCC. The following are summaries of the various arguments.

4.3.1 Carriers: ACTA's Petition

In its petition of March 4, 1996, ACTA described itself as

> a national trade association of competitive interexchange, non-dominant telecommunications companies. Its members provide interexchange telecommunications services to the public on an intrastate, interstate, and international basis to the public at large. Some of its members also act as underlying (or wholesale) carriers, providing network facilities, equipment, and service to other member carriers, which permits telecommunications services to be resold to the public. Other ACTA

> members supply facilities and equipment to member and nonmember wholesale and resale carriers.[15]

The petition emphasized that ACTA is under regulation:

> ACTA's carrier members must be certificated and tariffed before the FCC and most state regulatory commissions in order to render their telecommunications service to the public.... In addition, the FCC and most states require interexchange carriers to assess and collect from the using public specific charges to support various regulatory policies and programs used to sustain and advance national and state goals for telecommunications.[16]

It claimed that

> Entities...which do not comply with or operate subject to the same statutory and regulatory requirements as ACTA's carrier members, distort the economic and public interest environment in which ACTA carrier members and nonmembers must operate.[17]

ACTA also claimed that if the FCC continued to allow such entities to operate without complying with or being subject to the same legal and regulatory requirements as ACTA carrier members, ACTA could not serve the public. It therefore asked that such entities be regulated.

The petition contained the following "Summary of Filing":

> [ACTA], a trade association of interexchange telecommunications companies, submits this Petition for Declaratory Ruling, for Special Relief, and for Institution of Rulemaking Proceedings. This petition concerns a new technology: a computer software product that enables a computer with Internet access to be used as a long distance telephone, carrying voice transmissions, at virtually no charge for the call.
>
> ACTA submits that the providers of this software are telecommunications carriers and, as such, should be subject to FCC regulation like all telecommunications carriers. ACTA also submits that the FCC has the authority to regulate the Internet.
>
> ACTA submits that it is not in the public interest to permit long distance service to be given away, depriving those who must maintain the

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[15]America's Carriers Telecommunications Association, Provision of Interstate and International Interexchange Telecommunications Service via the "Internet" by Non-Tariffed, Uncertified Entities, Petition for Declaratory Ruling, Special Relief, and Institution of a Rulemaking, RM-8775 (filed March 4, 1996) (*ACTA Petition*). Quotations from this source hereafter cited as ACTA Petition; see FCC, "Internet Phone Petition (R.M. No. 8775) [On-line]. URL: <fcc.gov/Bureaus/Common_Carrier/Comments/actapet.html>

[16]Ibid.

[17]Ibid.

telecommunications infrastructure of the revenue to do so, and nor is it in the public interest for these select telecommunications carriers to operate outside the regulatory requirements applicable to all other carriers.

ACTA asks the Commission to issue a declaratory ruling confirming its authority over interstate and international telecommunications services using the Internet.

ACTA asks the Commission, as special relief, to order the Respondents to immediately stop their unauthorized provisioning of telecommunications services pending their compliance with 47 U.S.C. Sections 203 and 214. and in order to give the Commission time for appropriate rulemaking.

ACTA asks the Commission to institute rulemaking to govern the use of the Internet for providing telecommunications services.[18]

The following points were noted in the petition:

• **ACTA criticized the rule that allows end users of the Internet to bypass LECs and IXCs in order to make telephone calls "for virtually no cost." Under the current regulatory regime, people can enjoy low-priced long-distance and international calls.** "A growing number of companies are selling software for the specific purpose of allowing users of the Internet to make free or next to free local, interexchange (intraLATA, interLATA) and international telephone calls using the user's computer.... The software enables users to audibly talk with one another in real-time. Respondents make a one-time charge for the software, but users incur no other charges for making local or long distance telephone calls to any other 'Internet Phone' user in the world (except for whatever the user already pays monthly to whomever provides them Internet access)."[19]

• **Regulation leads to unfair competition; Internet telephony service providers should be subject to tariff-filing or other regulatory requirements now imposed on IXCs.** ACTA asked that the FCC ban Internet telephony services until software providers filed interstate tariffs and obtained facilities authorizations. ACTA focused on convincing the FCC to regulate "Internet telephony service providers" as "telecommunications service providers" under the Telecommunications Act of 1996.[20]

• **Significant reduction of the Internet's capacity.** VOI, which demands a great amount of bandwidth, reduces the Internet's capacity for other kinds of transmissions.

• **Use of VOI rather than the PSTN would threaten the health of the telecommunications industry and achievement of the goal of universal service.** ACTA cited concerns that Internet capacity might be

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[18]Ibid.

[19]Ibid.

[20]For tariff-filing and facility authorization requirements affecting both LECs and IXCs, see § 203 and § 214 of the Communications Act.

taken up increasing by voice transmissions: misuse of the Internet as a way to handle the customary types of Internet traffic; inaction on this issue...could the threaten the health of the telecommunications industry and threaten the achievement of universal service goals; "Such developments would clearly be detrimental to the health of the nation's telecommunications industry and the maintenance of the nation's telecommunications infrastructure."

• **The health of the telecommunications industry is a prerequisite for universal service.** "The Commission has a duty to oversee and effect the Telecommunications Act of 1996 as well as its long-standing duties under 47 U.S.C. Section 151. The Commission should take action in order to preserve fair competition and the health of the Nation's telecommunications industry. Absent a healthy industry, with users paying telecommunications companies a fair price for Telecommunications services, the Commission's duty to effectively promote universal service cannot be achieved."

• **Unlawful uses.** "New technology could be used to circumvent restrictions traditionally found in tariffs concerning unlawful uses, such as gambling, obscenity, prostitution, drug traffic, and other illegal acts."

4.3.2 Arguments Against ACTA's Petition

Although AT&T and other carriers agreed with ACTA that the exemption from paying access charges and other regulatory exemptions enjoyed by ESPs should be removed,[21] they disagreed with other parts of ACTA's petition. In AT&T's view, ACTA's request to apply tariff-filing and facility authorization requirements found in sections 203 and 214 of the Communications Act to ISPs "is foreclosed by the fact that these statutory provisions apply only to 'carriers,' a category that plainly does not apply to computer software vendors."[22]

4.3.3 VON Coalition

According to PR Newswire, the VON Coalition, "an Internet organization devoted to creating global awareness of audio, video, multimedia, and Internet Telephony products and software, along with major computer industry organizations and companies filed joint reply comments [on June 10, 1996] asking the...[FCC] not to ban Internet Telephony as requested

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[21]"Companies Split along Industry Lines on ACTA's Petition for Internet Regulation," *Telecommunications Reports*, 29 (May 13, 1996), 22, 55.

[22]Ibid., 21.

in March by [ACTA], a group representing approximately 130 long distance telephone carrier resellers."[23]

VON urged the FCC to deny the ACTA Petition, for six reasons:

1. **The unfettered development of the Internet is important and in the public interest.** "While ACTA argues that Commission regulation is necessary to protect the development of the Internet, the Joint Parties are unified in their belief that such regulation is not needed and would slow innovation in this vibrant new medium. Thus, the Joint Parties respectfully urge the Commission to make the public interest in a free, dynamic Internet its paramount concern and deny ACTA's proposal, a policy scheme designed to protect the economic self-interest of a narrow group of companies at the cost of a variety of beneficial new services."[24]

2. **Software developers and vendors are not "telecommunications carriers."** "Clearly, software providers only sell their software products, and do not provide any transmission services. Thus, they do not provide telecommunications."

3. **Commission regulation of the Internet would conflict with explicit congressional policy.**

4. **"Any plan to regulate VON services is impractical, as it is impossible to distinguish between voice packets and other data packets."**[25]

5. **"The volume of Internet use for anything resembling telephony is not significant and does not require urgent attention**...voice communication via the Internet is in its incipient stage, and the amount of voice traffic currently on the Internet is *de minimis*."

6. **"The Commission should not change its policies for enhanced service provider payment for access charges.** The Joint Parties strongly urge the Commission not to make such a radical change or even consider such an action in this proceeding. The current treatment of enhanced services is fair, it has had the intended consequence of permitting enhanced services to develop, and its modification could have a serious consequence for the continued development of

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[23]"Financial News," PR Newswire (June 11, 1996) [NEXIS]. See also "Internet Industry Files Jointly Against Long-Distance Carriers" and "Before the Federal Communications Commission, In the Matter of The Petition of America's Carriers Telecommunications Association for Declaratory Ruling, Special Relief, and Institution of Rulemaking, RM-8775" in VON Coalition Press Release, FCC Joint Reply Comments—June 10, 1996, [On-line]. URL: <von.org/prreply.htm>

[24]This and following passages are taken from "Before the Federal Communications Commission...," in VON Coalition Press Release... [On-line]. URL: <von.org/prreply.htm>

[25]According to Zachary M. Schrag, "Despite occasional claims that Internet telephony packets are indistinguishable from other Internet traffic, in fact each Internet software package marks its packets with distinctive port number. For example, packets generated by Internet Phone all are marked with port number 22555." See Schrag, "The Achilles Heel of Internet Telephony" in *Telegeography 1996/97* (Washington, D.C.: TeleGeography, 1996), 39.

these services. Moreover, enhanced service providers are not subject to the universal service obligations of the Telecommunications Act."

4.3.4 Digital Affordable Telecommunications Access (DATA) Coalition

"A group of the heavy hitters from the computer and information service industries have formed a coalition to fight telephone industry efforts to shift part of the interstate access cost burden to Internet service providers.:

> Led by the Information Technology Industry Council (ITI) and the Information Technology Association of America (ITAA), the [DATA] Coalition's 'core' members include more than a dozen personal computer and software manufactures and online service providers, as well as American Electronics Association and the Business Software Alliance.[26]

The coalition came into being as the result of a decision by major computer and information services industry players "to deal with the access charge issue as one body."[27] The founding members of the DATA Coalition "have committed to funding two studies to buttress the group's policy objectives: One study is to explore economic issues associated with access charges. The second study is to survey technological alternatives that telcos could use to alleviate demands placed on network transmission and switch resources by the burgeoning Internet."[28]

4.3.5 Internet Access Coalition (IAC)

The Internet Access Coalition was organized by Microsoft, IBM, and AOL, and it is one of the DATA study groups. The IAC requested the FCC to continue to exempt ISPs from access charges, because Internet users purchase new telephone lines and thus pay additional bills. The IAC pointed out that in the case of Bell Atlantic, half of the purchasers of second telephone lines were Internet users. It insisted that the increase in the burden from paying access charges will be make for short usage on the Internet.

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[26]"Group Forms to Lobby Against Telco Efforts to Levy Access Fees on Internet Service Providers," *Telecommunications Reports* (Nov. 18, 1996), 29. In addition to the trade associations, founding DATA Coalition members include: PC manufacturers (IBM, Compaq, Apple, and Digital Equipment Corp.), systems integrators (Electronic Data Systems Corp.), chip manufacturer (Intel), software giants (Microsoft, Novell, Oracle, and Netscape), and on-line service providers (America Online, CompuServe). AT&T is a member of ITI and ITAA, but decided against joining the new DATA Coalition directly.

[27]Ibid.

[28]Ibid. Paul Misener, manager of telecommunications and computer technology policy at Intel and chairman of the DATA steering committee, said the "xDSL" (Digital Subscriber Line) technologies addressed in the second study will support "much higher connectivity speeds"—on the order of 6 Mbps–8 Mbps—for on-line service users.

4.3.6 National Telecommunications and Information Administration (NTIA)

On behalf of the Clinton administration, the National Telecommunications and Information Administration urged the FCC not to agree to ACTA's petition for rulemaking. After evaluating nonregulation on the Internet, the NTIA concluded that it should be continued. The NTIA said that "ACTA not only mischaracterizes the existing law but also reflects a fundamental misunderstanding of the way in which the Internet operates and of the services now making use of the Internet."[29] The Commission's decision in the 1970s not to regulate enhanced service providers was "a wise one that has conferred substantial benefits on American consumers."[30] The FCC should not "risk stifling the growth and use of the vibrant technology in order to prevent some undemonstrated harm to long distance service providers." The NTIA recommended postponing any decision to regulate these services until concerns are raised about harm to consumers or the public interest. "Now is not that time."[31]

4.3.7 U.S. Telephone Association (USTA)

The U.S. Telephone Association claimed that the ESP industry was already mature and does not need protection and that it should be required to pay the access charge. In the view of USTA, ESPs are considered telecommunications service providers. In 1983, ESPs were granted a "temporary" exemption from paying interstate access charges because of the "nascent nature of the industry at that time,"[32] according to the USTA. Since the exemption was granted, the ESP industry "has undergone a remarkable maturation,"[33] and ESPs now include such corporations as AT&T, MCI, and Microsoft. Several carriers said that ESPs should be required to contribute to universal service funding mechanisms, citing their role as "telecommunications service providers."[34]

4.3.8 The National Telephone Cooperative Association (NTCA)

The National Telephone Cooperative Association expressed its opinion from the point of view of the economic burden principle, that the person who enjoys the benefits should pay the price. According to the NTCA, "While software providers may not be covered by the

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[29]"Companies Split along Industry Lines on ACTA's Petition for Internet Regulation," *Telecommunications Reports*, 29 (May 13, 1996), 22.

[30]Ibid.

[31]Ibid.

[32]Ibid.

[33]Ibid.

[34]Ibid.

definition of providers, Internet access service and other information service providers are." It added that "neither LECs, long distance providers, nor subscribers and customers should have to bear the cost associated with 'free service' over the Internet."[35]

[35]Ibid.

Chapter Five

VOI in Japan

5.1 The Internet Market in Japan

In Japan, development of the commercial Internet—including the Internet infrastructure, or "backbone"[1]—began in 1993. At that time, the Internet Initiative Japan (IIJ) and AT&T Jens together established the Spin project, which began to provide commercial Unix to Unix Copy Program (UUCP)[2] service. Following the provision of Internet service through that project, other companies entered the market: Fujitsu (InfoWeb), NEC (C&C Internet Service mesh), Tokyo Internet (TokyoNet Internet Service), NTT PC Communications (InfoSphere), IBM Japan (IBM Internet Access Service), and Hitachi (netSpace). In 1995, fifteen Special Type II and 260 General Type II companies (noncarriers) entered this market.[3]

5.1.1 Internet Service Pricing

The Japanese telecommunications market was privatized in 1985, and since then new common carriers (NCCs) have entered the market and telephone rates have decreased by about one-third. The heaviest telephone traffic is between Tokyo and Osaka. The NCCs entered this area in what NTT considers a "cream-skimming" fashion, and as of 1997 they provide nationwide service. Before their entry, the telephone rate between Tokyo and Osaka was ¥400 for three minutes, but in 1997 that decreased to ¥110.

Japanese telecommunications tariffs remain high, however, in comparison with those in the United States, and for this reason VOI might be expected to spread quickly in Japan. But because Japanese telecommunications tariffs are usage-based and Japanese Internet providers' services are not cheap and most have usage-based pricing, people cannot obtain Internet service as easily as in the U.S. Further, computer penetration is low in Japan. As of January 1995, by company, the number of PCs per 1,000 employees was as follows: U.S., 551.4; Japan, 146.5, so that in the U.S., PC penetration was 5 times greater than in Japan. The number of systems connected to the Internet was as follows: U.S., 3,179,000, Japan, 96,000, so that Internet connection in the U.S. was 30 times greater than in Japan.[4]

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[1]T. Takahashi, "History of the Internet in Japan," *Internet Hakusho '96* (Internet White Paper '96), edited by the Japan Internet Assoc. (Tokyo: Japan Internet Assoc., Impress, 1996), 51.

[2]Software developed in the mid-1970s that allows one computer to copy files to or from another over a (usually dial-up) connection. See Douglas E. Comer, *The Internet Book: Everything You Need to Know About Computer Networking and How the Internet Works* (Englewood Cliffs, N.J.: Prentice-Hall, 1995).

[3]Takahashi, 51.

[4]Nihon Jyouhou Syori Kaihatu Kyoukai, "Jyouhou Ka Hakusyo," 1995. Data as of January 1995.

As of 1997, things have begun to change. Though Japanese telecommunications tariffs have been usage- and distance-based, since mid-1995 carriers (Nippon Telegraph and Telephone [NTT] and the NCCs) have provided Internet-oriented services with a combined tariff (flat rate only during off-peak times and a usage-based rate during peak times). For example, in 1995 NTT began to provide off-peak flat-rate service: users pay an extra ¥1,800 as a monthly fee, and from 11:00 PM to 8:00 AM they can use their telephone lines for as long as they wish.

At the end of 1996, some carriers announced that they would provide new network services for computer communications, including the Internet. NTT started to provide Open Computer Network (OCN) service in December 1996.[5] The new architecture, as shown in **Figure 5-1**, was, according to NTT, intended to respond to demands for easy connectivity between various types of terminals and networks and for inexpensive, easy-to-use services. Japan Telecom (JT), a long-distance carrier, started to provide open data network (ODN) service beginning April 1997. After examining the concept of ODN, JT decided to provide a high-quality service, called "First," rather than an economical one, and it has targeted large companies and ISPs.[6] The local telecommunications carrier, Tokyo Telecommunications Network (TTNet), also announced that beginning July 1997 it will provide the TTNet Computer Network (TTCN), which will support the fiber distributed data interface (FDDI), a feature targeting ISPs, that in September 1997 will provide a 128-kbps to 6-Mbps flat-rate service more cheaply than OCN.[7]

For the residential market, as of December 1996, AT&T Jens provides AT&T WorldNet service with flat-rate pricing. According to AT&T WorldNet, its main appeal is that AT&T Jens is a primary ISP and that it has a 45-Mbps backbone, which allows customers comfortable access.[8] Initially, there were only two access points, at Tokyo and Osaka, and this may prove a weakness. Even if AT&T WorldNet provides flat-rate access service, except for people who can access its access points at ¥10 for three minutes (normal local rate), no one will contract with AT&T WorldNet to pay expensive telephone charges to the access points. To address this weakness, AT&T WorldNet has joined JT to allow users to access the access point at ¥10 per minute from all over Japan. The price is a one-time ¥3,000 contract

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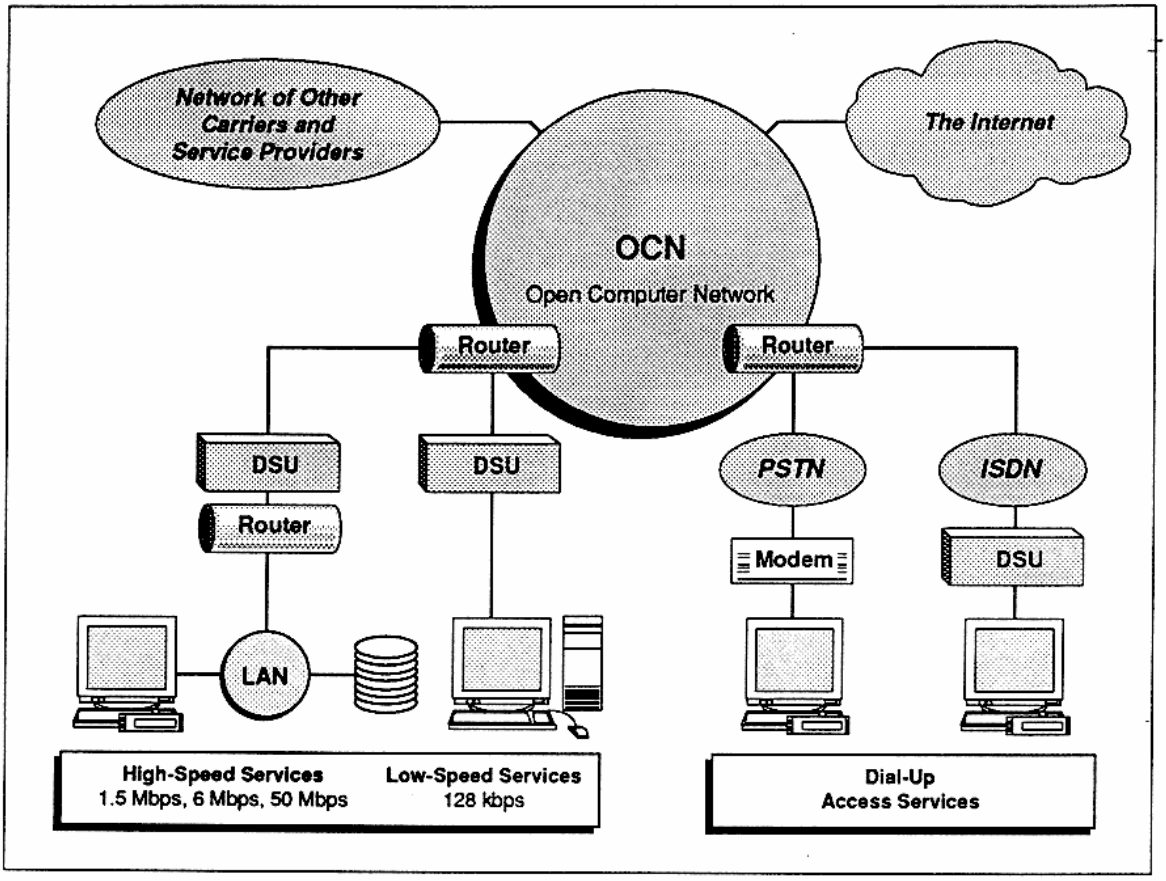
[5]OCN is a router-based network that provides nationwide Internet access service to end users, along with Internet backbone services for other carriers. See "NTT Service Gets Nod from Council," *TR International*, Nov. 8, 1996, 16.

