# THE PROSPECTS FOR INTERNET TELEPHONY IN EUROPE AND LATIN AMERICA

## TPP 127 Telecom Modeling and Policy Analysis


**Team members :**

Dionne Baxter
Mahesh M. Bhatia
Pam Campos
Bertrand Delcaire
Sawan Deshpande
Gonzalo Figuera
Jessica Gama
Eduardus Isworo
Mugo Kibati

**Technology and Policy Program**

**Massachusetts Institute of Technology**



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## 1. INTRODUCTION

As recently as two years ago Internet telephony was considered a side technology of interest only to hackers. In the last 18 months, however, improvements in quality of service and the creation of gateways have made Internet and telecom companies look twice at this technology. As a technology that demonstrates the final convergence of data communications, computing, and telephony, Internet telephony is not only a potentially important service for Internet Service Providers, but also an example of the important role of networking technologies in the future. Already, many trunk networks are packet switched using such technologies as frame relay and ATM. From this perspective, voice over IP is merely the extension of packet-switching to the local loop.

The market for international phone calls remains one of the most lucrative telecommunications markets. This is in part due to regulatory agreements and in part due to lack of competition. For this reason, it is quite likely that the emergence of Internet telephony on a large scale will take place in the international area. In addition, as telecommunications becomes more important for establishing the competitive advantage of different regions, governments are gaining interest in creating policies to foster growth in this area.

While many global areas might take advantage of lower international calling rates, this report focuses on two countries within the European Union, and one emerging market, Mexico. France and Spain offer an opportunity to examine the importance of new telecommunication issues in the context of the evolving European Union. Mexico, provides an opportunity to examine how emerging markets might make policy decisions relevant to the development of their information infrastructure.

This paper compares the cost of establishing an Internet Service Provider (ISP) that provides Internet telephony service in Mexico, the European Union, and the US. It presents the status of the Internet market in Mexico, Spain and addresses the potential for Internet telephony growth in Mexico, Spain, and France. Finally, the costs for these international ISPs are compared to those of a US based ISP.

In all three regions that this report addresses, there have been significant efforts to deregulate the telecommunications industry and promote market based competition. Since market entrants make investments based on the likelihood of gaining a profit, we have focused our analysis on the costs and revenues of an individual ISP. This report provides preliminary information about the main cost and revenue elements , and makes recommendations about possible policy ramifications. While this report doesn’t incorporate Internet-PSTN gateways, it does provide an initial assessment of the feasibility of providing Internet telephony service.

The first section introduces the technical structure of internet telephony, focusing on the costs and benefits of packet switched telephony. The second section examines the market structure, including regulatory issues, in the three countries considered. Section 4 introduces the cost model and its results with sensitivity analysis. Finally, policy implications are developed in the concluding section.

# 2. TECHNICAL OVERVIEW OF INTERNET TELEPHONY

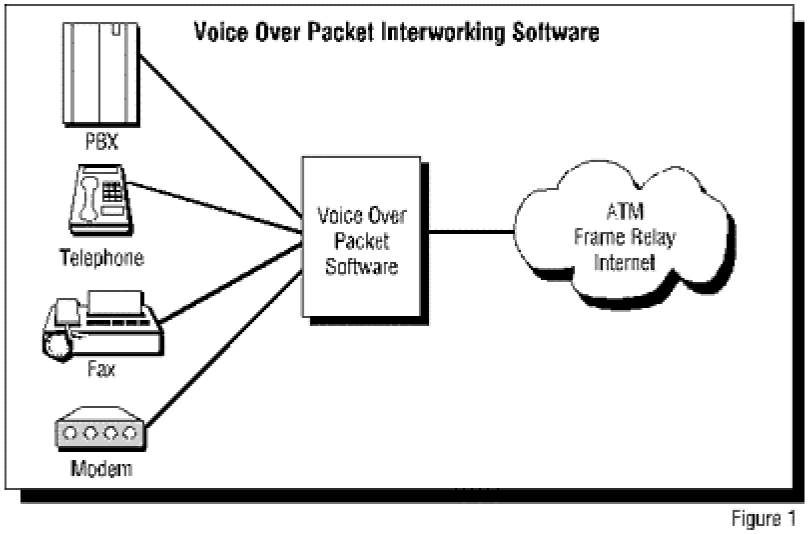
## 2.1 Description of The Generic Service

Internet telephony differs from traditional telephony in two fundamental ways. First, rather than using the public switched telephone network (PSTN) normally provided by long distance telephone companies, Internet (or Web) phones use the network or combination of networks that make up an Internet connection (the Internet). Second, digital data that describes the voice signal is transmitted rather than the analog signals that are customarily transmitted by telephone companies. Unlike the PSTN network which employs a circuit switching technique, the Internet uses a packet switching technique. In the case of circuit switching, a dedicated physical connection is first established between the sender and the receiver. This connection is maintained during the entire duration of the conversation. Packet switching, on the other hand, does not establish a dedicated connection. Instead, packets are constructed with source and destination addresses that allow them to work their way through the internetwork and find the receiver.