[6]"JT Reconsiders ODN Plan," *Nikkei Communications 1997* (Feb. 17, 1997), 78.

[7]M. Fujikawa, "TTNet Will Begin New Service for Data Communication," *Nikkei Communications 1997* (Feb. 17, 1997), 76. See also "TTNet to Offer Inexpensive FDDI Access," Japan BizTech News, Communications, BizTech Seminar Series, Distribution into Asia (N.Y., June 1997) [On-line]. URL: <japanbiztech.com/articles/855960453.html>

[8]AT&T WorldNet (SM) Service Services1 [On-line]. URL: <attnet.or.jp/svcs.html>



DSU = digital service unit
ISDN = integrated services digital network
LAN = local area network
PSTN = public switched telephone network

Source: Nippon Telegraph and Telephone, Annual Report (1996), 8.

Figure 5-1

NTT's Open Computer Network Service

fee and then a monthly ¥2,000 fee for unlimited usage.[9] The biggest ISP, IIJ, began with a ¥4,900 per month flat-rate service. These changes in the fees will allow people easier access to the Internet. See **Table 5-1**, ISP Tariffs.

In 1996–97, articles in Japanese newspapers emphasized the advantages of cable television (CATV) telephony to access the Internet,[10] claiming that it offers much higher speeds than PSTN (or the integrated services digital network [ISDN]), about one million times as fast. The strong point for CATV telephony is that, because it connects directly with

[9]Ibid.

[10]See, for example, Y. Matsumoto, "Connect to the Internet," *Nihon Keizai Shinbun*, Jan. 1, 1997, 44.

Table 5-1

ISP Tariffs in Japan: Dial-up Connection

Internet Service Pricing:	Name of Service	Initial Service Charge (¥)	Monthly Charge (¥*)	
Flat-Rate				
• Internet Initiative Japan (IIJ)	IIJ4U	8,000	4,900	
• AT&T Jens	AT&T WorldNet Service	3,000	2,000	
Flat Rate and Usage-Based			**Monthly Basic**	**Surcharge**
• NTT	OCN	3,800	2,300 (15 hr)	9 per min
• Network Information Service	NIS Internet Service	3,500	900 (30 hr)	10 per 3 min
• Tokyo Internet	TokyoNet Internet Service	3,000	500 (2 hr)	3 per min
• Fujitsu	Infoweb	3,000	2,000 (15 hr)	10 per min
• Sony Communication Network	So-net Internet Service	5,000	1,000 (3 hr)	10 per 3 min
• Nifty	Nifty Serve	—	1,800 (high-speed 3 hr)	7 per min; 15 per min
• NEC	BIGLOBE	—	2,000 (15 hr)	10 per min
• Microsoft (U.S. $)	MSN	—	$12 (2 hr)	$5 per hr

*Except where noted.
¥124 = U.S. $1 (Q1 1997, estimated)

Source: Data from "Main ISP Residential Internet Connection Services" (Table), "Internet Service Providers: Different Prices," *Nihon Keizai Shinbun*, March 15, 1997.

contractors, it can provide Internet access with flat-rate pricing.[11] According to the *Nihon Keizai Shinbun* (Jan. 1, 1997), CATV telephony charges will be about ¥1,800, including line charge and connection fee, and Tokyu CATV will provide an Internet access service beginning April 1997.

In February 1997, Japan announced to the World Trade Organization (WTO) that it would waive its prohibition against foreign investment, on the condition that less than 20 percent of foreign ownership of NTT and Kokusai Denshin Denwa (KDD) will be protected. This move will promote the entry of foreign investment into the Japanese telecommunications market. If, as a result, competition increases, circumstances certainly will change in Japan.

[11]Ibid.

5.1.2 Size of the Market

According to statistics from the Ministry of Posts and Telecommunications (MPT), "At the end of 1996 there already were 1,300 Internet Service Providers...and more than 1.5 million users. And those numbers [were] rising almost daily."[12]

5.1.3 Political Support for the Internet

The MPT has promoted the Internet. According to the *Nihon Keizai Shinbun*, "Beginning in 1997, the MPT will build circumstances for Internet commerce and high-speed giga-bit information transmission."[13] According to *Nikkei Business* (Feb. 10, 1997), about twenty local autonomous bodies each established semipublic organizations to make it easy for local residences to use the Internet. These organizations provide residential users with Internet access at cheap prices, for example, dial-up access for at ¥6,000 per year. ISPs have criticized this move as putting pressure on the private ISP business.

5.2 VOI

5.2.1 PSTN Market

The Japanese telecommunications market has begun to change. In domestic long-distance communications, in 1995, domestic carriers began to provide discount-rate services, such as wide area telephone service (WATS) and virtual private network (VPN) services. Deregulation (in October 1996) now allows domestic public-private-public (or bypass) connections, and competition has emerged.

Since October 1996, when, as said above, bypass was allowed, new entrants have appeared in the long-distance market that provide long-distance communications at rates lower than those of the long-distance telecommunications carriers. In January 1997, the carriers responded by announcing a decrease in their prices as of February 3, 1997. For a daytime call at a distance of more than 100 kilometers (km) for three minutes, NTT dropped its price from ¥130 to ¥110 and JT dropped its price from ¥120 to ¥100.[14] In response to the move by the carriers, bypass providers then announced that they will continue to provide their services always at cheaper rates than the carriers. Since the bypass connection was allowed,

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[12]"Japan's Internet Market Flooded by 1,300 Providers, 1.5m Users," BizTech Special Report, Feb. 21, 1997 [On-line]. URL: <japanbiztech.com/articles/856637787.html>

[13]"MPT Plans to Promote the Internet," *Nihon Kezai Shinbun*, Aug. 28, 1996, 1.

[14]In response to NTT's announcement that on Feb. 3, 1997, it would cut its long-distance rate, one NCC, JT, filed to cut its own rate also on that date. See "JT Cuts Long-Distance Call Rates to ¥100 per 3 Minutes," *Nihon Kezai Shinbun*, Jan. 17, 1997, 7.

competition in the long-distance communications market has intensified, and the price competition between carriers and bypass providers seems likely to continue.

Other kinds of telecommunications providers have been emerging: a company that contracts to use WATS service joined with a credit card company, and together they resell telephone service to the card holders at a rate 15 percent cheaper than the carriers' normal rate. In November 1996, the Tokyo Information Systems Company joined the JCB Company, a travel company, and now Tokyo Information Systems uses the long-distance company's discount services, like WATS, which allow it to save 25 percent. Tokyo Information Systems resells telecoms service to JCB cardholders at a 15 percent discount.[15]

Regarding the international communications market, in October 1996, AT&T announced its entry into the Japanese international telecommunications market as a call-back provider. In 1997, with the introduction of the international public-private-public connection, ISRs will be allowed.[16]

Thus, the Japanese telecommunications scene will change dramatically in the next few years.

5.2.2 VOI

Given (as of 1997) that fewer people in Japan have PCs than in the United States, that the number of Internet users is smaller than in the U.S., and—the largest factor—that domestic and international telephone fees are high in Japan, phone-to-phone VOI seems likely to spread more rapidly there than PC-to-PC VOI.

ISPs have begun to provide phone-to-phone VOI service since February 1997. The high Japanese telecommunications rates, even for the domestic long-distance market, allow providers of VOI to emphasize VOI's price advantage. For example, on April 21, 1997, one ISP, Rimnet of Tokyo, started an inexpensive domestic telephone service using the Internet for its own Internet users. The charge will be ¥60 for three minutes, compared with NTT's charge of ¥110. The service will initially cover six major cities, including Tokyo and Osaka.[17] See **Table 5-2**. Just as when the telecommunications market was privatized, new service providers entered the market with the heaviest traffic, that is, between Tokyo and Osaka.

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[15]"With Public-Private-Public Connection, Bypass, Permitted, New NCCs Have Emerged One After Another," *Telecommunications* (Japan) (December 1996), 80-81.

[16]"AT&T Enters as a Call-Back Service Provider," *Nihon Kezai Shinbun*, Oct. 29, 1996, 3.

[17]"Rimnet to Use Internet for Long-Distance Service," Japan BizTech News [On-line]. URL: <japanbiztech.com/articles/854582941.html>

Table 5-2

Phone-to-Phone VOI Services in Japan

Service Description	Phone-to-Phone VOI Service Providers			
	Live & Love	**Rimnet**	**Japan ITS**	**Chiyoda Sangyo**
Start date	February	April	April	June
Access point (beginning of service)	Tokyo Osaka	Tokyo Osaka Nagoya Sapporo Yokohama Fukuoka	Tokyo Osaka	Tokyo Osaka
Rate (includes NTT telephone fee to access point)	¥55 per 3 min	¥60 per 3 min; ¥20 surcharge per min after 3 min	¥45 per 3 min (¥2500 per mo)	¥48 per 3 min

¥124 = U.S. $1 (Q1 1997, estimated)

Source: Data adapted from T. Kikuchi et al., "Phone-to-Phone Service Providers to Provide Long Distance Calling at about Half the Price of NTT; Will They Open a New Market?" *Nikkei Communications*, Feb. 17 1997, 73.

The phone-to-phone VOI connection is made in the following way, which is very similar to IDT, a global exchange carrier company (see section **3.2.1**). A caller using an ordinary telephone dials a toll-free number (in Japan, 0120, like 800 in the U.S.) to access the Internet gateway. (The rate for the service includes the telephone fee to the access point, so the only rates the caller has to pay are to the provider's company.) Next, the caller dials the user ID number given by the ISP and then calls the desired party's telephone number.

According to Takashi Kobayashi, president of the ISP Rimnet, the quality of this service has come closer and closer to that of PSTN but has not yet reached it.[18] According to Nikkei BP Online (Jan. 29, 1997), once restrictions on international "public-private[-public] access" connections of public and private lines occur as scheduled (1997), Rimnet also would like to offer international service. The service would make it possible to call the United States for ¥90 (less than U.S. $1.00) for three minutes.

A membership fee of ¥5,000 and a registration fee of ¥2,000 will be required to use the new service.[19] To place a call, members must dial a toll-free number, then enter a personal

[18]Quoted in T. Kikuchi, "Phone-to-Phone Service Providers to Provide Long-Distance Calling at about Half the Price of NTT; Will They Open a New Market?" *Nikkei Communications*, Feb. 17, 1997, 73.

[19]"Rimnet to Offer Long-Distance Internet Calls," *The Japan Times*, Jan. 29, 1997, 1.

ID number followed by the number to be called." Rimnet is preparing to offer this new Rimnet service as a GXC.

5.2.3 VOI Price Advantage Over PSTN

Figure 5-2 presents a price comparison between VOI and PSTN in the domestic and international markets. VOI clearly has a significant advantage in both.

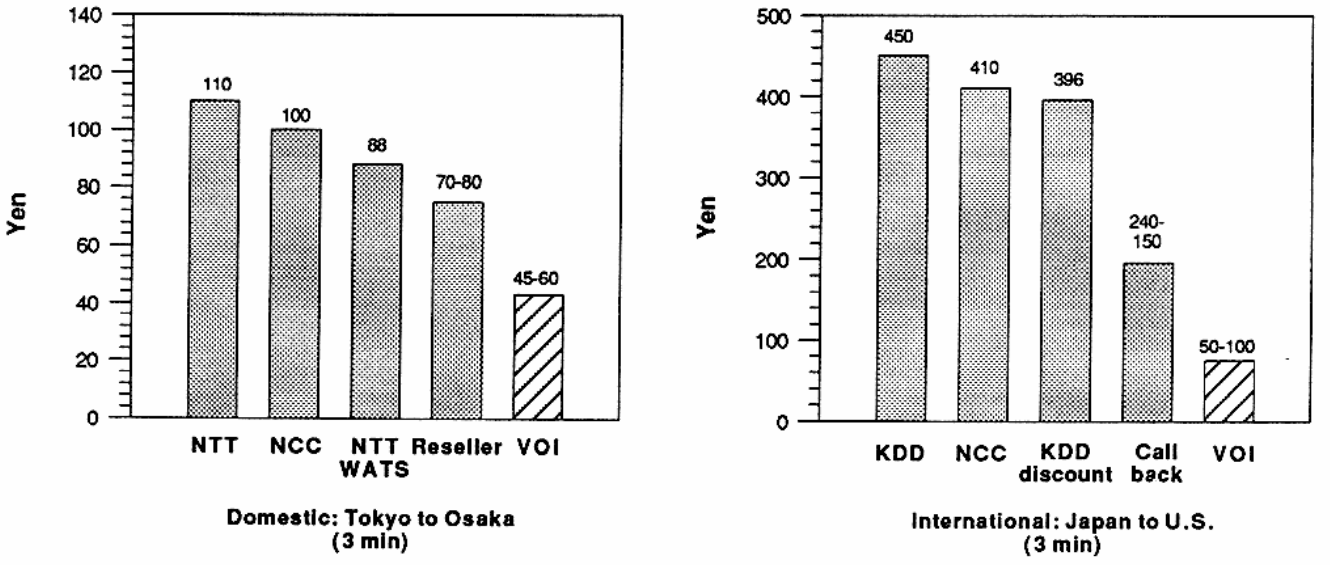

Figure 5-2

VOI Pricing Advantage in Japan
(as of January 1997)

5.3 Arguments Regarding VOI

In Japan, unlike in the United States, arguments regarding VOI have been few: no coalition, no body has filed a petition with the MPT.[20] Carriers have only looked at VOI to see when and whether to enter that market.[21] The reasons probably are that there are few developers in Japan and that phone-to-phone VOI services began to be provided only in April

[20]But see "KDD and Two Other Companies Filed Petition with MPT to Prohibit Some Methods of Call-Back," *Asahi Shinbun*, Jan. 19, 1997, 11.

[21]See T.Kikuchi, Table 1-1, "The Responses of Carriers to VOI," in "Power of VOI" (Internet Denwa no Iryuko), *Nikkei Communications* (Nov. 4, 1996), 94.

1997. Even though these providers have a price advantage, customers using this service are limited because the service has only limited access and destination points.

Part Three

The Future of VOI

Chapter Six

Issues Involved in Wide Use of VOI

In a speech at the "Telecom 95" Conference, in Geneva, Switzerland, in October 1995, Christian Huitema, an architect of the Internet, said, "There is no need for the telephone. The Internet will be the communication network in the twenty-first century."[1]

Will the Internet replace the PSTN in the next century? Since it was commercialized, for some data transmissions the Internet has indeed replaced the PSTN. Even for voice transmission, the Internet has begun to challenge more traditional methods of communication. Other real-time communications, such as video, also are trying to transmit via the Internet. According to Edward R. Cozel, senior vice-president and chief technical officer of Cisco Systems, "1997 will be a year when companies use the Internet practically. The Internet will have a greater role as communication tool than today. All communication will be realized on the Internet."[2]

Will the Internet integrate all services? Will the Internet come to be used generally instead of the PSTN for both real-time and non-real time communication? Whether that will happen depends partly on whether VOI comes to be used broadly. **Part Three** presents a discussion of issues involved in determining whether VOI will broadly be used. These include the Internet in the near future (**Chapter Seven**), regulation (**Chapter Eight**), the viewpoints on VOI and actions of carriers (**Chapter Nine**), ISPs (**Chapter Ten**), vendors (and manufacturers) (**Chapter Eleven**), the future of the present price advantage of VOI (**Chapter Twelve**), and customer needs (**Chapter Thirteen**).

Whether phone-to-phone VOI will eliminate two-stage dialling, thus making VOI easier to use and therefore more attractive, is a regulatory and technical matter beyond the scope of this report.

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[1]*Nikkei Sangyou*, Jan. 17, 1997. (Translation by the author.)

[2]*Nikkei Communications*, March 3, 1997, 90. (Translation by the author.)

Chapter Seven

Real-Time Communication over the Internet

This chapter focuses on quality of service (QoS) in VOI, which will determine whether people will use VOI, as will the challenge for developers to provide VOI with QoS on the Internet.

As discussed in **Chapter Two**, the Internet provides only one level of service, which has been called "best effort." This service is suitable for applications for which delays are not critical. For other applications, however, such as real-time audio and video, best-effort is not good enough, because real-time transmission is important. Something better is needed.

VOI is cheaper than ordinary telephone, resale, or call-back. Once users no longer see VOI as a novelty, they will pay more attention to its quality, particularly business users, who will judge the quality of both voice and reliability. The question is, what can be done to improve them—that is, can an IP network transmit voice without delay and with high quality? According to Internet phone analyst Jeff Pulver:

> Voice performance is gauged by measuring delay. Calls on the [PSTN] usually exhibit a 50- to 70-millisecond delay [which] increases substantially on the Internet, where it typically ranges from 500 milliseconds to 1.5 seconds ([and more] when it comes to voice traffic).[1]

"[S]lowdowns on a corporate Intranet (where traffic is transmitted over a single carrier's network) range 70 to 120 milliseconds," Pulver continued. The delay comes from processing voice coding and packaging in the PC or at the gateway and from the architecture of the Internet. According to Alon Cohen, "Even though the problems are addressed through continually improving compression algorithms, and new networking and routing technologies, many factors of the public network in the short term are outside the control of the application developers."[2]

The Internet can become congested, and network congestion affects the quality of voice. The remedy is development of both real-time VOI applications (see **Chapter Three**) and, as discussed in this chapter, a new network architecture, a new protocol, and new routing, to address the congestion itself.

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[1]Quoted by Robin Gareiss, "Voice Over the Internet," *Data Communications* (September 1996), 98.

[2]Telephone interview by the author with Alon Cohen, Director and Chief Technology Officer, VocalTec, March 17, 1997.

7.1 Attempts to Support Real-Time Applications on the Internet

As said in the previous section, the Internet originally offered only best-effort service: it attempted to deliver packets as quickly as possible but with no guarantee of delivery or of delivery without delay. The FIFO packet scheduling algorithm (see section **2.2.3**) allows the first packet that arrives at a network switch to be the first one sent. The network cannot prevent overloads by refusing service. When it becomes overloaded, delays increase and packets are dropped.

VOI applications have fundamental bandwidth and delay requirements. VOI cannot tolerate delay. If the transmission is reasonably steady, the receiver side will be able to depacketize and play back an undistorted voice, but when the network is congested, quality drops. To overcome this shortcoming, the traditional scheduling algorithm of packet switches, FIFO, needs to be changed.

There have been many attempts to support real-time applications such as voice and video on the Internet. A number of working groups have been trying to make an integrated services Internet, i.e., an Internet with a range of qualities of service to support both real-time and non-real-time applications. The following working groups, whose efforts are discussed below, have been dealing with the areas shown:[3]

- The Integrated Services (int-serv) group: a new IP service model, including a set of services suited to real-time applications (sections **7.1.1** and **7.1.2**);

- The Resource ReSerVation Protocol (RSVP) group: a resource reservation protocol, by which the appropriate service for an application can be requested from the network (section **7.1.3**);

- The Internet Stream Protocol V2 group (ST-II) group: upgrading a stream-oriented Internet protocol that provides a range of service qualities (section **7.1.4**); and

- The IETF IP over ATM (asynchronous transfer mode) working group (section **7.1.5**).

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[3]See Marty Borden, Eric S. Crawley, Bruce S. Davie, and Stephen G. Batsell, "Integration of Real-time Service in an IP-ATM Network Architecture," Network Working Group, RFC 1821 [3-4]. [On-line]. URL: <andrew2.andrew.cmu.edu/rfc/rfc1821.html> Information on working groups used here was drawn from this source.

7.1.1 New Network Architecture: Integrated Services Architecture (ISA)

The following passages, quoted from "Real-Time Services for Router Nets," by Fred Baker, of Cisco Systems (unless otherwise indicated),[4] offer information about integrated services architecture.

The traditional Internet as TCP/IP provides no service guarantees whatever.

> The IETF has been developing the ISA, a suite of standards, that permits networks to provide QoS transport over IP nets. ISA can be implemented through advanced congestion management and queuing algorithms that limit delay, jitter, and bandwidth consumption in the network. It also includes protocols, such as the RSVP, which make it possible to reserve bandwidth for particular applications. Together, these capabilities let IP networks handle real-time applications like voice and video.

Implementing the ISA requires making software, and possibly "firmware," upgrades to switches and routers.[5]

According to int-serv, "an important aspect of this working group's charter is in coordination with the development of IP Next Generation."[6]

> The ISA defines two kinds of services, and more are under development. Guaranteed service permits applications to obtain both bandwidth and delay guarantees and assumes that the network (or at least its key points) uses the weighted fair queuing algorithm. Controlled load service makes delays minimal and doesn't require a particular type of queuing. To provide these guarantees, the architecture categorizes traffics into inelastic traffic and elastic traffic. Voice traffic is categorized as inelastic traffic, for which guarantees have to be made.

To identify inelastic traffic, the ISA "builds on the concept of flows, which are like a TCP or a System Network Architecture (SNA) session but with two key differences: it's unidirectional and there can be more than one recipient of a flow. Messages are associated with a particular flow according to their source and destination addresses, port numbers, and protocol types. Inelastic traffic is identifiable by flow."

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[4]Fred Baker, Cisco Systems Inc., "Real-Time Services for Router Nets": "The IETF's integrated services architecture lets IP internetworks handle real-time applications like voice and video" [On-line]. URL: <data.com/Tutorials/Real_Time_Services.html>

[5]Many manufacturers produce switches and routers. Two developments were the Ipsilon network's IP Switching (released March 1996) and Cisco Systems' "Tag Switch" (released September 1996). See section 7.2.2.

[6]Integrated Service (int-serv) Charter [On-line]. URL: <ietf.snri.reston.va.us/html.charters/int-serv-charter.html>

> To provide the service guarantees required for inelastic flows, router and switch software must be modified to handle the flows. The ISA has modified the route-selection procedure and advanced queuing policy and flow admission with a setup protocol. Under the ISA, once a switch or router has determined the destination of the message in the route database, the router also decides if the message is part of a flow. Each flow is associated with a queuing policy, so if the message is part of a flow, the router adjusts queuing to provide the right services for it....
>
> Queuing adjustment is handled by a signaling protocol that communicates information about the flows between routers. The signaling protocol has two main purposes: to ensure that network resources are available to carry the flow and to install a queuing policy that meets its needs....
>
> Defining an effective queuing policy is a key component of the ISA. Today, most switches and routers use first-in-first-out queuing. While simple and speedy, this doesn't perform well when links are congested. There are several ways to resolve this problem. One way of resolving this problem is fair queuing, which calls for the switch to discriminate among traffic flows and to sort them, ensuring that no flow can take over the network link. Fair queuing also makes sure that flows using relatively little bandwidth are guaranteed minimal latency and that flows using more bandwidth can achieve approximately the same throughput, though at the cost of potentially increased latency....
>
> Another way that switches can implement ISA guarantees uses a variant of the Random Early Detection (RED) congestion control mechanism. Although not specifically designed to handle real-time traffic, RED can be extended to provide different service guarantees for different types of traffic. The theory behind RED is that most data-transport schemes are sensitive to loss and will at least momentarily slow down if some of their traffic gets dropped. Extending RED to handle real-time traffic is fairly is as follows: basically, the router simply drops messages at different rates for different flows, depending on their throughput and delay tolerance....
>
> RSVP also implements ISA's admission and QoS architecture. As its name implies, RSVP reserves network bandwidth and installs queuing policy for inelastic flows. If resources are available, the router installs the queuing policy needed to manage the flow and forwards the request to next router along the path.

ISA also works with a number of other protocols developed by such standards bodies as the IETF and ITU-T. The NSF plans a Very High-Speed Backbone Network Service (vBNS). The U.S. government is attempting to establish the Internet II, which will be the infrastructure

for the research and education community, with the intention of decreasing use of the current commercial network by this community of users.[7]

7.1.2 IPv6

IPv6[8] will be one of the key supports for real-time applications on the Internet, according to Lee W. McKnight and Joseph P. Bailey, in whose view QoS on the Internet may be made possible by IPv6:

> While today the Internet only delivers very low-quality video or voice, a future Internet may be able to offer a guaranteed quality of service that is consistent with the public switched telephone network. The capacity of integrated service to offer quality seems likely with development of the new Internet Protocol version 6 (IPv6).[9]

The current version of the IP, IPv4, is sometimes referred to as a "thin layer" because it provides only a small amount of functionality; its best-effort model of delivery does not guarantee whether, when, or how packets will be delivered without error. The best-effort delivery model is not good enough for real-time communication, which requires tight bounds on delay and packet loss. The current protocol has another problem, too: the Internet has grown large and is continuing to grow much faster than the original designers of the IP could have imagined, so that the protocol's usefulness as a primary enabler of interoperability has become increasingly limited. To resolve problems inherent in IPv4 required a new version of the protocol, IPv6, which was approved by the Internet Engineering Steering Group on November 17, 1994, and made a Proposed Standard.[10]

IPv6 has QoS capabilities. The default is current Internet use, sufficient for e-mail and FTP; the nondefault can be used for voice and video. One new capability has enabled labeling packets for special handling, such as nondefault service or real-time service.

There are two fields in the IPv6 header not present in IPv4, the flow label and the priority (see **Figure 7-1**), which were designed to facilitate handling real-time traffic. These fields can be used to identify packets for which a host specifies special handling by IPv6

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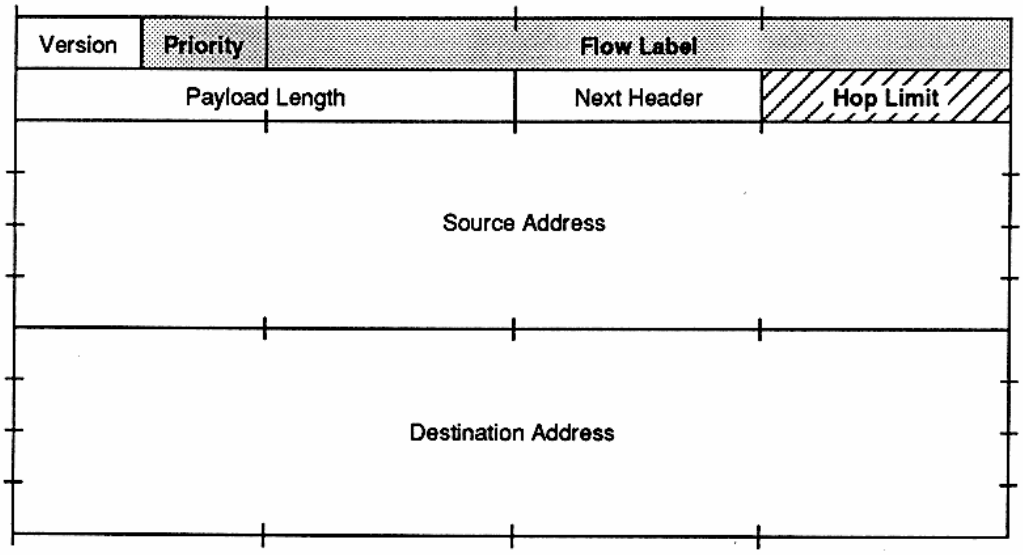
[7]Internet II is designed to provide a variety of services "on demand" in support of advanced applications. See "Internet II and UCNet" [On-line]. URL: <ucsb.edu/detche/library/www/internet2.html>

[8]Robert Hinden, "IP Version 6 Addressing Architecture," RFC.

[9]Lee W. McKnight and Joseph P. Bailey, *Scalable Internet Interconnection Agreements and Integrated Services* (forthcoming). By permission of the authors, extended by Joseph Bailey, e-mail, May 20, 1997.

[10]Robert M. Hinden and Stephen E. Deering, "IPv6: Technical Overview," in *IPng, Internet Protocol Next Generation*, edited by Scott O. Bradner and Allison Mankin (Reading, Mass.: Addison-Wesley, 1996). "IPv6 supports large hierarchical addresses and new routing capabilities which will allow the Internet to continue to grow. IPv6 also provides a platform for new Internet functionality, including support for real-time flows, provider selection, host mobility, end-to-end security, autoconfiguration, and autoreconfiguration" (222).

routers, such as nondefault service, real-time service, or relative priority. With this capability, IPv6 can support multimedia, real-time, and other applications that require some degree of consistent throughput, delay, or jitter.[11] So, IPv6 is significant for its expansion of the service model to "integrated services," adding two new levels above best effort. The top level is "guaranteed service," the second level is "controlled-load service."[12]



Source: Christian Huitema, "Architecture of the Internet," IPv6: The New Internet Protocol © 1996, p. 6. Reprinted by permission of Prentice Hall, Inc., Upper Saddle River, N.J.

Figure 7-1

IPv6 Header

The flow label is used to distinguish packets all of which require the same treatment, that is, they are sent by a given source to a given destination with a given set of options.

> A flow is a sequence of packets sent from a particular source to a particular (unicast or multicast) destination for which the source desires special handling by the intervening routers.[13]

The definition of flow comes implicitly from the definition of flow label itself. A flow is the set of packets that comes from the same source to the same destination and bears the same

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[11]Ibid., 234.

[12]See Susan E. Thomson, "The Fully Operable Internet," *Bellcore Exchange* (Fall 1966), 6-11.

[13]For information on IPv6 labeling of flows in connection with RSVP, see Christian Huitema, *IPv6: The New Internet Protocol* (Upper Saddle River, N.J.: Prentice-Hall PTR, 1996), 127-130.

flow label. Flows are related with priorities, with exception routing, and with setup procedures. Flow labels will be used when the transmission mandates some special treatment, for example, for applications with severe real-time constraints.

There are two ways to support real-time applications in IPv6 (see **Table 7-1**): (1) the reservation procedure and (2) fair queuing.

Table 7-1

Support for Real-Time Applications in IPv6

1. Reservation	• Labelled flows in connection with RSVP • Hop-by-hop option
2. Class-based fair queuing	• Priority label

IPv6 = Internet Protocol version 6
RSVP = Resource ReSerVation Protocol

Reservation procedures, which are important for real-time traffic, aim at creating a special lane, as on a highway, for some well-identified packets. There are two ways to support reservation in IPv6: (1) by IPv6 labeling of flows in connection with RSVP (see section **7.1.3**)[14] and (2) by using a hop-by-hop option of IPv6, in the header of some packets. The routers would remember the associated parameters and associate them with the flow. The flow is uniquely identified by the combination of a source address and a nonzero flow label. Packets that do not belong to a flow are labelled zero. The exact nature of the special handling is conveyed to the intervening routers by a control protocol, such as RSVP, or by information within the flow's packets themselves, e.g., in a hop-by-hop option contained in the header.

Regarding the second way to support real-time applications in IPv6, according to Christian Huitema, "fair queuing may well be a more effective way of sharing network resources than reservations, especially when combined with procedures such as class-based queuing."[15] The basic idea of fair queuing is that packets are classified within queues so that each packet gets the same amount of resources. "The assignment of packets to queues is very similar to the classification of packets in flows when reservations are used. Different implementations may use different classes. Some will set one class per source address; others

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[14]Ibid. See also Huitema, *IPv6: The New Internet Protocol*, 127-130.

[15]Huitema, 131.

will have one class per destination address or one class per TCP connection. But there is no explicit reservation. The policy merely enforces that each user gets a fair share, even if some of them are trying to play foul with the rules."[16]

But users are not all equal. Fair queuing is the effective way of sharing network resources, but fair queuing itself cannot prioritize the users. So, hierarchical coding is used to prioritize packets. "Hierarchical coding enables the applications to prioritize their data so that the most significant bits get dropped last. Hierarchical coding is supported by the drop priority label, which is encoded as a 4-bit integer in the first octet of the IPv6 header."[17] It has 16 possible values. "Values 0 through 7 are used to specify the priority of traffic that 'back off' in response to congestion (i.e. congestion-controlled traffic, such as TCP traffic). Values 8 through 15 are used to specify the priority of traffic that does not back off in response to congestion, (i.e., non-congestion-controlled traffic, e.g., 'real-time' packets being sent at a constant rate)."[18]

According to Huitema, "We have to support real-time applications in the Internet.... We could expect a wide consensus on the inclusion of real-time support in IPv6."[19] But Huitema has also pointed to controversies, in particular on three topics: the usefulness of flow labels, the need to support reservations, and the relation between IPv6 and ATM."[20]

7.1.3 Reserve the Bandwidth: RSVP

One way to realize real-time communication on the Internet is by reserving bandwidth, but when many users use the same network, the bandwidth necessary for VOI is not always guaranteed. To reserve bandwidth, RSVP[21] is useful, because it defines how to route software reserves circuits for a designated transmission. Initially, users will call their ISP to order a circuit between locations with a specified amount of bandwidth; later, when the software has been upgraded, the packets themselves will include flags to indicate that the sender is paying for RSVP priority.

According to an article in *CommunicationsWeek International*:

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[16]Ibid., 133.

[17]Ibid., 135.

[18]Robert M. Hinden and Stephen E. Deering, "IPv6: Technical Overview," in *IPng, Internet Protocol Next Generation*, 235.

[19]Huitema, 136-141.

[20]Ibid., 136-141.

[21]For the specification, see Robert Braden, Lixia Zhang, Steve Berson, Shai Herzog, and Sugih Jamin, "Resource ReServation Protocol (RSVP), Version 1 Functional Specification," edited by Robert Braden [November 1996] [On-line]. URL: <ftp,ietf.org/Internet-drafts/draft-ietf-rsvp-spec-14.txt>

> There is a consensus that RSVP, intended to give quality of service assurances on the public Internet by reserving bandwidth, is far from ready. Network providers, manufactures and engineers say there are shortcomings in the protocol's specifications, such as limited scalability and inefficient multicasting capabilities. Additionally, Internet service providers (ISPs) are struggling to devise charging models.... The outcome is that the Resource Reservation Protocol may remain an offering restricted to single networks, such as Intranets, until the problems are resolved and the protocol makes it onto the public network as originally envisioned.[22]

In 1996, Japan Cisco and Hitachi together experimented on the effect of RSVP[23] and found it was to address the delay of voice-packet transmission. Parameters were set in advance to maintain bandwidth, because to date there is no function that can set bandwidth for the router from the PC or terminal.

UUnet Technologies, an ISP in the United States, also tested RSVP and concluded that it is difficult to use on the Internet, for the following reasons: (1) RSVP must be set in advance for the router, and (2) it cannot change for each application (e.g., e-mail, voice, FTP); (3) moreover, the use of RSVP adds to the already large burden on the Internet backbone.[24]

RSVP has defects that make it unsuitable for commercial use: one technical defect is that it cannot handle a lot of traffic; one nontechnical defect is that it is hard to set a price for service that uses RSVP. ISPs have been struggling to devise price models. The consensus thus far is that RSVP may remain an offering restricted to single networks, such as Intranets, because of the limited scalability and inefficient multicasting capabilities and lack of charging models. According to Michael Myjak, senior research scientist at the University of Central Florida, in Orlando, "the protocol limits the maximum number of simultaneous flows to 2,300, meaning users can be blocked from getting allocated bandwidth—not because the network is clogged but because of shortcomings in the RSVP process."[25] This shortcoming gives rise to the question, how can priorities among users be set? It remains to be answered. According to David Clark, who works on RSVP at the Lab for Computer Science at MIT,

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[22]Kenneth Cukier, "Internet Quality Protocol Still Flawed—There Is a Mismatch Between Expectation and Reality," *CommunicationsWeek International* (Jan. 20, 1997), 16.

[23]T. Kikuchi, "RSVP by Router Is Now Coming into Practical Use, Cisco and Hitachi Confirm Its Effect on Voice Transmission," *Nikkei Communications* (March 3, 1997), 88.

[24]"One More Internet," *Nikkei Communications* (Oct. 7, 1996), 80.

[25]Clark quoted in Cukier, "Internet Quality Protocol Still Flawed...."

"the problem lies in the routers, which need significant amounts of memory to classify and handle the special RSVP packets."[26]

Although RSVP can be used for an Intranet, to ensure the bandwidth the company needs, provision of commercial service using this protocol continues to be discussed. Because RSVP can provide a higher level of service, ISPs would like to bill by level of service: they would charge less for low-priority transmissions that can tolerate delay and more for higher priority transmissions. For example, the lowest level of service is for e-mail, the next one up is for FTP, and the last, the highest priority, is for real-time communication. But the problem of pricing models, that is, determining how to bill—"who gets paid and how"—is difficult and beyond the scope of technology, and has still to be worked out. To provide RSVP, many ISPs function in the following way.Traffic travels many networks (see **Figure 7-2**). For example, a user whose provider is an ISP could request the highest level of service from city A to city B. To get to city B, the traffic might travel through networks owned by ISPs X, Y, and Z, because each network must guarantee the requested bandwidth in order to establish the connection. To simplify, ISP A provides its services but only when ISPs B and C (or any of many others available) can guarantee the bandwidth. This goes beyond technology.

According to Joseph P. Bailey, the rough idea is that ISP-A gets paid and then shares the payment with the other ISPs.[27] And according to Jordan Becker, vice-president for network service at Advanced Network and Services (ANS), "[ANS]'ll start tailoring pricing to reflect the type of traffic being transmitted once we can figure out how to discriminate." As of the end of 1996, there were no ISPs in the United States that provide service using RSVP. Until a billing mechanism can be worked out, service classes on the Internet will not be available either for public service or for residential customers.

Corporate Intranets are another matter. Because Internet traffic travels over one network, providers have control of the service levels from end to end and can bill accordingly. Thus, some ISPs, such as ANS, BBN, MCI, Sprint, and Japan KDD, plan to offer Intranet services based on RSVP (see **Chapter Ten**).

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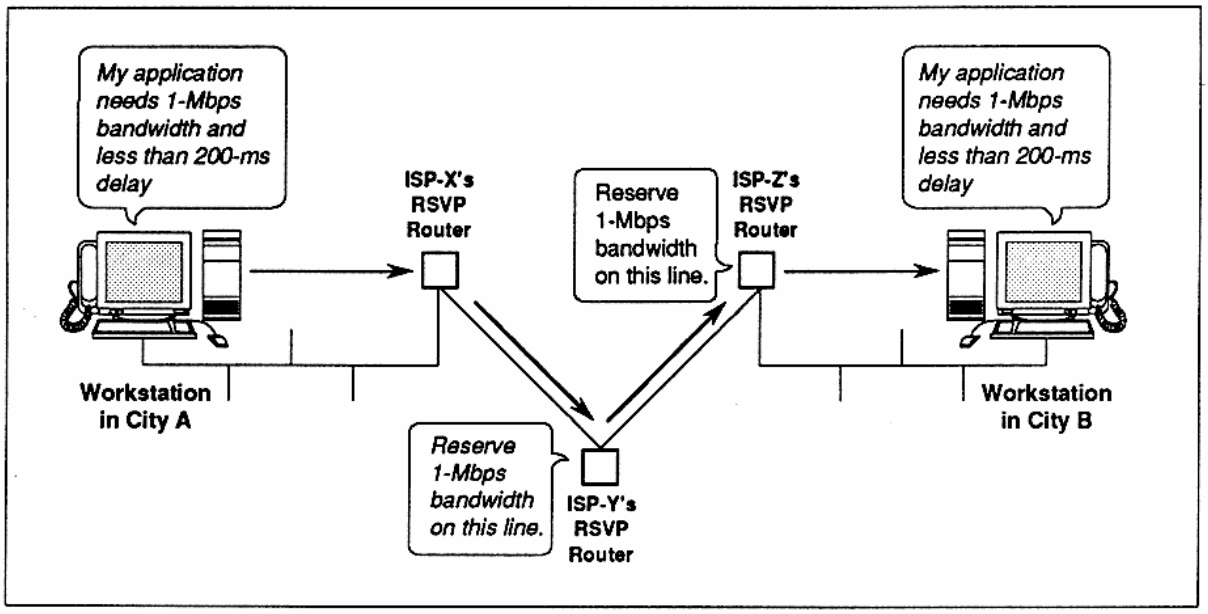
[26]Ibid.