The development of voice over packet applications that meet the challenges of combining legacy voice networks (PSTN) and packet networks (such as the Internet) by allowing both voice and signaling information to be transported over packet networks have provided the impetus for the growth of Internet telephony. The Internet is only one of a general class of protocols (the others include ATM and Frame Relay) that are able to transport voice over packet networks as a result of the development of modular software objects.

Typically, when making a call over the Internet, the caller speaks into the computer's microphone, and special software converts the voice signal into digital data "packets" that are the medium by which signals are transported over the Internet. After transmission via the Internet, these packets are collected by the receiver's computer and converted back to a voice signal that can be heard via the receiving computer's speakers.

***Figure 2.1.*** *Voice over packet Internetworking software*




*Source: Introduction to Internet Telephony (Phonezone)*

## 2.2 Brief Description Of The Component Technologies

Strictly speaking, Internet telephony is not just a service. Rather, it also encompasses the collection of software components that users install on their computers. Internet telephony requires equipment for recording and generating sound, plus software to transform and adapt it into transmission units that may be transported as Internet traffic. In addition, users need a direct connection to the Internet, such as from AT&T or local Internet-access services.

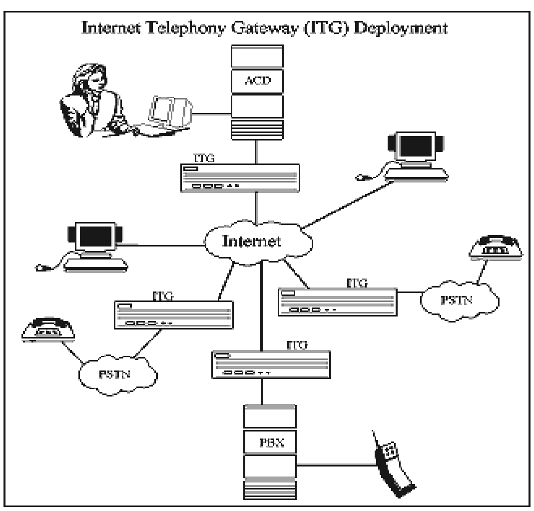
To enable the transmission, the sender's computer samples the sound generated by the sender and digitizes it using an analog-to-digital converter (a modem). After digitization, audio compression software known as codecs (for compression/decompression) compresses and breaks the digitized signals into more manageable transmission units known as packets. These packets which in addition to the digitized data bear the address of the receiver's computer system (destination address), are multiplexed with other traffic and sent out to the Internet. Relying on the address information in the packets, Internet routers and servers direct these packets over the Internet until they arrive at their destination. The receiver's computer collects and reassembles the packets, passing them up to higher layers of software that decompress the data and perform digital to analog conversion. The resulting signals are then relayed to speakers on the receiver's computer.

## 2.3 Different Internet Telephony Formats

In addition to the more common personal computer (PC) to PC format, there are two other ways in which an Internet based telephone call can be accomplished:- PC to telephone or vice versa; and telephone to telephone. However, in order to achieve the interface between PSTN networks and the Internet, Internet telephony gateways that link the two networks are necessary.

A telephone to telephone call works as follows:- The caller connects to an Internet telephony gateway over the PSTN. In an office setting, callers may simply dial a specific extension or precede the phone number they are dialing by a special string of digits. The Internet telephony gateway answers the call and prompts the caller to enter the phone number (including country code and area code) of the party they wish to call. The Internet telephony gateway will then look for the remote gateway that is local to the called party. The second gateway will attempt to locate the called party by placing a local PSTN call. Once the connection is established voice travels from the PSTN on and off the Internet between parties.