[27]According to Anthony G. Oettinger, in a conversation with the author (March 1997), there are "precedents in railroads, traditional phone companies, etc." For a detailed analysis, see McKnight and Bailey.



ISP = Internet service provider
Mbps = megabits per second
ms = milliseconds
RSVP = Resource ReSerVation Protocol

Source: Adapted from "Resource Reservation Protocol (RSVP)" in "RSVP for the Multimedia Party," Cisco 10S [On-line]. URL: <cisco.com/warp/public/724/4.html>

Figure 7-2

RSVP

7.1.4 Internet Stream Protocol Version 2 (ST-2)

The Internet Stream Protocol Version 2[28] is an experimental resource reservation protocol intended to provide end-to-end real-time guarantees over the Internet. It allows applications to build multidestination simplex data stream with desired quality of service.

7.1.5 IP Over ATM

The IETF has been working on developing an integrated service model, designed to support real-time services on the Internet. At the same time, the ATM Forum has been developing ATM networking, which similarly provides real-time networking support.[29] ATM on the Internet is already being used as a link layer protocol. Both the IETF and the ATM

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[28]See RFC 1819. ST2 Working Group [IETF], "Internet Stream Protocol Version 2 (ST2) Protocol Specification—Version ST2+," edited by L. Delgrossi and L. Berger [On-line]. The specification can be downloaded. URL: <intermic.net.rfc/rfc1819.txt>

[29]Borden, Crawley, Davie, and Batsell. RFC 1821 provides a clear statement of what issues need to be addressed in interfacing the IP integrated service environment with an ATM service environment. RFC 1932, "IP over ATM: A Framework Document," is a summary of working group documents.

Forum are producing specifications for IP over ATM, in an attempt to create a seamless interface between the two in support of end-users desiring real-time networking services. Both groups are exploring how an Internet with real-time service capacity might make most effective use of ATM networks.

7.2 Controlling Congestion: Reliability of the Internet

Packet delay comes from network congestion—congestion of the Internet backbones (see sections **7.2.1–7.2.3**) and congestion of the PSTN (sections **7.2.4–7.2.5**). This section discusses only a technical way to control congestion (another way is pricing control; see **Chapter Twelve**).

7.2.1 Speed Up the Backbone Network

For real-time communication, speeding up the network is necessary to address the problem of network routing delay. The bandwidths of backbone networks are rapidly growing larger. In the United States

> [t]he size of the [Internet] backbone is constantly growing. In 1991, the NSFNet backbone consisted of T-1 (1.5 Mbps) lines, which were the highest-capacity lines used for the Internet at that time. In the early 1990s, this backbone was upgraded to T-3 speeds (45 Mbps), and now several commercial T-3 networks cover the United States. Even 45 Mbps may soon seem slow, as MCI has installed OC-3 (155 Mbps) lines on both its own U.S. network and the vBNS network it operates for the National Science Foundation. In June 1996, MCI announced plans to upgrade its commercial network to OC-12 (622 Mbps).
>
> A recent initiative to improve bandwidth is the Internet Railroad, part of the Internet 1996 World Exposition. The Railroad's stated goal is to build "a backbone circling the world at 45 Mbps."[30]

UUnet Technologies also is planning to upgrade its network and operate a nationwide 622-Mbps Internet backbone network.[31]

In Japan, too, Internet backbone service providers are planning to upgrade. According to *Nikkei Communications*,[32] as of July 1996, there were only three 45-Mbps backbones between the United States and Japan, but by mid-1997 there are expected to be thirteen 45-

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[30]Zachary M. Schrag, Box 2, "High-Speed Internet Backbones, 1995-96," *TeleGeography* (Washington, D.C.: TeleGeography, 1996), 53.

[31]John Rendleman, "UUnet Plans Ahead, Upgrades Network with 622-Mbps Transmission Technology," *CommunicationsWeek International* (March 3, 1997), 33.

[32]"Examine, Internet Infrastructure in Japan" (Kenshou, Nihon no Internet Infra), *Nikkei Communications* (Aug. 5, 1996), 72-103.

Mbps backbones, for a total of 585 Mbps. By setting a new network access point, the maximum ISP capacity will increase from 1.5 Mbps to 45 Mbps.

7.2.2 Upgrade Routers

The use of many routers cannot by itself speed up Internet transmission, because each router checks each packet for where it should be delivered. Router vendors and manufacturers and IP-switch vendors and manufacturers are competing to provide solutions for ISPs in forms that can match public demand. Speeding up the delivery of packets requires ATM switches, instead of multiple routers. (ATM is a good way to create a backbone by OC-3 [155 Mbps] and OC-12 [622 Mbps] circuits between major traffic centers.)

For example, the Ipsilon network developed IP Switching, which allows ATM switches to do IP routing, was released in March 1996. The IP switch allows high-speed data transmission by changing the nature of router transactions. Usually, routers transact with each packet, but the IP switch omits this transaction for succeeding packets. By checking only the first packet in a row and allowing succeeding packets to follow the first, IP switching can make high-speed transmission possible.

Cisco Systems released its "Tag Switch" software in September 1996. The tag-switching technique allows ISPs to identify, prioritize, and route traffic by prearranged routines. If successful, it will enhance QoS guarantees. The software can be installed into current routers and can manage another protocol, so it can be used in frame relay, Intranets, and backbones. A high-performance router, called a "gigarouter," is expected to appear in 1997: the StataCom BPX will be used for ISPs; LightStream 1010 for Intranets; and Cisco 7500 for the main backbone.[33]

7.2.3 Bypass Network Access Points (NAPs)

Another way of addressing network delay is by bypassing the congestion at network access points. Because congestion of Internet backbones results largely from the shared, decentralized nature of the Internet, network delay occurs owing to slow-speed circuits in a network. The Internet is composed of thousands of individual networks, each linked at one or more NAP, where high-capacity routers pass traffic from one net to another. The trouble is that NAPs are "hot spots" for congestion.

One solution is to optimize backbone design by bypassing the NAPs and thus reducing the number of routers that packets must transit. Many ISPs have established private connections with one another, and consolidation of the infrastructure would enable the

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[33]*Nikkei Communications* (Oct. 7, 1996), 64-65.

reduction of many small routers to fewer "mega" routers, which would be better maintained and controlled by larger telcos rather than by the many small providers available at present.[34] Large ISPs have begun to provide their own IP networks, which are separate from the Internet, and by doing this they are differentiating their networks from others (see **Chapter Ten**).

In Japan, NTT and IIJ (one of the large ISPs) have announced that they are planning together to provide NAP services, which means an effort to change the flow of the contents of the network. They plan to set the contents server at their own access point and let the contents concentrate at that server. The contents server will be connected to ISPs with high-speed lines. The experiment is expected to begin in June 1997.[35]

7.2.4 Control Congestion on the PSTN

In reports filed with the FCC in 1996, the RBOCs, also sometimes called "baby Bells," and independent local telephone companies claimed that congestion from the Internet was damaging their voice network systems. Addressing the problem of congestion, Amir Atai, Bellcore's director of network traffic and performance, said that congestion occurs in two places, at the access portion of the network and at the trunking lines. Atai suggested that the following solutions might be useful for the short or medium term:

Access Solutions
- Manage the way it's done now [1996] (short-term).
- Promote ISDN with packet services (short- to medium-term).
- Screen calls before they reach the switch (medium-term).

Trunk Solutions
- Manage the way it's done now (short-term).
- Route calls where they can be handled (short-term).
- Offer ISP a modem pool in the central office (short-term).[36]

According to Atai, "In the medium to long term, the Internet congestion problem may be relieved by development and convergence in the general telecommunications infrastructure."[37]

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[34]Telephone interview by the author with Alon Cohen, March 17, 1997.

[35]"NTT and ITJ Begin to Provide Interconnection Services to Remove Internet Congestion," *Nihon Keizai Shinbun*, April, 10, 1997, 11.

[36]Amir Atai, "Too Much of a Good Thing," *Bellcore Exchange* (Fall 1996), 4-6.

[37]Ibid.

7.2.5 Speed Up Access to the Net

Speed of access to the Internet defines the quality of VOI. Customer access bottlenecks occur because of the limitations of dial-up modems, which can be resolved by high-speed cable modems or other digital access services. Using an asynchronous digital subscriber line (ADSL) is one solution. ADSL technology allows a PSTN to be used as a high-speed data communications network. Modems attached to twisted-pair copper wiring can transmit 1.5 Mbps–9 Mbps downstream (to the subscriber) and 16 kbps–640 kbps upstream (to the Internet), depending on the distance of the line. Speed downstream is much faster than upstream, in order to let the customer download items, such as software files, from the Internet at high speed or for video on demand. ADSL has a limitation: the longest transmission distance is only several kilometers. ADSL allows users not only to use ordinary telephone lines and telephone equipment they have but also to use telephone and data communications at the same time. It also protects carriers from needing to change their networks from copper to optical fiber.

LECs are expected to begin Internet access service using ADSL in 1997.[38] ISPs are eager to use xDSL, particularly providers that want to differentiate themselves from other ISPs and sell the lines to their customers, for example, by saying, as Tom Simonds, president of InterAccess said, "this service is cheap T1 [1.5 Mbps] access, but it's not going to have the quality or reliability of a regular T1 line."[39]

> While local telephone companies continue testing Digital Subscriber Line technology, Internet service providers are pushing ahead to deploy the technology, using "dry" copper lines leased from a telephone company to give there customers access at speeds up to 1.5 megabits per second. The ISPs lease only the copper wire from the telephone companies and use their electronic equipment to provide the signal.[40]

But ISPs need to figure out how to charge for ADSL service.[41]

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[38]According to *Inter@ctive Week* ([Jan. 22, 1997], 8), "U S West had been testing ADSL systems from Westell Technologies Inc., but has decided to wait until the next generation of ADSL systems, which will have the ability to adjust transmission rates to available bandwidth, come onto the market later this year."

[39]Quoted in Carol Wilson, "ISPs Taking The xDSL Lead," *Inter@ctive Week* (Feb. 17, 1997), 33.

[40]Ibid.

[41]According to *CommunicationsWeek International*, Signet Partners (based in Austin, Texas) will be among the first ISPs to offer commercial ADSL. Signet buys copper lines from local telephone companies and resells them at $20 a month. The lines terminate at Signet's point of presence and attaches ADSL manufactured by Netspeed at both ends of the line. The price planned is $1,295. One trial user was quoted in *Inter@ctive Week* (ibid.) as saying, "$1,295? Good Luck!" suggesting that users do not yet find the prices acceptable.

DataQuest estimated that the number of users of ADSL will surpass that for those using ISDN or CATV high-speed data communications services. Another research company said that 56-kbps modems will probably be used most.

In Japan, NTT announced that it "has already used high-speed digital subscriber lines (HDSL) for high-speed digital, but, regarding ADSL, NTT is now evaluating its technical feasibility. So far, our consideration is Positive, but we are continuing to investigate it. If we use ADSL, we will offer it for commercial service. We don't think we will sell subscriber lines as they are."[42]

There are many ways to access the Internet at high speed: the integrated services digital network (ISDN)—DSL, I-DSL, HDSL—CATV, and satellite; see **Table 7-2**.[43]

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[42]*Nikkei Communications* (March 3, 1997), 85, quoting Kazuaki Katori, director of the OCN department, in remarks at the NET & COM '97 Conference, Makuhari messe, Chiba Prefecture, Japan, Feb. 14, 1997, in the session on "The Future of the Internet." (Translation by the author.)

[43]AT&T's new (1997) fixed wireless service provides two phone lines and high-speed Internet access to a customer's site at a transmission rate of 128 kbps total capacity and 16 kbps per customer. See John Rendleman, "AT&T Wireless Links to Bypass Telcos," *Internet Week*, March 3, 1997.

Table 7-2

Methods of Internet Access

Description of Method	Analog Modems	ISDN	xDSL	Cable Modem	Satellite	Wireless Cable
Speed	14.4–33.6 kbps	64–128 kbps	1.5–6 Mbps downstream/64 kbps–1.5 Mbps upstream (future: 26–52 Mbps downstream/2–6 Mbps upstream)	Up to 10 Mbps (possibly higher) downstream; (shared)/2 Mbps upstream	12 Mbps downstream; analog modem upstream	128 kbps (practical limit)
Suitability	E-mail, FTP, text-based Web sites	Text-based applications, graphical interfaces, low-resolution video	Text, graphics, and full-motion video of VCR quality, possibly higher (~HDTV?) later	Text, graphics, and full-motion video; but quality may depend on number of users	Full-motion video of VCR quality if bw continuously available	Text-based applications, graphical interfaces, low-resolution video
Development status	OTS; plug into POTS network	OTS; special line needed; configuration sometimes difficult	Development originally for video-on-demand and interactive television; designed for integration into existing telco plant	Requires rebuilding of CATV plant; estimated that between 1996 and 2004, 58,300,000 CATV homes will be capable of using cable modems	Capability engineered into DBS system	Can be delivered with existing analog system; effective bw utlization requires digital broadcasting
Equipment	OTS, robust, reliable	OTS	Second-generation commercial equipment available; designed to use POTS line with special equipment at each end	Second-generation equipment available; several manufacturers working on second-generation equipment	Requires DBS system (COTS) plus computer adapter (COTS)	Technology similar to cable modems; first-generation equipment available
Deployment plans and problems	Wherever analog line available	Available in most metropolitan areas; coverage ~75% of U.S.	Text and evaluation sites only. GTE: Dallas; Bell Atlantic: Northern Va.; U S West: Denver; large number of users would require deployment of large high-speed switches	Test and evaluation sites only, including Jones Cable, Alexandria, Va.	Available from Hughes Network Systems	Trial being conducted by CAI Wireless
Price	$100 to $200 + $5–$10/mo	$500 + $30–$50/mo	$2000 + $60/mo declining to $30/mo	$650 to $750 + $20/mo	$699 +$15.95/mo for first 30 Mbytes; 80¢/Mbyte beyond that	Not determined but probably about $400 + $20/mo
Issues	Higher speeds unlikely, 28.8 marginal in some locations	Pricing	May undecut telco pricing on T1 and other digital services; liable to undermine ISDN	Unclear whether CATV providers can justify huge expense of rebuilding plant	Number of users that could be served simultaneously	Number of users that could be served simultaneously
Widespread availability	Now	Now	1–2 years	2–4 years	Now	2–3 years

bw = bandwidth
CATV = cable TV
COTS = commercial off-the-shelf
DBS = direct broadcast satellite
FTP = file transfer protocol
ISDN = integrated services digital network
Kbps = kilobytes per second
Mbps = megabits per second
OTS = off the shelf
POTS = plain old telephone service
T1 = large-capacity telecommunication for digital transfer
xDSL = digital subscriber line

Source: Table 1: Thomas B. Fowler, "Comparison of Internet Access Methods," Internet Access and Pricing: Sorting Out the Options," *Telecommunications*, Feb. 1997, 68.

Chapter Eight

Regulation

Will VOI be regulated in the same way as the telecommunications carriers (see FCC 96-488 sections 203 and 214)? Will VOI providers need to pay an access charge (FCC 96-488 Common Carrier Docket Number 96-263)? These questions have been hotly argued since March 4, 1996, when ACTA filed a petition with the FCC to regulate VOI (see **Chapter Four**). As of early 1997, VOI providers have been categorized as ESPs and have not yet come under FCC regulation. They do not need to file a tariff and they are exempt from paying an access charge. In its petition, ACTA argued that this situation led to unfair competition. How the FCC will deal with these issues will affect the price of access to the Internet and both the price and use of VOI.

Before discussing the FCC's point of view, it is useful, first, to discuss the access charge (looked at briefly in **Chapter Four**) and, then, to summarize the arguments about regulation: the RBOCs have claimed that the congestion on their networks is due to traffic on the Internet, and they have requested that the ISPs be asked to pay them an access charge, which would allow the RBOCs to upgrade their networks. The RBOCs filed with the FCC regarding the access charge by showing how their networks become congested by heavy Internet traffic.[1] In response, the ISPs filed with the FCC to say that the Internet does not damage the LECs and argued that the imposition of an access charge would have a negative effect on economic growth:

> ...four BOCs [Bell Atlantic, NYNEX, U S West, Pacific Telesis] have filed studies in recent months [June–July 1996] purporting to show that the current pricing structure for Internet access contributes to the congestion of incumbent LEC networks. The BOCs claim that Internet users typically stay on the line far longer than voice users, but that the flat monthly rates Internet service providers pay to incumbent LECs do not cover the additional cost of network upgrades that are required to support such traffic.
>
> In response, information service providers argue that the rates they pay to incumbent LECs, combined with the additional revenues from sources such as second lines installed for Internet usage, more than cover the costs they impose on their network. These parties also argue

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[1]Pacific Bell, for example, reported congestion on the Internet. PacBell looked at eleven switches in neighborhoods where Internet surfing is popular; 3 percent of the lines were used for 30 percent of the traffic; 1 in 6 calls failed. The number of Internet users is growing rapidly, and even though there are still fewer users for the Internet than for the PSTN, usage style on the Internet differs from that on the PSTN. According to Bellcore research, the average connection time is about 3 minutes for ordinary telephone, but for the Internet it is on the order of 20 minutes. Qualitatively and quantitatively, Internet traffic is different from voice traffic. See Amir Atai, "Too Much of a Good Thing," *Bellcore Exchange* (Fall 1996), 2.

> that the imposition of access charges would stifle growth, investment, and innovation in information services, causing detrimental effects for the economy and U.S. competitiveness.[2]

The RBOCs have said that to address the problem of congestion they must upgrade their networks, and, to help with the cost of upgrading, they are asking the ISPs, whose traffic the RBOCs bear, to pay access charges. But about this there is a lot of argument. MCI, for example, has argued that the cost for upgrading their networks shown by the RBOCs is exaggerated. Some have said that it is very strange to ask others—the ISPs in this case—to pay the costs of upgrading their own networks.[3] Most of the RBOCs have entered the ISP market, which it would seem they would not do if there were congestion in it. So, ISPs have claimed that the RBOCs appear two-faced.

Tables 8-1 and **8-2** summarize the positions taken by various groups.

Concerning the first issue, whether VOI should be regulated in the same way as telecommunications carriers, the FCC wrote the following:

> We seek comment on whether we should distinguish between different categories of information or enhanced services. In addition, several companies now provide software that allows a voice conversation to be conducted over the Internet. Such "Internet telephony" allows what appears to be a basic service—voice transmission—to take place over a packet-switched interactive data network that we have traditionally considered to be an enhanced service. We seek comment on how new services such as Internet telephony, as well as real-time streaming audio and video services over the Internet, should affect our analysis. (Para. 316)

In a footnote, the FCC added that "We plan to address the legal questions about Internet telephony raised in the *ACTA Petition*, and broader issues about the continued viability of our basic/enhanced dichotomy, in separate proceedings."

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[2]FCC 96-488, § VIII.B, Treatment of Interstate Information Services, para. 286-287. Further references to FCC 96-488 will be indicated by paragraph number and included in the text.

[3]MCI claimed that the RBOCs exaggerated the cost of upgrading their networks to handle the growth of Internet traffic. It claimed that although Pacific Bell said it would spend U.S. $25 million to U.S. $100 million to upgrade sixteen switching facilities, the switch that takes Internet traffic off the voice switch and routes it into data traffic costs something in the neighborhood of U.S. $5,000. MCI also said that even if the cost were $25 million, that would be a small percentage of Pacific Bell's capital budget of $1.5 billion. "MCI: Bells Inflate Costs," *Inter@ctive Week* (Nov.18, 1996), 8.

Table 8-1

Should VOI Software Vendors and ESPs Be Regulated under FCC 96-488 Sections 203 and 214?

Telecommunications Associations	Position
ACTA	Should be regulated.
NTCA	Software vendors should not be regulated: they may not be covered by the definition of "providers." But ESPs should be regulated, because Internet access services and other service providers are.
NTIA	Should not be regulated. Has evaluated nonregulation and insists it should be continued. Recommends postponing decision to regulate these services until harm to consumers or to the public interest becomes apparent.
Other Carriers	ESPs need not be regulated because they are not telecommunications carriers, but they should pay access charge.
USTA	ESPs should be regulated. Sees them as telecommunications service providers.
VON	Because they are not telecommunications carriers, they need not be regulated. They sell products and do not provide telecommunications services.

ACTA = American Carriers Telecommunications Association
NTCA = National Telephone Cooperative Association
NTIA = National Telecommunications and Information Administration
USTA = U.S. Telephone Association
VON = Voice on the Net

Regarding the second issue, whether to permit incumbent LECs to assess the interstate access charge on information service providers, the FCC offered a tentative answer,[4] and asked for comments.[5] In FCC 96-488, § VIII.B, it tentatively concluded that "information service providers should not be subject to interstate access charges as currently constituted" (Para. 288). To date, the FCC has not changed its stance, as was shown by the 1983 Access Charge Reconsider Order, when the FCC decided that "although ESPs may use incumbent LEC facilities to originate and terminate interstate calls, ESPs should not be required to pay interstate access charges." It gave the following reason for this decision:

> ...the existing access charge system includes non-cost-based rates and inefficient rate structures. We see no reason to extend this regime to an

[4]FCC 96-488 § VIII.B, Treatment of Interstate Information Services, Paras. 282-292.

[5]FCC 96-488 § X, Notice of Inquiry on Implications of Information Service and Internet Usage, paras. 311-318.

additional class of users, especially given the potentially detrimental effects on the growth of the still-evolving information services industry. Although our original decision in 1983 to treat ESPs as end users rather than carriers was explained as a temporary exemption, we tentatively conclude that the current pricing structure should not be changed so long as the existing access charge system remains in place. The mere fact that providers of information services use incumbent LEC networks to receive calls from their customers does not mean that such providers should be subject to an interstate regulatory system designed for circuit-switched interexchange voice telephony. We seek comment on this tentative conclusion. (Para. 288)

Table 8-2

Should ESPs, Historically Exempt from Paying Network Access Charges, Continue Exempt?

Telecommunications Associations	Position
ACTA	Should pay access charges.
IAC	Need not pay access charges, because Internet access has no affect on local telephone companies' revenues. Congestion on telephone lines creates demand for second phone lines, offsetting cost of carrying traffic.
IXCs	Should pay access charges; should not continue exempt.
NTCA	Should pay access charges. LECs, IXCs, subscribers, and customers should not have to bear cost associated with "free service" over the Internet.
RBOCs	Should pay access charges. FCC should rescind "temporary" exemption, because commercialization of the Internet has created costly problems on the voice network. If ISPs are not charged extra fees, regular telephone users will bear financial burden of network upgrades to accommodate data traffic.
USTA	Should pay access charges. ESP industry has matured remarkably. ESPs should be required to contribute to universal service funding mechanism.
VON	Need not pay access charges. FCC should not change its position.

ACTA = American Carriers Telecomminications Association
FCC = Federal Communications Commission
IAC = Internet Access Coalition
IXCs = interexchange carriers
LECs= local exchange carriers
NTCA = National Telephone Cooperative Association
RBOCs = regional Bell operating companies
USTA = U.S. Telephone Association
VON = voice on the Net

The FCC evaluated the ESPs' exemption from access charges, reasoning as follows:

> It is extremely likely that, had per-minute interstate access rates applied to ESPs over the past 13 years, the Internet and other information services would not have developed to the extent they have today—and indeed may not have developed commercially at all. (Para. 285)

The FCC also evaluated the effects of both the information services, such as the Internet and other interactive computer networks, and its own ruling. "Such new services create significant benefits for the economy and the American people." (Para. 282) "Therefore, as part of this comprehensive proceeding, we must consider how our rules can provide incentives for investment and innovation in the underlying networks that support the Internet and other information services." (Para. 283)

So, even if, at some later point, the FCC were to request that the ESPs pay something to the LECs, it would still want to consider the effect of that request on the growth of the Internet. For example, in November 1996, it established the Network Reliability and Interoperability Council (NRIC), as an advisory committee of industry representatives organized to advise the FCC and to look into the effects of Internet usage on the PSTN.[6] The FCC requested comments in order to examine various fundamental issues about the implications of usage of the PSTN by information service and Internet access providers:

- The FCC asked to for technical ways to address congestion, e.g., ADSL and wireless. (Para. 313)

- It requested comment on regulatory barriers. (Para. 314)

- It requested comment on the effects of the current system on network usage, incumbent LEC cost-recovery, and the development of the information services marketplace, and asked for data to be submitted. (Para. 315)

- It requested comment on the current division between basic and enhanced services, and between enhanced service and information service. (Para. 316)

- It introduced the NRIC (see FCC 96-488 § VIII), to evaluate the effect of Internet usage on the voice network, and encouraged interested parties among incumbent LECs and ESPs to work together to identify which technological solutions hold the greatest promise in carrying Internet traffic most efficiently and with the least adverse price impact on consumers. (Para. 317)

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[6]See "Hundt Asks Network Reliability and Interoperability Council to Monitor Impact of Internet Growth on Public Networks," Nov. 1, 1996 [news release]. As discussed in Para. 287, note 389, the FCC's "consideration of congestion issues in this proceeding in no way precludes or supersedes the efforts underway by the NRIC."

As the FCC wrote, "As usage continues to grow, such services may have an increasingly significant effect on the public switched network." (Para. 282) The FCC recognizes the problem and understands that the current access charge program is not perfect; in its view, the exemption from the access charge is a tentative answer, and it is eager to discover the truth from data and comments submitted.[7]

Whatever conclusion the FCC reaches will affect Internet service pricing and VOI. According to the ISPs' coalition, Access Service Provider (ASP), when the ISPs pay the LECs the access charge, they would prefer to pay per line, not, as the IXCs pay, per minute. In short, the access charge has two faces. If the ESPs need to pay it, as an extra charge, it will not promote the growth and spread of the Internet. Instead of having what some have viewed as an unfair exemption, an unfair competition may emerge, between phone-to-phone VOI service providers and IXCs. If the ESPs continue to be exempt from access charges, the complaint will continue to be made that the ESPs unfairly do not contribute toward the universal service funding mechanism. If the ISPs were to pay access charges, according to Andrew Sears, "the likely result would be that Internet telephony [VOI] could not go through the LECs lines but would instead go through cable companies and cellular providers, who could use the lower priced long distance as a competitive advantage."[8] Sears continued, pointing out other sites of this problem, "This is the case in many countries which charge on a per minute basis for local calls, and in many of these countries this advantage is enough to give the LECs a monopoly on Internet access."

In Japan, until April 1997, there were arguments in favor of regulating call-back service providers, but not VOI service providers or ISPs. The MPT appeared to begin to regulate phone-to-phone VOI, because that was an illegal international bypass service. In April, however, the MPT announced that it will not regulate this service.[9]

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[7]But is it knowable? See Anthony G. Oettinger, *The Formula Is Everything: Costing and Pricing in the Telecommunications Industry* (Cambridge, Mass.: Harvard University Program on Information Resources Policy, P-88-2, October 1988).

[8]Andrew Sears "The Effect of Internet Telephony on the Long Distance Voice Market" [On-line]. URL: <rpcp.mit.edu/itel/Ideffct.html>

[9]After the announcement by the WTO that it would not prohibit International Simple Resale (ISR), the MPT indicated its stance, that if carriers change the clauses, they can provide the phone-to-phone VOI services. See "KDD Requests Deregulation to MPT, in the Face of Removing VOI Prohibition," *Asahi Shinbun*, April 4, 1997.

Chapter Nine

Carriers' Points of View and Activities

In considering the future of VOI, that is, whether VOI will replace the PSTN, the activities of the carriers must be examined, as the following statement illustrates:

> Many of the rosy predictions of a mass market for Internet telephony are based on the fact that users currently get the service for almost no additional cost, and that equation will change as telecom carriers pass on the escalating costs of transmitting data traffic and upgrading their networks.[1]

This chapter looks at what carriers think about VOI, their entry into the ISP market, and actions they may take in response to the advent of VOI (e.g., Intranet service, integrated services, voice over frame relay). These issues will indicate how strongly carriers are entering the Internet market and whether they are preparing to offer VOI.

9.1 What Carriers Think about VOI

According to Andrew Sears, "The different [U.S.] IXCs have had different strategies toward the Internet, which could be interpreted as to what degree they view [VOI] as an opportunity or threat. MCI, Sprint, and Worldcom/MFS/UUNet could view [VOI] as another mechanism to take market share from AT&T."[2] Sears described the arguments of some analysts: "the development of [VOI] may have been a key factor in the merging of Worldcom, MFS and UUNet."[3] This section provides views of both U.S. and Japanese carriers.

9.1.1 AT&T

According to AT&T: "Internet (phone) call rates are 'attractive,' but [AT&T sees] Internet calling as an opportunity, not a threat.... Sure, he said, rates 'will certainly fall' if Internet calling becomes widespread, but added that AT&T is looking at the 'possibility' of

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[1]Eric Arnum, editor of "*TR*'s sister publication, *Electronic Mail & Messaging Systems*," quoted in "FCC's Levin Warns Stay Could Delay Access Reform," *TR Daily*, Oct. 24, 1996, 4.

[2]Andrew Sears, "The Effect of Internet Telephony on the Long Distance Voice Market" [On-line]. URL: <rpcp.mit.edu/itel/Ideffect.html>

[3]Ibid.

providing the same service." "Whether we get in will depend on what our customers tell us and the evolution of the technology."[4]

At a conference, Glenda Norton, vice-president for AT&T's Advanced Internet Services, emphasized the following points:

> There are many ways of using the Internet: FTP, VOCP, e-mail, Internet Cat, www. For the customer, price is not the only consideration when making a purchase decision. Customers are looking for overall value. Quality and reliability must also be considered as part of the value equation.
>
> Business markets attach importance to improved operations efficiency, customer loyalty, and employee productivity. Consumer markets attach importance on ease of use, quality, and entertainment.
>
> To close the gaps between what business and consumer customers want, and what is currently available, AT&T would like to develop value-based services. These services would combine traditional telecommunications services and voice on the Internet technologies to offer market based solutions to customer needs. Voice on the Internet and telecommunications services do not seem to be mutually exclusive, instead they can be combined in intelligent ways to enhance the effectiveness of communications.[5]

According to officials from AT&T and Sprint, these companies "plan eventually to put all or most traffic on packet-switched backbone networks."[6] AT&T does not consider the present quality of VOI good enough yet to offer it to its customers:

> "We already have the functionality.... We could have come out with this thing today, but the quality isn't there." She said until the Internet infrastructure becomes more reliable, AT&T won't risk upsetting customers with lower quality voice calls transmitted over the Internet. "There's less here than meets the eye," added another AT&T spokesperson.[7]

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[4]Susan Pulliam, "Rising Internet Stocks Signal Faith in New Era of Voice Communications" ["Heard on the Street"], *The Wall Street Journal*, Nov. 17, 1995.

[5]Glenda Norton, presentation at the conference on "Voice on the Net," San Diego, Calif., Feb. 3, 1997. Printed by permission of the author (as extended by Bob Lucido, personal communication, March 27, 1997).

[6]"Dueling Internet Announcements Put Sprint, MCI in Spotlight—AT&T, Sprint Skeptical of MCI Strategy," *Telecommunications Reports* (Feb. 3, 1997), 26.

[7]Ibid.

9.1.2 Sprint

According to the same article in *Telecommunications Reports*:

> Sprint was...skeptical. A spokesperson said focus groups have told the company "they prefer the higher-quality call you get over the regular phone network." Sprint is "looking at all sorts of IP...applications," but doesn't plan to switch voice calls over to [a] SONET [synchronous optical network]/ATM backbone for at least 12 to 18 months. She said many of the Internet's service reliability and quality problems should be resolved by then.[8]

9.1.3 MCI

According to Fred Briggs, chief engineering officer of MCI Communications, for IXCs, VOI is a way to escape paying access charges, but it will not replace traditional telephony:

> Currently, in the United States, long-distance providers such as MCI must pay nearly 40% of revenues to the local phone companies to gain access to their customers' homes and business.
>
> Internet telephony would free long-distance providers from paying these high access fees, enabling them to offer lower rates to customers.... Internet telephony won't take away business from long-distance providers, but it will create complementary products, evolving as did cellular and paging technologies.
>
> ...Internet-based telephony will play a key role, bringing us closer to the day when communication becomes seamless across all media and revolutionizing the way business is conducted. Soon, customers and business will be able to communicate over the Internet with the same ease as they do today via the telephone network.
>
> Will VON [Voice over the Net] ever replace traditional telephony? No. But the variety of business applications available via Internet telephony will create different value-added services that will drive new business and new markets.[9]

At the "Voice on the Net" conference (San Diego, Calif., February 1997), Joseph Rinde, director of switched network architecture at MCI, said that the price advantage of VOI will change if the surrounding conditions change and if the IXCs' access charges are cut, and if the LECs' tariffs are changed to be based on usage; then, the ISPs' tariffs also will change, making the advantage of VOI disappear. Rinde stated that "There is no reason why a PC can't coordinate a PSTN call with shared applications over the Internet. Nowhere is it written that

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[8]Ibid.

[9]Fred Briggs, "Internet Telephony Poised for Next Communications Surge," *Lightwave* (November 1996), 62.

voice must pass over the Internet. A PBX can decide how phone calls will be routed, a PC can do the same."[10] Regarding the impact of VOI, he said that "Absolute usage will increase. Not just a shift of usage. Internet and conventional telephony will live in harmony for years to come."[11] Regarding the future of VOI, he emphasized that

> This is not an economic issue. [VOI] will be sold on feature function. Facilitation of collaborative computing. Part of the PC centric workplace. Foster new, not replacement, communication. Creates new economic opportunities for those who exploit its potential.[12]

9.1.4 NTT

In an interview printed in *Sangyo Keizai*, Junichiro Miyazu, president of NTT, was quoted as saying:

> In April [1997], another company will begin to offer cheap Internet-based phone-to-phone VOI service. NTT won't throw cold water on it. Instead, we will watch it carefully (to see whether in the future this service will compete with NTT, or not)—but will not warmly welcome it.[13]

In interview published in *Telecommunications* (Japan), Kazuaki Katori, of NTT's OCN department, responded to the question, "Do you think the Internet phone will be used broadly?"

> Much VOI software has emerged and is constantly improving. Even in Japan, it is easy to think that some users will begin to use the telephone, fax, and TV conference calls over the Internet.[14]

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[10]Joseph Rinde, "How to Transport Voice," Slide 30, from materials presented at the conference on "Voice on the Net," San Diego, Calif., Feb. 3, 1997; see also Joe Rinde, "Telecommunications Carriers and Voice of the Internet," in *New Developments and Opportunities in Voice on the Net* (Southborough, Mass.: International Business Communications [IBC], Feb. 3-5, 1997).

[11]Rinde, "Impact of IP Telephony," Slide 32, from materials presented at the conference on "Voice on the Net."

[12]Ibid., "The Future of IP Telephony," Slide 33.

[13]*Sangyo Keizai*, Feb. 1, 1997. (Translated by the author.)

[14]"Cannot Stop the Use of the Internet," *Telecommunications* [Japan] **13**, 8 (September 1996), 37. (Translated by the author).

9.1.5 KDD

According to Tadashi Nishimoto, president of KDD, in an interview with *Nikkei Communications*, with KDD's ordinary international communications, out of a hundred calls, ninety-nine will connect, but with VOI there is no such guaranteed connection. Those willing to bear with lack of guaranteed service will use VOI. Nishimoto was asked whether KDD, which finances Rimnet, a provider of phone-to-phone VOI services, planned to provide VOI on its own. He responded with the example of Singapore Telecom, which offers call-back service: "As with a lunch menu, there are different qualities and different prices. High-quality services are expensive and not the same as less expensive services."[15] If Singapore Telecom, which offers high-quality service, were to continue to offer only that, then other providers would meet the market demand by offering lesser quality services at lower prices. To retain market share, Singapore Telecom will offer cheaper services (call-back) as well as continue its high-quality service.

9.2 Carriers' Alternatives to Explore VOI

9.2.1 Enter the Internet Market as ISPs

The FCC's Third Computer Inquiry ruled that carriers can offer "enhanced" Internet service on an unregulated basis through a separate subsidiary. In return, they must provide unaffiliated ESPs access to the basic service that constitutes the building blocks of the offering. The carriers have entered the Internet market as ISPs (see section **4.1.1**), and they take for granted that the penetration of Internet use offers them a new business opportunity.

According to Kenneth Hart, "because backbone providers can reduce costs by achieving economies of scale" they will be able "to route local ISP traffic to and from exchange points across the Internet at a price."[16] Hart quoted Vinton Cerf, senior president of data architecture at MCI, as saying that

> backbone providers make money by leasing an international circuit to ISPs from outside the United States to tap back into the U.S. based array of network access points. This means telcos such as MCI have a "hairy billiard ball" leased lines stretching out into Asia and Europe. Without the deployment of a global grid MCI would eventually run out of fiber optic cable capacity.[17]

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[15]"We Will No Longer Rely on Regulation. Using Tariffs and Quality, We Will Compete," *Nikkei Communications* (April 7, 1997), 10.

[16]Kenneth Hart, "Building the Global Internet Backbone," *CommunicationsWeek International* (July, 15, 1996), 20, 22.

[17]Ibid., 20.

MCI and British Telecom (BT) announced that they plan to build a total of twenty regional exchange points in Asia, Europe, and North America as part of their global Internet backbone. The project, called Concert Internet Plus, is expected to generate over U.S. $2 billion in revenues by the year 2000, up from more than U.S. $100 million in 1996.

Global One also plans to invest more than U.S. $100 million in internetworking infrastructure to deploy a global backbone network complete with regional exchange points. Revenues from this service are expected to exceed U.S. $200 million in 1996, mostly stemming from smaller ISPs.[18] MCI plans to continue to spend about U.S. $100 million annually on Internet upgrades and will double its current capacity by year-end.[19]

9.2.2 Plan to Offer Integrated Services and VOI and Voice over Frame Relay (VoFR)

"As carriers strive to save costs by integrating all their voice and data traffic onto a single broadband infrastructure, so [VOI]"[20] could generate revenues and even allow long distance operators and resellers to avoid paying local interconnection charges.

AT&T, MCI, and Sprint, all large long-distance companies, plan to integrate voice telephony and data traffic in an attempt to offer a more robust and "seamless" experience for users. They appear to be planning eventually to put all or most traffic on packet-switched backbone networks. Quality, however, is not yet possible, and the Internet infrastructure is not yet sufficiently reliable to begin to provide VOI. *Telecommunications Reports* quoted a Sprint spokesperson as saying that the problems of Internet service reliability and quality should be resolved in twelve to eighteen months.[21]

AT&T has not yet said that it will provide VOI services, but at the end of 1996 it already offered a trial service, Project iA [instant Answer], which integrates Web access and AT&T's long-distance network (see **Figure 9-1**):

> A trial service, [was] launched in October [1996], will allow web surfers to click on an icon to initiate a telephone conversation with a customer service agent. Additionally, the agent will be able to send images to a customer's screen to illustrate the products or services being discussed. The telephone conversation is provided through the AT&T

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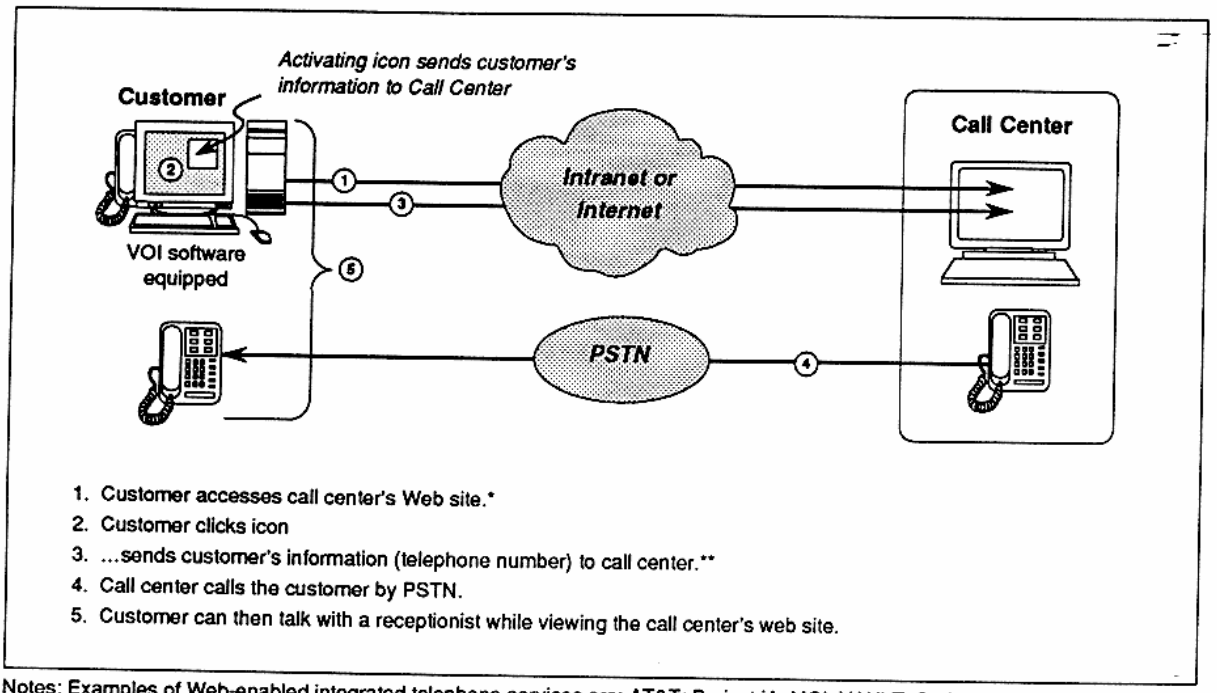
[18]Ibid.