***Figure 2.2. Internet telephony gateway deployment***




*Source: IP Telephony Basics (Dialogic)*

## 2.4 Technical Contrast with Traditional Circuit Switched Telephony

When contrasted to the circuit switched mechanism of the traditional telephone (PSTN) networks, the packet switched technique employed by Internet telephony is cost effective and makes efficient use of bandwidth because of data compression[1] and because network resources are only utilized when actual data is being transmitted. During pauses, when no actual conversation (and hence data transfer) is taking place, these resources are released for use by other Internet telephony connections. Circuit switching makes inefficient use of scarce bandwidth by tying up the network even when no actual signals are being transmitted.

Packet switching, however, has its downside. It is an unreliable and low quality means of communication because the lack of a dedicated connection causes delays and even complete loss of some of the transmitted packets.

Within the confines of existing technology, a choice of Internet telephony over PSTN means that one picks efficiency and cost effectiveness over reliability and quality of service.

### 2.4.1 Quality of Service

While Internet telephony is beginning to find commercial use, most real-time applications remain experimental because sound quality remains low for the vast majority of Internet users. The advantages of reduced cost and bandwidth savings of carrying voice over packet networks such as the Internet are associated with some quality of service issues unique to packet networks. The most notable drawbacks include:- 1) Slow transmission speed for most users. The bandwidth of each user's Internet connection determines how many digitized bits can be transmitted at one time, and therefore the accuracy with which sound is reproduced. In most cases sound quality is not as good as in PSTN telephones, although this could be remedied in the future as more users demand higher bandwidth and the demand causes costs to decrease; 2) Unreliability. Because all Internet traffic is broken into packets and sent over a variety of channels rather than a dedicated circuit, users can experience short delays; 3) Half-duplex connections. Many products allow only one party to talk at a time.

The following are the technical impediments to high service quality:

[1] Strictly speaking, compression is a factor of digitization and not necessarily packetization. Consequently, digital

#### 2.4.1.1 Delay

Delay causes two problems - echo and talker overlap. Echo is caused by the signal reflections of the speaker's voice from the far end telephone equipment back into the speaker's ear. Echo becomes a significant problem when the round trip delay becomes greater than 50 milliseconds. Since echo is perceived as a significant quality problem, voice over packet systems must address the need for echo control and implement some means of echo cancellation.

Talker overlap (or the problem of one talker stepping on the other talker's speech) becomes significant if the one-way delay becomes greater than 250 milliseconds. The end-to-end delay budget is therefore the major constraint and driving requirement for reducing delay through a packet network.

Following are the sources of delay in an end to end voice over packet call:

- ***Accumulation Delay*** (sometimes called algorithmic delay): This delay is caused by the need to collect a frame of voice samples to be processed by the voice coder. It is related to the type of voice coder used and varies from a single sample time (.125 microseconds) to many milliseconds.
- ***Processing Delay*****:** This delay is caused by the actual process of encoding and collecting the encoded samples into a packet for transmission over the packet network. The encoding delay is a function of both the processor execution time and the type of algorithm used.
- ***Network Delay:*** This delay is caused by the physical medium and protocols used to transmit the voice data, and by the buffers used to remove packet jitter on the receive side. Network delay is a function of the capacity of the links in the network and the processing that occurs as the packets transit the network. The jitter buffers add delay which is used to remove the packet delay variation that each packet is subjected to as it transits the packet network. This delay can be a significant part of the overall delay since packet delay variations can be as high as 70-100 milliseconds in some Frame Relay networks and IP networks.

#### 2.4.1.2 Jitter

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circuit switched systems can also utilize compression techniques to reduce bandwidth requirements.

The delay problem is compounded by the need to remove jitter, a variable inter-packet timing caused by the network a packet traverses. Removing jitter requires collecting packets and holding them long enough to allow the slowest packets to arrive in time to be played in the correct sequence. This causes additional delay[2].

#### 2.4.1.3 Lost Packet Compensation

Lost packets can be an even more severe problem, depending on the type of packet network that is being used. Because IP networks do not guarantee service, they will usually exhibit a much higher incidence of lost voice packets than connection oriented networks such as ATM. In current IP networks, all voice frames are treated like data. Under peak loads and congestion, voice frames will be dropped equally with data frames. The data frames, however, are not time sensitive and dropped packets can be appropriately corrected through the process of retransmission. Lost voice packets, however, cannot be dealt with in this manner.