[19]Information in this paragraph taken from "Dueling Internet Announcements Put Sprint, MCI in Spotlight," *Telecommunications Reports* (Feb. 3, 1997), 26.

[20]Tim Kelly, head of Operations Analysis, ITU, quoted by Kenneth Hart, in "Boost for Internet Telephony," *CommunicationsWeek International* (July 15, 1996), 33.

[21]"Dueling Internet Announcements Put Sprint, MCI in Spotlight," 26.



Notes: Examples of Web-enabled integrated telephone services are: AT&T: Project iA; MCI: VAULT; Sprint: Give Me A Call.
*Customer needs two lines unless an ISDN line is available.
**Steps 1 and 3: calls are made on the same line.

Figure 9-1

Web-Enabled Telephone Service: Integrated Service

> network and simultaneously the image is transmitted through the Internet.... AT&T is the first company to announce this type of network-based, two-way, agent-assisted transaction processing technology for the Internet, code named Project iA....[22]

To use this service, a Web surfer needs at least two telephone lines: the first for access to the Internet Web site and to enter a phone number in the designated field (after which the user clicks on the "Call me now" icon), the second to receive the call from the Web site's call-center agent. "Internet experts believe the technology is best suited to serve niche applications."[23]

Sprint also plans to integrate voice telephony and data traffic. The company plans to offer "Give Me a Call" service, which will allow companies to use the PSTN for voice calls

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[22]"Integrated AT&T Web and Network Lets Surfers Click to Talk to a Service Agent," Aug. 27, 1996 [AT&T news release] [On-line]. URL: <att.com/press/0896/960827.bsa.html>

[23]Hart, 22.

with customers while also accessing the Web over the same phone line.[24] The service is similar to AT&T's Project iA. On January 28, 1997, Sprint announced that it planned to launch "a single, all-digital backbone using SONET...transmission and ATM...switching technologies."[25] A new Internet-based conference call using Sprint's "Internet Conference Center" is expected to undercut other audio conferencing services by 30 to 40 percent.[26] According to *TR Daily*:

> Sprint said that customers of its "Give Me a Call" service who see a product on a company's Internet site could enter a phone number and connect to a sales representative. Calls would be initiated from the Internet but carried over Sprint's long distance network. Future offerings will include Internet-based voice service, conferencing, and multimedia collaboration services, Sprint said. *Sprint intends eventually to move all its services—voice, data, imaging, and video—to a single SONET-based backbone employing ATM.*[27]

In January 1997, MCI announced that it would introduce a new network architecture code—called VAULT—that would go a step further by actually mixing PSTN and Internet traffic over an integrated network.[28] According to *TR Daily*:

> The VAULT system is "another great leap forward" that will "redefine how customer service is done" and allow for "collaborative multimedia applications," said Fred Briggs, MCI's Chief Technology Officer. "People are going to buy services. They're not going to buy access," Mr. Briggs predicted, adding that customers won't care whether traffic is being carried over the Internet or over the PSTN. Instead, MCI simply will mix voice and data in whatever way is "best for the customer."[29]

VAULT appears similar to AT&T and Sprint's integrated service.

According to Vint Cerf, MCI is not planning to put all voice traffic on the Internet under current conditions but, instead, it will merely be "using the Internet to help control

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[24]"Dueling Internet Announcements Put Sprint, MCI in Spotlight," 24.

[25]Ibid.

[26]Ibid.

[27]"MCI, Sprint Unveil Internet Telephony Services," *TR Daily*, Jan. 29, 1997, 3. (Emphasis added.)

[28]Ibid.

[29]Ibid.

some of the voice traffic."[30] Asked whether MCI would eventually migrate all traffic to an IP-based network, Cerf replied, "Quite possibly."

9.2.3 Examples: Enter the ISP Market and Provide VOI

The RBOCs have a strong motive for offering VOI. According to Andrew Sears, they may offer VOI as a way to enter the long distance market: "The LECs might want to offer their own [VOI] service as a way to cut into the long-distance market and could probably capture a significant portion of the market from the IXCs."[31]

Late in 1996, Ameritech introduced "Voice Over [Ameritech] Frame Relay [VoFR],"[32] "which is intended to enable users potentially to lower costs by consolidating voice and fax with data traffic over frame relay."

> By adding voice capabilities, the service enables customers to use networks better and connect multiple sites more efficiently and at a lower cost compared with private line networks. "This added feature really enables customers to maximize the financial benefits of frame relay," said Tim Whiting, Ameritech Frame Relay product manager.
>
> To offer the service, Ameritech is using Motorola's 6520 MPRouter, a network manageable router that supports frame relay. The routers have voice compression software that makes it possible to have high-quality audio possible while using bandwidth efficiently, according to Ameritech.[33]

NTT developed "VocaLink-GW," its gateway server, which bridges the Internet and the PSTN and is open to the public for phone-to-phone VOI. It uses the real-time transfer protocol (RTP) and the real-time control protocol (RTCP), and its codec, TrueSpeech, which compresses voice to 6.3 kbps, is manufactured by American Digital Signal Processor (DSP) groups.[34]

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[30]Ibid.

[31]Sears [On-line].

[32]"Ameritech Releases Voice over Frame Relay," *Phone+* (November 1996), 23.

[33]Ibid.

[34]"NTT Opened Its Internet Telephony to the Public, NTT Appealed Its Technology Worrying about Its Impact on PSTN," *Nikkei New Media* (Feb. 17, 1997), 3. (Translation by the author.)

9.3 The Carriers: A Summary

Unlike carriers in the United States or Japan, Telecom Finland has gone ahead with VOI by itself.[35] It started Internet service in December 1996. Finland has the most Internet hosts per 1,000 inhabitants in the world: 55.5.[36] Its telecommunications market is competitive, with forty-six local telecommunications companies. Telecom Finland, which is government-owned,[37] has a nationwide broadband Internet backbone on ATM technology, and in December 1996 it announced a new class of telephone service with Internet telephone integrated with the Web. The VOI service, called TF-MediaNet phone, is available for all Internet users.[38] According to Mika Uusitalo, head of Telecom Finland's Medialab, "Our target is to encourage business users to build new value-added applications based on Internet telephone services."[39]

In the view of the carriers, VOI will not replace the current telephone for several years to come. Rather, it will exist in harmony with it. All carriers have already entered the ISP market and tried to increase their backbones. The three largest ICXs have begun to provide integrated services—a call is initiated from the Internet but carried over the long-distance networks—and will probably eventually put most traffic on packet-switched backbone networks. The carriers, like the large ISPs, can also provide high-grade Intranets[40] (see **Chapter Ten**). And some have begun to provide VoFR.

The carriers face a dilemma: if they provide packet-based service too actively, they risk accelerating erosion of their revenues from conventional services, but the alternative would be to lose everything to new entrants.

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[35]"Telecom Finland Starts Internet Telephone Service," Internet Access Company (IAC) SM Newsletter Database (TM), M2 Communications, M2 Press Wire, Dec. 12, 1996 [NEXIS].

[36]"A Bright Outlook for Communications," *OECD Observer*, 205 (April-May 1997), 20.

[37]Ibid.

[38]This service technology was jointly developed by Telecom Finland and VocalTec: the service concept and Web integration were developed by the Medialab, with client software based on VocalTec's Internet phone technology.

[39]"Telecom Finland Starts Internet Telephone Service," [NEXIS].

[40]Denise Pappalardo, "MCI Promises Internet QoS Service," *Networld* (March 31, 1997), 13.

Chapter Ten

Activities of the ISPs and Their Impact

At mid-1997, most ISPs were struggling for money—about half of them are in the red.[1] Some will try to use VOI to their own advantage. They are eager to combine Internet and PSTN services and establish pricing for different levels of service. VOI will promote consolidation of ISPs, in the view of Andrew Sears.[2]

10.1 Adding Voice Options

Most ISPs—including ANS Co+re Systems, BBN Planet, CompuServe, Global Enterprise Services, Istar Internet, Netcom Online Communication Services, and Performance Systems International—have configured their Web servers to accommodate audio. Many resell Internet voice software and offer customer support for the service, and most claim to be upgrading their networks to handle voice better.[3] Some vendors and ISPs have a simple philosophy about Internet voice: in Robin Gareiss's allusion, "Build it and they will come." "Today, voice over the Net is a hobby," according to Alan Taffel, vice-president of sales and marketing at ISP UUNet Technologies, but "the future is a very different story." As the technology matures, he predicted, corporate Internet/Intranet strategies will shift accordingly.[4]

10.2 Provide Phone-to-Phone VOI Service

On March 25, 1997, the international carrier USA Global Link, of Fairfield, Iowa, unveiled a "Global Internetwork" telephone service, which is phone-to-phone VOI.[5] Similarly, in Japan ISPs may offer voice access to the Internet with minor changes. By using a gateway, ISPs there began to provide phone-to-phone VOI service; Rimnet, which is partly financed by KDD, provides services using a Vienna Systems gateway. ISPs and simple resellers also have begun to provide this service in Japan.

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[1]For the U.S., see "ISPs Face Losses, Consolidation," *Inter@ctive* (Feb. 17, 1997), 9. For Japan, see "59% of ISPs Are in the Red," *Nihon Keizai Shinbun*, Sept. 16, 1996, 15; and "ISPs Begin to Consolidate," *Nihon Keizai Shinbun*, Oct. 4, 1996, 11.

[2]Andrew Sears, "The Effect of Internet Telephony on the Long Distance Voice Market" [On-line]. URL: <rpcp.mit.edu/itel/Ideffect.html>

[3]Robin Gareiss, "Voice over the Internet," *Data Communications* (September 1996), 94.

[4]Ibid.

[5]See "At Last—True Telephone-to-Telephone Internet Telephony," USA Global Link [On-line]. URL: <usagl.com/Internetwork/index.htm>

10.3 Internet Service Diversification

MCI and British Telecom (BT) use "weighted fair queuing," a technique developed by Cisco Systems that automatically administers traffic queues in routers according to the traffic patterns. MCI and BT sell premium services to corporate and small users.[6] According to Vinton Cerf, of MCI, the Cisco Systems technology and RSVP make QoS possible. MCI differentiates services according to customer, charging more to users running mission-critical applications over InternetPlus.[7]

AT&T and its partner BBN Planet aim to launch commercial RSVP-enabled services in 1997.[8] Meanwhile, Braun and UUNet Technologies, both large ISPs, are planning prioritized service, known as "rationalized" service. By labeling certain data packets according to type of content, destination, or habitual flow, prioritized packets may pass through less congested paths at premium prices.

10.4 High-Grade, High-Performance Intranet Service

After 1996, ISPs began to offer business users high-grade, high-performance Internet service for their WANs.[9] After that, business users began to accept the Internet as having a quality and reliability similar to private-circuit and frame-relay WAN services.

For businesses, the Internet is easy to use and manage, and it provides low-cost performance, leading to a strong demand for it among business users. But the reasons businesses hesitate to use it for private networks are primarily lack of security and lack of reliability. To respond to the strong demand, ISPs offer high-grade, high-performance Intranets, like frame-relay service, which can set a Committed Information Rate (CIR) to reserve bandwidth and maintain a data-transmission speed below the CIR limit. With this service, users can use the Internet with confidence.[10]

In 1996, AT&T WorldNet began to offer "Intranet Connect Service,"[11] a highly secure VPN that "combines Internet access with Intranet capabilities so that [the user] can use the same service, the same physical connection, and the same protocols for...internal networking

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[6]Kenneth Hart, "Telephone Companies Are Developing High-Speed Global Networks," *CommunicationsWeeek International* (July 15, 1996), 22. Hereafter cited as Hart.

[7]Ibid.

[8]Ibid. According to Hart, "Internet experts believe the technology is best suited to serve niche applications."

[9]"One More Internet," *Nikkei Communications*, 231 (Oct. 7, 1996), 68-94.

[10]Ibid., 73.

[11]"AT&T WorldNet Intranet Connect Service" [On-line.] URL: <att.com/worldnet/Intranet>

communications. Plus, the service offers greater security for closed user groups."[12] To offer it, AT&T WorldNet uses the AT&T-managed backbone, an IP network distinct from the current Internet backbone.

AT&T and BBN Planet expect to launch commercial RSVP-enabled services in 1997.[13] And Sprint offers "Intranet Access," which (to avoid repetition of offer) also provides high security. Sprint uses another IP network, separate from the current Internet backbone, but uses the same access points as the Internet backbone.

ISPs are planning to provide these high-grade, high-performance Intranets at prices higher than the Internet but lower than frame relay. Prices are expected to become more and more attractive for destinations that are more and more distant.

In Japan, KDD provides high-grade Intranet service. KDD launched Business IP Service. NTT, too, plans to provide high-grade Internet service as one of the options of the OCN (see section **5.1.1**), but it does not plan to use RSVP because the levels of quality allowed by this protocol are difficult to price.[14] Vint Cerf, of MCI, was quoted as saying that "In the near future, a greater proportion of traffic and revenues will spring from managed Intranet services running within a secure IP backbone network."[15]

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[12]Ibid.

[13]Hart, 22.

[14]On Jan. 7, 1997. "KDD to Launch Business IP Service" [On-line.] URL: <kdd.co.jp/press-e/97-002.html>

[15]Quoted in Hart, 22.

Chapter Eleven

Vendors

Vendors are a very strong driving force, as shown by the following sample as of April 1997: "Cisco and Intel Take Next Step in Delivering High Quality Multimedia Over the Internet"[1]; "Motorola to Sell VocalTec Software for Calls via Internet"[2]; "CTI (Computer Telephony Integration) Vendors Add Voice over the Internet Function."[3]

According to Eric Hochstein, senior manager of strategic planning at Rockwell Switching Systems, "The role of the Internet as a vehicle for customers to communicate to business is something we are seeing a lot more frequently in call centers."[4] The article reported that "Suppliers are scrambling to help users consolidate voice and Internet calls,"[5] and it included examples of CTI vendors integrating VOI in their products.

For example: "Rockwell has made a stab at the Internet question under a reseller agreement with NetSpeak Corp.,"[6] whose WebPhone software enables Web users with multimedia PCs to talk to a call-center agent in real time: "after users click on a Web page icon, a message is routed to an agent's phone."[7] Rockwell's Pioneer Program has been undergoing a business test, and the completed version was expected to be available in April 1997.[8]

Lucent Technologies joined with Spanlink Communications to develop Spanlink's WebCall software, at $15,000 "an add-on program for the Lucent Conversant voice response system."[9] The software permits Web users "to notify an agent that they want to be called back. The information is transmitted into an agent group queue, where a representative will

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[1]"Intel's PC-RSVP and Applications" (March 7, 1997), Intel [On-line]. URL: <intel.com/pressroom/archive/releases/incisco.htm>

[2]*The Wall Street Journal*, March 3, 1997, B6.

[3]Kathy Chin Leong, "Integration Hang-Ups," *CommunicationsWeek International* (March 3, 1997), 38-42.

[4]Ibid., 41.

[5]Ibid.

[6]Ibid.

[7]Ibid.

[8]Ibid.

[9]Ibid.

return the message."[10] In the fall of 1996, "Lucent introduced its new generation of multimedia call centers that support Internet and video calls."[11]

Microsoft is positioning a new version of its system platform, Windows NT 5.0, which supports integrated telephony and data communications.[12] It will include consistent application programming interfaces (APIs) for bridging telephone systems, computers, and the Internet. The new framework will combine now separate interfaces, such as Microsoft's Telephony API (TAPI), its IP-based NetMeeting development environment, and ActiveMovie, into a suite of common object-oriented components. These components will let developers build applications using the same APIs that link to a telephone or a Web browser and support consistent links to either telecommunications network or the Internet. Common APIs will make it easier for organizations to build a consumer service application that links a Web page to a telephone-based call center.[13]

Voice-to-data bonding is considered difficult when

> joining a voice and data network in a multivendor environment. CTI products for a call center involve PBXs, ACDs;[14] CTI middleware, which makes the voice/data integration click); voice response units (VRU)[15] that provide automated responses to queries; desktop CTI boards; CTI servers; and a myriad of other applications and devices.[16]

Will using the Internet eliminate the difficulties inherent in a multivendor environment? According to Jeffrey Schwartz, "With all this effort, vendors may soon put the 'I' back in computer-telephony integration."[17] This strategy was apparent in a speech quoted by Schwartz that was given by Bill Riley, Lucent's managing director of CTI solutions: "This is challenging for us as vendors because we don't believe all customers will be necessarily

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[10]Ibid.

[11]Ibid., 42.

[12]"Intel's PC-RSVP and Applications," <intel.com/pressroom/archive/releases/incisco.htm>: "Intel's PC-RSVP software [was] licensed to Microsoft in August [1996] for use in future applications and revisions of the Windows operating systems.... Intel's PC-RSVP software runs on a user's PC (Windows NT or Windows 95 environment) and enables RSVP connections to Cisco or other routers running RSVP. The application developer then writes to the Winsock 2 API (developed through the collaboration of Intel, Microsoft and others) to make [QoS] calls. Intel is licensing this technology to accelerate the development of rich multimedia applications for the Internet."

[13]Jeffrey Schwartz, "Microsoft's CTI Solution," *CommunicationsWeek International* (March 10, 1997), 12.

[14]Automated call distributors.

[15]VRU automatically answers a caller with a voice that offers a menu of options, and VRU allows a customer to leave a message.

[16]Leong, 39-40.

[17]Schwartz, 12.

jumping to the Web. It will be a hybrid, and a big opportunity for us to position ourselves to handle various services."[18]

[18]Ibid.

Chapter Twelve

Price: Will VOI Maintain Its Advantage?

One reason people may prefer VOI to voice telephony is its lower price—but will VOI keep its price advantage?

Considering the future of VOI, that is, whether VOI will replace the PSTN, requires considering the price. As discussed in **Chapters Four** and **Five**, VOI offers a price advantage over voice telephony. Whether this advantage will continue will depend on the prices of the PSTN and the Internet.

Several factors may reduce the price advantage of VOI in the future: first, cheaper provision of the PSTN; and, second, a higher price for use of the Internet along with price diversification for Internet applications, which will increase the price of VOI.

12.1 Price of the PSTN

Among the factors that may lead to a decrease in the price of the PSTN are changes in regulation, heavier competition, and improved voice compression technology.[1]

Two questions arise regarding regulation: will the access charge that IXCs pay be cut,[2] and will international accounting rates be decreased.[3]

12.1.1 Will the Access Charge IXCs Pay Be Cut?

In FCC 96-488, the Notice of Proposed Rulemaking (NPRM) released December 24, 1996, the FCC, showing that it recognized the industrywide consensus that the Commission should begin to undertake a comprehensive review of its access charge regime, stated:

> There is a consensus among virtually all participants in the telecommunications industry on the need to reform our interstate access charge rules. IXCs and incumbent LECs, for example, agree that current per-minute interstate charges exceed economically efficient levels and that, consequently, per-minute interstate access charges must be reduced.[4]

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[1]The extent of price cuts is beyond the scope of this report.

[2]Related to FCC Common Carrier (CC) Docket No. 96-262.

[3]Related to FCC CC Docket No. 96-261.

[4]FCC 96-488, Para. 41.

In a news release, the FCC stated the following about the formation and purpose of its access charge policies:

> The Commission's existing access charge policies were adopted at the time of the divestiture of AT&T. These policies were designed primarily to promote competition in the interstate, interexchange market by ensuring that all long distance companies would be able to organize and terminate their traffic over incumbent local exchange carrier (LEC) network at just, reasonable, and non-discriminatory rate.[5]

The FCC added that "While these policies contemplated long distance competition, they did not attempt to address the potential effects of local competition," and explained that it had begun to review access charge rules concerning local competition:

> The FCC begins a review of its Part 69 interstate access charge rules to establish fair rules of competition for both the local and long distance markets and determine the extent to which it must revise these rules in light of: the local competition and Bell Operation Company entry provisions of the 1996 Act and state actions to open local network to competition; the effects of potential and actual competition on incumbent LEC pricing for interstate access; and the impact of the Act's mandate to preserve and enhance universal service.[6]

The FCC indicated that there were two possible approaches: a market-based approach and a prescriptive approach (see FCC 96-488 §XI). The purposes of these approaches are (1) to address claims that existing access charge levels are excessive,[7] (2) to establish a transition to access charges that more closely reflect economic costs, and (3) to deregulate incumbent LEC exchange access services as competition develops in the local exchange and exchange access markets.

The FCC sought comment on whether either approach should be used, and whether singly or combined. There were more than sixty comments,[8] many of them controversial. For example, AT&T commented:

> [The] FCC should set access rates based on their total-element long-run incremental cost (TELRIC) and apply those rates to IXCs and ESPs.

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[5]"Commission Initiates Proceeding to Reform Interstate Access Charges," News Report No. DC 96-113 Action in Docket Case Dec. 24, 1996.

[6]Ibid.

[7]FCC 96-488 NPRM, Para. 11: "AT&T asserts, for instance, that the current average per-minute access rates of the BOCs are nearly seven times the forward-looking economic cost of providing that service, and that total interstate access charges collected today from interexchange carriers exceed forward-looking economic cost by $11 billion, or 70 percent of the total."

[8]Comments and reply comments available on-line. URL: <fcc.gov/isp.html>

> TELRIC-based pricing would send appropriate economic signals and thereby help deter any potential network congestion.

From the LECs' side, if TELRIC-based pricing were adopted, there would be no way to fund universal service. The LECs proposed that if they cannot recoup lost revenues in this way, the FCC should consider either raising monthly "subscriber line charges"—of about U.S. $3.50 for a residential customer and U.S. $6 for a business customer—or raising local rates.

> Access fees can account for as much as 45 cents of every dollar the long-distance carriers collect and then return to the incumbent local exchange carriers (ILECs). It is estimated that the average access fee is three or four cents a minutes, assessed at both the originating and terminating ends of a call. The long distance carriers argue that actual connect costs are closer to a penny a minute.[9]

Whichever approach the FCC adopts, the fee the IXCs will pay the ILECs may be cut.

In Japan, NTT cut the access charge about 12 percent, from ¥10.46 to ¥9.20 per 3 minutes. Charges for long-distance calls were just cut, in February 1997, but this decrease offers the possibility of another cut.[10] Regarding the access charge required in Japan, the FCC asked the MPT to recalculate the charge, which would result in a cut of about one-tenth that would ease the way for foreign telecommunications companies to enter the Japanese market.

12.1.2 Will International Accounting Rates Decrease?

The FCC released FCC 96-484 NPRM[11] on December 19, 1996, regarding International Settlement Rates:

> A multilateral consensus has emerged that the traditional accounting rate system must be reformed because it results in settlement rates that are substantially above costs and creates competitive distortions and inefficiencies in the global telecommunications market.[12]

The FCC set the benchmark International Settlement Rates on the basis of market Tariffed Components Prices.[13]

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[9]FCC 96-488 NPRM.

[10]"Access Charge Cut 12 Percent" (Jigyousya Setuzoku Ryoy 12% Nesage), *Nihon Keizai Shinbun*, March 9, 1997, 1.

[11]Before the FCC 96-484, In the Matter of IB Docket No. 96-261, International Settlement Rates, Notice of Proposed Rulemaking, Adopted: Dec. 19, 1996. Released: Dec. 19, 1996.

[12]Ibid.

[13]Ibid.

The FCC pointed out that the reason the current accounting rate was high was that it was developed as part of a regulatory tradition that international telecommunications services were supplied through a bilateral correspondent relationship between nation monopoly carriers. The traditional accounting system, in most cases, is that settlement rates greatly exceed the underlying costs of providing the service. The FCC emphasized that "As a result of recent technological advances, the underlying costs of providing telephony are becoming virtually distance insensitive." It claimed that:

> the benchmark rates should be revised to reflect recent technological improvements, their associated cost reduction, and the market structure changes occurring in the global telecommunications market." It further said that "these revisions are necessary to move settlement rates closer to the actual costs incurred by foreign carriers to terminate intentional traffic."[14]

The goals of the NPRM were the following: (1) to promote effective competition in the global market for communications services; (2) to prevent anticompetitive conduct in the provision of international services or facilities; and (3) to encourage foreign governments to open their communications markets.[15]

Replies to the NPRM were received from developing countries in Asia and Europe.[16] If every country were to comply with the FCC's demand, international accounting rates would be cut, leading to a cut in the international rate.

On April 17, 1997, the ITU demanded that member nations cut accounting rates: in 1997, a cut of 5 to 10 percent, then, in 1998, another cut of 5 to 10 percent.[17]

12.1.3 Wider Use of International Simple Resale (ISR)

According to Gregory C. Staple:

> Broadly defined, ISR refers to the wholesale purchase of international private line (IPL) capacity from a facilities-based carrier which is then resold to customers for switched telephone service.... ISR thus may be

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[14]Ibid.

[15]NPRM, Para. 5.

[16]See "Foreign Carriers Seek to Shoot Down FCC's Proposal for Accounting Rate Benchmarks," *Telecommunications Reports* **63**, 7 (Feb. 17, 1997), 18-22.

[17]"ITU Demanded International Accounting Rates Cut 5-10%" (Jigyousya—Setuzoku Ryoukin, 5-10% Sage Yousei), *Nihon Keizai Shinbun*, April 18, 1997, 9.

> defined simply as an IPL interconnected to the PSTN at one or both ends.[18]

An ISR carrier pays a flat monthly rate for its transmission capacity (i.e., the IPL). ISR carriers do not pay a settlement charge to the underlying facilities-based carriers. Traffic handled by ISR carriers therefore bypasses the international accounting rate regime.

ISR will be permitted in 1997 in Japan and in 1998 in most member nations of the European Union (EU). It is not yet wholly clear what its impact will be on the telecommunications market, but it may be safe to predict that the experience will be educational. According to Staple, "Since 1992, when the U.S. and the U.K. first authorized ISR, it has become a powerful strategic weapon for carriers in a complex game for traffic and revenues."[19] **Table 12-1**, based on Staple, shows that if ISR were permitted, the telephone accounting rate would decrease. According to Staple, once ISR is permitted in the EU market, "as competition drives down accounting rates on key routes and as traffic becomes more balanced, the incentive to use ISR on intra-European routes may be relatively limited."[20] But he also said that the ISR game may finally begin in earnest:

> Two of these alliances, Concert and Global One, have put in place sophisticated international backbone networks. Once ISR becomes lawful in more countries, these new backbone networks may well become the primary means for some of the world's largest carriers in a way which providers the optimal mix of collection charges and settlements for their owners.[21]

Regardless of whether people use ISR or the PSTN, after ISR becomes lawful in most countries, competition will drive down the accounting rates, and then the rate of the PSTN will be cut. In any case, international calls through the PSTN or ISR will be cheaper than now.

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[18]Gregory C. Staple, "A Primer on International Simple Resale: The End Game Has Barely Begun," *TeleGeography 1996/97*, edited by Gregory C. Staple (Washington, D.C.: TeleGeography, 1996), 15.

[19]Ibid. Between the United States and the United Kingdom, ISRs are already permitted. Phone to-phone VOI services have already lost their price advantage: from the U.S. to the U.K. these services are 16¢ per minute. BT commented that it is not afraid of VOI; in its view, ISRs are the real competition.

[20]Ibid.

[21]Ibid.

Table 12-1

The Impact of ISR on Carrier Accounting Rates

Country	Number of ISR Carriers (June 1996)	1995 Total Outbound ISR Traffic (Million Minutes)	Telephone Accounting Rate per Minute (SDR)		
			Route	Before (1991)	After (1995)
Australia	>50	40-80	Aus.–U.K. Aus.–U.S.*	0.70 0.68	0.39 0.308**
Canada	>20	250-300	Can.–U.K.	~0.40	0.20
Sweden	~10	20-30	Swed.–U.K. Swed.–U.S.	0.40 0.50	0.23 0.25
U.K.	>40	~250	U.K.–U.S.	0.53	0.25***
U.S.	>50	200-250	U.S.–Can.	0.20	0.15

ISR = international simple resale SDR = special drawing right (International Monetary Fund's currency unit)

Note: Accounting rates are for largest carrier on each route (AT&T or BT). 1 SDR = $1.4585 on Sept. 1, 1996.
* U.S. ISR applications on this route pending as of Sept. 1996.
** 1996 average for the route, reflecting different Australian rates for terminating traffic in urban, rural, or mobile networks.
*** 1996.

Source: Data from "The Impact of ISR: Carriers, Traffic and Accounting Rates" (Box 4), in "A Primer on International Simple Resale," *TeleGeography 1996/97* (Washington, D.C.: TeleGeography, Inc., 1996), 19.

12.1.4 Technology Cuts Costs of Telecommunications

As the FCC said in the NPRM, "As a result of recent technological advances, the underlying costs of providing telephony are becoming virtually distance insensitive."[22] Thanks to new technologies, the costs of providing telephony have decreased. But, as the FCC pointed out in the NPRM, some systems, such as the access charge and the accounting settlement rates, do not reflect this cost decrease and, for that reason, price will not reflect real cost.

Competition from another category, such as ISR and the Internet, will lead to prices in the telecommunications industry that reflect actual costs.

[22]Before the FCC 96-484, In the Matter of IB Docket No. 96-261, International Settlement Rates, NPRM, Adopted: Dec. 19, 1996. Released: Dec. 19, 1996.

12.2 Internet Pricing

Internet pricing will have an impact on the price of VOI. There are many models of Internet pricing. Some are concerned with controlling network congestion, others with real-time support over the Internet—in other words, QoS—and still others with the issue of internetwork settlements.

12.2.1 Price Diversification

Whatever new Internet pricing models will be adopted, the price of real-time VOI will undoubtedly be higher.

Existing users shifting to increasingly bandwidth-intensive applications will put serious pressure on the Internet's bandwidth. One way to control Internet congestion is "smart market" pricing methods. A "smart market," in the terms of Jeffrey K. MacKie-Mason and Hal R. Varian, requires efficient pricing of the Internet in relation to congestion costs. MacKie-Mason and Varian propose a usage-sensitive charge when the network is congested:

> An efficient pricing mechanism would have the following structure: (1) a packet charge close to zero when the network is not congested; (2) a positive packet charge when the network is congested; (3) a fixed connection charge that differs from institution to institution. Current pricing is almost always limited to a fixed connection charge. The main difference in what we propose is the addition of a usage-sensitive when the network is congested.[23]

MacKie-Mason and Varian described a method to implement efficient pricing for heavily used, congested networks; they think it would be better to use a "smart market," because, on the basis of their analysis, congestion does not have a pattern but is relatively inflexible. Much of the time the network is uncongested, and the price of the usage should be zero. When the network is congested, packets are queued and delayed. MacKie-Mason and Varian think that packets should be prioritized, and pricing too, according to the value the user puts on getting the packet through quickly. Each customer could assign a packet by bid a willingness to pay for immediate service. At congested routers, that packet could be prioritized on the basis of the bid. Real-time audio or visual data could be assigned a high bid price.

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[23]MacKie-Mason and Varian, "Pricing the Internet," 292.

What MacKie-Mason and Varian proposed is a two-component pricing scheme: a flat connection charge, based on such characteristics as type of customer or size of bandwidth, and a per-packet congestion charge assessed when the network is congested.[24]

There are arguments against this proposed scheme: prices in a real-world smart market cannot be updated continuously. And a definition of network congestion is difficult.

Usage-based pricing was also proposed by research at the University of Texas at Austin, funded by the NSF and the Texas Advanced Research Program, which found that "differential pricing based on a user's sense of urgency to send or receive information—essentially a toll on congestion"[25]—would be beneficial to both Internet service providers and users. It found that "usage-based pricing will be more effective in staving off a 'collapse' of the Internet predicted by some observers than would investing hundreds of millions of dollars to bolster its infrastructure."[26]

On this issue, Zachary M. Schrag, for example, found that "New congestion controls could raise the price of realtime traffic."[27] Schrag proposed two possible ways for ISPs to control congestion: usage-base pricing for VOI and two classes of fixed monthly fees for Internet services, a more expensive real-time service and a less expensive delay-tolerant service. According to Schrag:

> 1. ISPs will be able to use RED[28]... to force users into a new pricing regime, in which delay-tolerant and realtime users pay for the level of service they want. The key to such a regime is yet another protocol RSVP. RSVP allows providers to charge additional fees for guaranteed bandwidth. Only those realtime [UDP] stream paying the extra would be allowed through the RED gateway. This would mean that Internet telephony would no longer be unmetered.
>
> 2. The current all-or-nothing approach to blocking UDP could divide ISPs into two classes. Some ISPs could raise their fixed monthly fees, using the money to invest in more capacity for realtime applications, thus forcing realtime users to bear the full cost of their bandwidth demands. Other providers could block out the realtime UDP traffic,

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[24]Hans-Werner Braun and Kimberly C. Claffy, "Network Analysis Issues for Public Internet," in *Public Access to the Internet*, 368.

[25]"Researchers Tout Usage-Based Internet Rates," *Telecommunications Reports* **62**, 45 (Nov. 11, 1996), 26; and "Researchers Say Usage-Based Internet Rates Could Prevent 'Collapse,'" *TR Daily*, Nov. 6, 1996, 5.

[26]Ibid.

[27]Schrag, "The Achilles Hell of Internet Telephony," 40.

[28]"This is the random early detection (RED) congestion control mechanism. Although not specifically designed to handle real-time traffic, RED can be extended to provide different service guarantees for different types of traffic." Ibid., 40.

> keeping congestion down without raising price. whether they choose between providers or between two types of service from the same providers, user will be faced with two classes of Internet services: a more expensive real-time service and a less expensive delay-tolerant service.[29]

Shenker and colleagues advocated "edge pricing," which means that "prices can be determined and changes assessed locally at the access point (i.e., the edge of the provider's network, where the user's packet enters), rather than computed in a distributed fashion along the entire path."[30] Parris and Ferrari offered a scheme for real-time pricing in computer networks that allows users to reserve resources.[31] Wang and colleagues proposed a pricing scheme for flows making network reservations (i.e., asking for a QoS that entails admission control and some assured service level) where prices optimize a given objective function.[32]

According to Mackie-Mason and Varian, both Estrin and Shenker made the important point that if applications require different combinations of network characteristics (responsiveness, reliability, throughput, etc.), then some sort of pricing will be needed to sort out users' demands for these characteristics.[33]

In another work, MacKie-Mason, Murphy, and Murphy proposed responsive pricing[34] and argued that "a feedback signal in the form of a variable price for network service is a workable tool to aid network operators in controlling Internet traffic. They suggested that these prices should vary dynamically based on the current utilization of network resources. In this model, the network provides feedback signals to user in times of congestion. Users can respond by adjusting traffic or quality of service demands."[35]

According to David Clark:

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[29]Ibid.

[30]See Scott Shenker, David Clark, Deborah Estrin, and Shai Herzog, "Pricing in Computer Networks: Reshaping the Research Agenda," *Telecommunications Policy* **20**, 3 (1996), 192.

[31]C. Parris and D. Ferrari, "Resource-Based Pricing Policy for Real-Time Channels in a Packet-Switching Network" [On-line]. URL: <http://tenet.cs.berkeley.edu/tenet-papers.html>

[32]Q. Wang, M. Sirbu, and J. Peha, *An Optimal Pricing Model for Cell-Switching Integrated Service Networks* (Pittsburgh: Carnegie-Mellon University Technical Report [May 1995]), cited in Shenker et al., "Pricing in Computer Networks...," 188

[33]MacKie-Mason and Varian, 282.

[34]Jeffrey K. Mackie-Mason, Liam Murphy, and John Murphy, "The Role of Responsive Pricing in the Internet," in *Internet Economics*, edited by Lee W. McKnight and Joseph P. Bailey (Cambridge, Mass.: MIT, 1997).

[35]Ibid.

> Once we give the user some means to adjust the level of service, it will be necessary to provide some constraint on the user, lest he just flag all his packet as *in*. An obvious approach is to attach some pricing scheme to the mechanism, so that asking for a better service has a higher price.[36]

Clark proposed introducing QoS and argued the need to get the right mechanisms implemented within the Internet to control bandwidth allocation, proposing a scheme he called "expected capacity pricing,"[37] which "has the advantage that users with different usage profiles can be charged different amounts, but the price to each user is fixed and predictable, which permits stable budgeting for network use."[38]

Gupta and colleagues, too, concluded that in the near future the Internet will provide a variety of services through multiple service classes, where each class provides a different performance in terms of response time. They also proposed a priority pricing scheme that can be used to manage a congested network.[39]

Shenker proposed introducing QoS on the Internet in a pricing scheme that would combine usage-based and QoS-sensitive pricing.[40] He categorized the IP application as real-time tolerant, that is, with "loose delay bounds,"[41] and advocated the integrated Internet, which has QoS:

> An efficient integrated services Internet must offer a rich service model that combines real-time service, best-effort service, and a modified virtual leased line service. Moreover, such a service model will only be used efficiently if it is combined with a usage-based and QoS-sensitive pricing scheme. However, the current Internet has neither a rich service model nor an accounting infrastructure capable of supporting sophisticated pricing schemes.[42]

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[36]David D. Clark, "Adding Service Discrimination to the Internet," *Telecommunications Policy* **20**, 3 (1996), 177.

[37]Ibid. Here Clark said that "It is desirable in the future to provide additional explicit mechanisms to allow users to specify different service needs, with the resumption that they will be differentially priced" (180). See also David Clark, "A Model for Cost Allocation and Pricing in the Internet," in *Internet Economics*, edited by McKnight and Bailey.

[38]Ibid., 177.

[39]Alok Gupta, Dale O. Stahl, Andrew B. Whiston, "A Priority Pricing Approach to Manage Multi-Service Class Networks in Real-Time," in *Internet Economics*, 112-151.

[40]Scott Shenker, "Service Models and Pricing Policies for an Integrated Service Internet," in *Public Access to the Internet*, 315-337.

[41]Ibid., 331.

[42]Ibid., 324.

Shenker claimed that, "most importantly, the Internet must adopt standards that mandate a full accounting infrastructure and a rich QoS service interface."[43]

Marjory S. Blumenthal pointed out the architecture side problem: "support for more collection of accounting information, necessary to support billing related more directly to actual use, is under consideration."[44] A working group within the IETF is considering "issues in accounting."[45]

For business users, service distinction has already begun. ISPs plan to provide high-grade Intranet service at a premium price (see **Chapter Ten**).

12.2.2 Internet Connection Pricing

Because more and more people are using the Internet, the bandwidth of the Internet has become scarce. ISPs have begun to increase their bandwidth, and they, too, have become more concerned about bandwidth. If traffic flows are sufficiently symmetric that a "no-settlements" policy is workable, especially given the nearly-zero incremental cost of transport (as long as capacity is sufficient). But according to MacKie-Mason and Varian, "resource usage is not always symmetric, and it appears that the opportunities to free ride on capacity investments by other network providers are increasing."[46]

From the late 1990s on, more and more people will use real-time applications, and securing bandwidth will be necessary. To reserve bandwidth, for example, by using RSVP, some settlement will be necessary.[47]

12.2.3 Access Charge

According to Joseph Rinde, of MCI, speaking at the "Voice on the Net" conference in San Diego, California, in February 1997, "The attraction of Internet voice is partly a consequence of the difference between the access charge levied by local exchange carriers for voice calls versus the no-access charge for data calls." As discussed in **Chapter Eight**, the resolution of this issue will affect price of the Internet, then the price advantage of VOI.

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[43]Ibid., 331. Shenker's basic opinion is "that a network that provides a variety of qualities of service must have detailed pricing because, despite its cost, such pricing is likely to be more cost-effective than doing without a QoS mechanism."

[44]Marjory S. Blumenthal, "Architecture and Economic Policy," *Telecommunications Policy* **20**, 3 (1996), 164.

[45]Ibid.

[46]Jeffrey K. MacKie-Mason and Hal R. Varian, "Economic FAQs About the Internet," in *Internet Economics*, 75-96.

[47]Regarding settlement policy, see Coway, in *Internet Economics*, 94-95.

Rinde used the following examples: that if the access charge for IXCs were cut in half and an access charge were levied for the ISPs, then VOI would lose its advantage.

But according to Andrew Sears, if this were to happen, Internet telephony could not go through the LECs' lines but would instead go through cable companies and cellular providers. Considering this, even if access charges were imposed, they would not strongly impact the price of VOI.[48]

12.2.4 Charging for IP Addresses

Joel Snyder reported that, "With no more government subsidy, the InterNIC will start charging for IP addresses. But these fees may improve the Internet routing system."[49] Although this would be new in North America, Snyder wrote that is already in use in Europe, Asia, and parts of Africa.[50]

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[48]Andrew Sears, "The Effect of Internet Telephony on the Long Distance Voice Market" [On-line]. URL: <http://rpcp.mit.edu/itel/Ideffect.html>

[49]Joel Snyder, "Upside to IP Fees," in *Internet Economics* (April 1997), edited by McKnight and Bailey, 94: "In North America, the registry for IP addresses is the InterNIC, the same company in charge of passing out domain names."

[50]Ibid., 95.

Chapter Thirteen

Customer Needs: Will Residential and Business Markets Accept VOI?

Using [the operating system], we try to integrate computers and communications. If the system, including infrastructures, is upgraded, the user will move simple telephone communications to computer integrated communications.[1]

— Microsoft strategy

Telephony will continue to grow and be important for the future for business. We predict that by 2010, 50 percent of all telephony will conducted via the Internet.[2]

— Vinton Cerf, MCI

As discussed in **Chapter Three**, there are now many VOI software and hardware products. The targeted user has shifted from individual hobbyists and residential users to business users and ISPs.

The order of emergence of the three kinds of VOI—PC-to-PC, PC-to-phone, then phone-to-phone—mirrors the route to universality, that is, ease of use. PC-to-PC VOI is beginning to offer more universality than the earlier kinds of VOI, through eventual standardization (call control, codec, and directory).

13.1 The Business Market

13.1.1 Business Users Use the Internet and Intranets

"In the near future," according to Vint Cerf, "a greater proportion of traffic and revenues will spring from managed Intranet services running within a secure IP backbone network."[3] Business users will certainly need to build their own private networks. In planning to build them, they need to take into account both the initial cost and the cost of running the network, but pricing is not the most important issue: ease of configuration and installation, high reliability, and security are factors of equal weight.

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[1]"Impact of the Internet Telephone," *Telecommunications* (Japan) (Aug. 13, 1996), 33. (Translation by the author.)

[2]"The Cerf Report Archives, Business Is the Future of the Internet," *Internet Expo* (Oct. 17, 1996) [On-line]. URL: <mci.com/technology/ontech/cerfreport1096b.shtml>

[3]Cerf quoted in Kenneth Hart, "Boost for Internet Telephony," *Communicationsweek International* (July 15, 1996), 20.

One reason that ATM has not been used widely in the business market is that this technology is not suitable to company infrastructure. It is the technology for upper 10-Mbps lines, whereas most business users have at most 1.5-Mbps private circuit lines. On the other hand, frame-relay service can transmit data efficiently even at that speed (1.5 Mbps), so businesses can use frame relay, rather than ATM.

Thus, as this example demonstrates, even when the technology is excellent, if it does not fit the business users' infrastructure and, further, if it requires these users to make many changes, as well as an investment in the changes, then the technology is liable to run into difficulty in being accepted by business users.

One reason the Internet is now easily used is the ease of configuration and installation: any kind of computer with any operating system can connect to the Internet and transfer and share data. For business users, precisely this ease of use of the Internet has led them to build their own Intranets.

"Nearly 75% of U.S. companies have already or plan to incorporate Intranets, according to the U.S.-based Business Research Group."[4] In Japan, the percentage is about the same: about 70 percent of business users have already built or plan to build their own Intranets. As discussed in **Chapter Ten**, many ISPs have begun to provide high-grade guaranteed Intranet and Internet VPN services in response to the demand from business users for reliability and security. Thanks to ISPs' offerings, business users now can use guaranteed Intranet services as an equivalent in reliability and security to frame-relay or private-circuit services and at a lower fee.

But even if business users come to use the Internet or Intranets more and more, it remains to be seen whether they will use them for voice communication.

13.1.2 Do Business Users Use VOI—and Will They in the Future?

It seems natural that every network manager of a corporation already using the Internet or an Intranet would consider beginning to use spare bandwidth to carry voice, because most corporations do not use all the capacity of dedicated access lines leased from ISPs. At this point, the manager must also consider not only the initial cost and running costs but also ease of configuration and installation as well as quality and security. As Robin Gareiss pointed out, "The network manager may be able to cost-justify Internet voice. It could be a different story it comes to justifying inconsistent quality."[5]

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[4]Robin Gareiss, "Voice over the Internet: A Progress Report," *Australian Communications* (December-January 1996–97), 82.

[5]Ibid., 81.

The following concerns may lead business users to use an Intranet for voice communication:

- ISPs have begun to provide bandwidth-guaranteed, high-grade Intranet services, which means QoS can be expected.

- Many manufacturers and vendors have begun to develop VOI software and hardware specifically for business users and ISPs. Business users can add the software and hardware to the public branch exchange (PBX) they currently use (so they do not need to replace the PBX), and these technologies also satisfy the demand for reliability. For example, Lucent Technologies' Internet telephony servers[6] will be able to route traffic transparently over either the Internet (or an Intranet) or the PSTN. If the Internet were too congested, for instance, the server could switch the transmission back to the PSTN.

Because, to date, no integrated services Internet architecture that guarantees QoS has emerged, either of the following outcomes may occur:

1. ISPs may provide Intranet service that offer business user voice communication capabilities, or

2. a business user may contract with an ISP for high-grade guaranteed Intranet service and then, by itself, set up a gateway to provide its own voice communication capabilities.

In this way, business users would be able to change their contracts from VPN services to voice-over-a-QoS-guaranteed Intranet.

For communication between businesses and customers, CTI vendors are trying to combine Web and VOI services. For this integrated service, PC-to-PC VOI could be widely used, but that depends on the number of PCs to penetrate the home market and the number of people (customers) using the Web.

Considering voice communication broadly, as **Figure 13-1** shows, not only VOI and voice-over-a-QoS-guaranteed Intranet but also VoFR and voice over ATM all are emerging technologies. VoFR still has problems of quality, but the technique is improving.[7] Thus, for business users, new choices are emerging. According to Sanjay Mewada, an analyst at the Yankee Group (U.S.), VoFR and voice over ATM are more likely to be used than voice over

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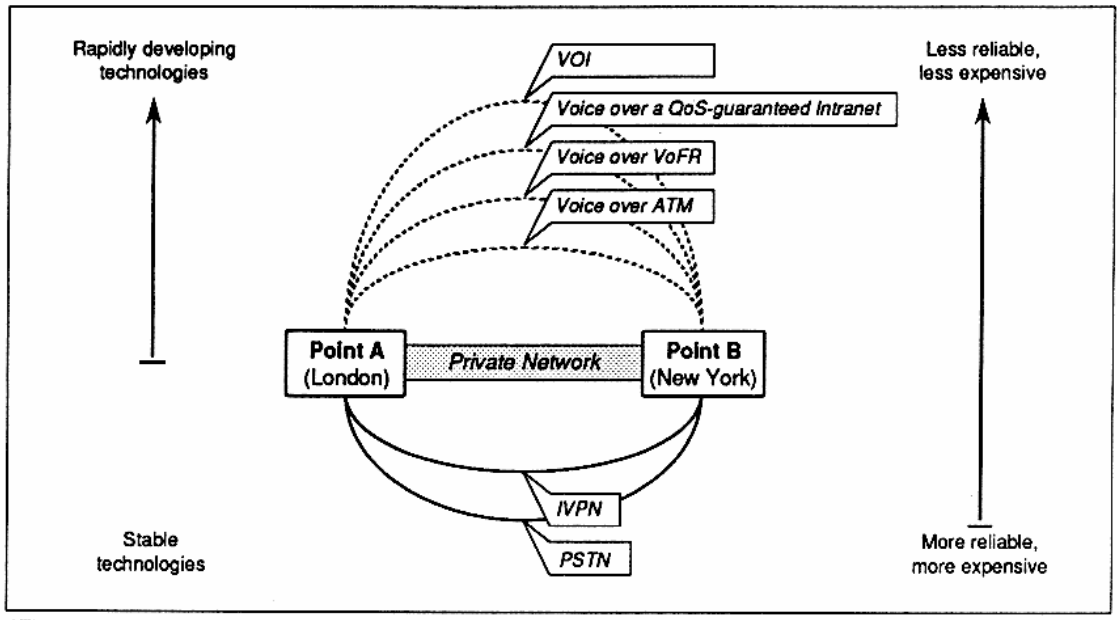
[6]"Lucent Technologies Announces Internet Telephony Servers to Put Voice, Fax and Voice Mail on the Internet," [news release, Sept. 17, 1996]. [On-line]. URL: <lucent.com/press/0996/960917.bcb.html>

[7]Regarding VoFR, see David Newman, Brent Nelson, and Siva S. Kumar, "Voice over Frame Relay, Imperfect Pitch," *Data Communications* (Sept. 21, 1996), 45-56, in which the nine VoFR products were evaluated.



ATM = asynchronous transfer mode
IVPN = international virtual private network
PSTN = public switched telephone network
QoS= quality of service
VOI = Voice Over the Internet
VoFR = Voice over Frame Relay

Figure 13-1

New Choices in Voice Communications for Businesses

IP (VOI and QoS-guaranteed Intranet). Mewada was quoted as saying that "the Internet is a third option for new phone services, behind frame relay and ATM."[8] ATM and frame relay are more reliable, but "The Internet option is more for smaller organizations right now."[9]

In the future, VOI pricing may be usage-sensitive. Zachary M. Schrag pointed this out, saying that if Internet telephony were

> no longer...unmetered...[it] might remain quite cheap...but not free. And cheap and free can be very different when it comes to business models. Given the range of international telecom service available, it is not clear why customers would pay much for Internet telephony when other inexpensive options, like call-back, offer superior quality and convenience.[10]

[8]Quoted in Jon Pepper, "Internet Telephony's New Look," *Information Week* (April 7, 1997), 132.

[9]Ibid.

[10]Zachary M. Schrag, "The Achilles Heel of Internet Telephony," *TeleGeography 1996/97* (Washington, D.C.: TeleGeography, 1996), 40.

According to Schrag, these days there are many services that business users can use more cheaply than before: for voice, these include WATS, VPN, and bypass. Voice compression is another way to cut the price of PSTN, and high voice compression could cut the price of PSTN.[11]

Deregulation and competition from ISRs may decrease traditional telephone fees (see **Chapter Twelve**). Businesses deciding whether to use the Internet or their Intranet for voice communication need to consider many factors.

13.2 The Residential User Market

Residential customers need ease of use, low cost, and entertainment. PC-to-PC communication is becoming easy to use. As of early 1997, a caller and a called party with multimedia PCs can communicate with each other very inexpensively. But not every household has a multimedia PC. According to Raymond James & Associates, PC penetration will be just over half of all homes in the United States alone by the year 2000.[12] PC-to-PC VOI will penetrate the residential market only after people begin to use PCs as easily as they do telephones.

ISPs have begun to provide phone-to-phone VOI services to customers who do not have multimedia PCs. Even though the customers must dial more numbers than is usual, the method is similar to using existing telephones. Because the called party's number for this service is the same as that party's ordinary telephone number, this service is as universal as conventional telephone. But phone-to-phone VOI service has limited access points, which means not everyone can enjoy this cheap conversation over the Internet. Further, the future price advantage of this service is largely open to change. As evident in the fact that between the United States and the United Kingdom, ISR is already permitted, phone-to-phone VOI services no longer offer a price advantage over ISR.

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[11]Basic voice compression is pulse-code modulation (PCM) operating at 64 kbps, but adaptive differential PCM (ADPCM) at 32 kbps and code-excited linear prediction at 16 kbps are now used. In March 1996, the ITU-T adopted 8 kbps as standard G.729.

[12]According to a report prepared by Raymond James & Associates, *The Internet and New Media Gold Rush*, "Within the United States there are about 37 million households with computers, representing about 38% of the total. In the year 2000, e-land projects 52 million households will own computers which should be just over half of all homes" (9).

Chapter Fourteen

Conclusion

This report has summarized what VOI is, how it works, and the circumstances surrounding it. Even if the progress of VOI were observed over only six months, that progress would be amazing. No one, it seems, can stop its growth. Many software and hardware products related to VOI are now offered. But is VOI a fad or the future?

From the technical viewpoint, voice applications have been improving, and developers are trying forge a standard in order to promote interoperability. (Even if congestion yields transmission delays, some VOI applications now can tolerate them.) But latency, or delay in voice signal delivery, has been the biggest thorn on the VOI rose and remains an issue.

> For that reason, most hardware and software suppliers, as well as carriers, say the voice-over-IP networks revolution won't use the Internet, but rather IP networks largely shielded from the Internet—such as local area networks, or LANs; Intranets; and...VPNs—to deliver voice and data.[1]

If the architecture of the Internet moves from single-level, best-effort service to a more complex model with explicit options for QoS, to support real-time applications such as video and audio, the quality of VOI will be much better. Further, enlarging the Internet backbone and increasing the speed of access lines also will help to relieve congestion and, then, to improve voice quality.

Supporting a real-time application over the Internet may sound difficult, but, it may happen because many different kinds of strong promoters are in place. There are strong demands on the Internet and on Intranets, such as for better quality and greater reliability and security, and vendors and working groups (developers and manufacturers) are trying to make a new Internet architecture and new products to address these needs: a new protocol (IPv6, RSVP) and IP switching, giga routers, and ADSL modems. Unless the Internet were to disappear, more and more Internet-related products will continue to be made and sold. Industry, including telecommunications carriers, will continue to try to enter and find markets on this stream, rather than stop the stream, because—there is a market there. And ISPs still struggling (they are in the red) have a good reason to change Internet pricing. All these factors may bring about a change in the Internet architecture and Internet pricing in the near

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[1]"Voice-over-IP Changes Business Communications," *Inter@ctive Week* (March 24, 1997), 70.

future.[2] When that time comes, VOI as a real-time application over the Internet will cost more than today.

Before these changes occur, VOI will be used on Intranets, because Intranets are more reliable than the Internet. Since the beginning of 1997, most large ISPs have begun to offer high-guarantee Intranet service. Companies using it do not need to build an Intranet by themselves—that is, they do not need to build a private network, such as a frame-relay network, by buying one from the carriers. ISP service is cheaper than carrier service, and its reliability and privacy are guaranteed by the ISP, so the companies do not need to manage the network themselves. For business users, this prospect offers more choice. But more broadly, VoFR and voice over ATM are emerging. Which service is better remains an open question.

From the political viewpoint, both the United States and Japan are trying to promote the Internet. In the United States, regulation of the Internet and of telecommunications may change. ACTA's petition to the FCC requested regulation of VOI allowed the FCC to reconsider its categories of basic, enhanced, and information services. As of early 1997, the FCC has tentatively decided to continue to exempt VOI from the access charge. Still, the unfair competition between IXC and phone-to-phone VOI service providers remains. Not all kinds of VOI that ACTA petitioned to have regulated but at least phone-to-phone VOI services may need to be regulated. If people use VOI more and more, the revenues of the IXCs will be eroded, and with the decreasing access charge revenue paid by the IXCs to LECs, the LECs will be unable to offer their services. If that happens, the FCC may need to levy access charges on the ISPs or to tax the ISPs in order to continue otherwise decreased support for universal service.

Major deciding factors for the future of VOI will include customer preferences, interoperability, quality of service, advantageous pricing, and ubiquitous connection on a level with today's PSTN.

Although the current price advantage of phone-to-phone VOI is likely to evaporate as phone charges go down and Internet charges rise, enthusiasm for multimedia connections and voice communication suggest that PC-to-PC VOI, which provides both, is likely to remain a method of communication in the future.

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[2]In March 1997, MCI announced it will provide Internet QoS. "The standard level will be used for e-mail-type traffic and the priority service level will typically be used for mission-critical or delay-sensitive traffic. These QoS capabilities will first be deployed in Concert's InternetPlus international service in the summer of 1997." See Denise Pappalardo, "MCI Promises Internet QoS Services," *Network World* (March 31, 1997), 13.

Acronyms

ACDs	automated call distributors
ACTA	America's Carriers Telecommunications Association
ADSL	asynchronous digital subscriber line
ANS	Advanced Network and Services
AOL	America Online
API	application programming interface
ARPA	Advanced Research Projects Agency
ASP	Access Service Provider
ATM	asynchronous transfer mode
BT	British Telecom
CIR	Committed Information Rate
codec	compression and decompression (code[r]-decode[r])
CTI	Computer Telephony Integration
DATA	Digital Affordable Telecommunications Access Coalition
DM	direct mail
DOD	Department of Defense
DSP	Digital Signal Processor
e-mail	electronic mail
ESPs	enhanced service providers
EU	European Union
FCC	Federal Communications Commission
FDDI	fiber distributed data interface
FIFO	first-in-first-out
FTP	file transfer protocol
GSM	global system for mobile communications
GXC	global eXchange company
HDSL	high-speed digital subscriber line
IDC	International Data Corporation
IDT	Internet Discount Telecommunications
IETF	Internet Engineering Task Force
IIJ	Internet Initiative Japan
ILEC	incumbent local exchange carrier
IMTC	International Multimedia Teleconferencing Consortium
IP	Internet Protocol
IPL	international private line
ISA	Integrated Services Architecture
ISDN	integrated services digital network
ISP	Internet service provider

ISR	International Simple Resale
ITAA	Information Technology Association of America
ITI	Information Technology Industry Council
ITU	International Telecommunications Union
IVC	Internet Voice Chat
IXC	IntereXchange carrier
JT	Japan Telecom
kbps	kilobits per second
KDD	Kokusai Denshin Denwa
kHz	kilohertz
km	kilometers
LANs	local area networks
LDAP	Light-weight Directory Access Protocol
LEC	local exchange carrier
Maven	Mac AV ENabler
Mbps	megabits per second
NCC	new common carrier
NPRM	Notice of Proposed Rulemaking
NRIC	Network Reliability and Interoperability Council
NSF	National Science Foundation
NTIA	National Telecommunications and Information Administration
NTT	Nippon Telegraph and Telephone
OCN	Open Computer Network
ODN	open data network
PBX	public branch exchange
PSTN	public switched telephone network
QoS	quality of service
RBOC	regional Bell operating company
RED	Random Early Detection
RFC	Request for Comments
RSVP	Resource ReServation Protocol
RTCP	real-time control protocol
RTP	real-time protocol
SNA	System Network Architecture
SONET	synchronous optical network
SR	simple reseller
TAPI	Microsoft's Telephony API
TCP	Transmission Control Protocol

TELRIC	total-element long-run incremental cost
TTNet	Tokyo Telecommunications Network
UDP	User Datagram Protocol
ULS	user location service
URL	uniform resource locator
UUCP	Unix to Unix Copy Program
vBNS	Very High-Speed Backbone Network Service
VoFR	Voice over Frame Relay
VOI	voice over the Internet
VoIP	Voice over Internet Protocol
VON	Voice on the Net Coalition
VPN	virtual private network
VRU	voice response units
WANs	wide area networks
WATS	wide area telephone service
WTO	World Trade Organization