*Solutions*

Some schemes used by voice over packet software to address the problem of lost frames are:

- Interpolate for lost speech packets by replaying the last packet received during the interval when the lost packet was supposed to be played out. This scheme is a simple method that fills the time between non-contiguous speech frames. It works well when the incidence of lost frames is infrequent. It does not work very well if there are a number of lost packets in a row or a burst of lost packets.
- Send redundant information at the expense of bandwidth utilization. The basic approach replicates and sends the nth packet of voice information along with the (n+1)th packet. This method has the advantage of being able to exactly correct for the lost packet. However, this approach uses more bandwidth and also creates greater delay.
- A hybrid approach uses a much lower bandwidth voice coder to provide redundant information carried along in the (n+1)th packet. This reduces the problem of the extra bandwidth required, but fails to solve the problem of delay.

#### 2.4.1.4 Echo Compensation

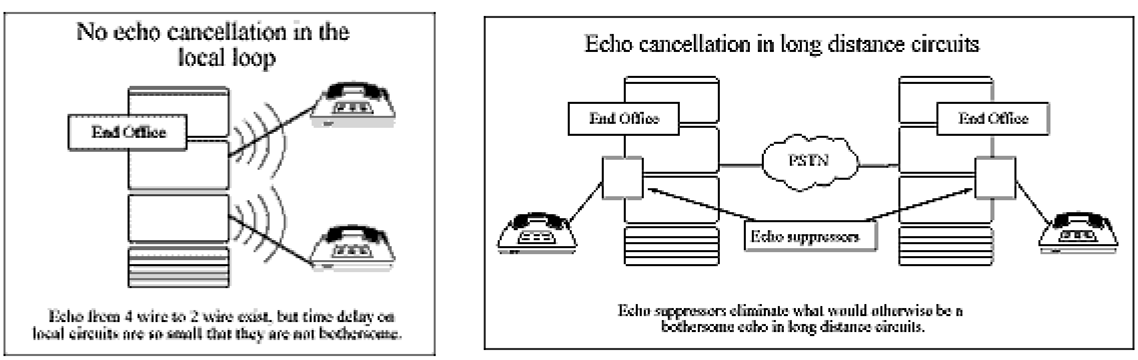
[2] The two conflicting goals of minimizing delay and removing jitter have engendered various schemes to adapt the jitter buffer size to match the time varying requirements of network jitter removal. This adaptation has the explicit goal of minimizing the size and delay of the jitter buffer, while at the same time preventing buffer underflow caused by jitter.

Echo in a telephone network is caused by signal reflections generated by the hybrid circuit that converts between a 4-wire circuit (a separate transmit and receive pair) and a 2-wire circuit (a single transmit and receive pair). These reflections of the speaker's voice are heard in the speaker's ear. Echo is present even in a conventional circuit switched telephone network. However, it is acceptable because the round trip delays through the network are smaller than 50 milliseconds. and the echo is masked by the normal side tone every telephone generates. Echo becomes a problem in voice over packet networks because the round trip delay through the network is almost always greater than 50 milliseconds. Echo cancellation techniques are employed to combat the echo

*Solutions*

Thus, echo cancellation techniques are always used. ITU standard G.165 defines performance requirements that are currently required for echo cancellers. Echo is generated toward the packet network from the telephone network. The echo canceller compares the voice data received from the packet network with voice data being transmitted to the packet network. The echo from the telephone network hybrid is removed by a digital filter on the transmit path into the packet network.

***Figure 2.3.*** *Source: IP Telephony Basics (Dialogic)*



## 3. MARKET AND REGULATORY OVERVIEW

### 3.1. Mexico

#### 3.1.1. The Mexican Telecommunications Market

The telecommunications industry in Mexico has recently experienced a significant change in its regulatory and market structure. After many years of government control, the telecommunications regulatory body, the Secretaria de Comunicaciones y Transportes (SCT) decided that it should reduce its participation in the economy to foster improvements in different sectors. During the last eight years, the government has reformed the telecommunication industry by allowing private ownership and promoting competition. After witnessing the global trend towards privatization and neo-liberal reforms, Mexico was one of the first countries in the world to fully implement the now widely accepted two phased reform process: first privatize the state telephone monopoly and then deregulate the industry. In Latin America, Chile was the first to initiate the process in 1982, and this process was subsequently adapted for use in Mexico. The process of reform of the Mexican telecommunications industry was started in 1989 when the quality of telephone service provided by the state monopoly Telmex (Telefonos de Mexico) declined to a very low level. Initially, the government decided to partially sell Telmex and subsequently relinquished its entire stake in mid-May 1992. [3]

Between 1989 and 1997, the level of service and the degree of telephone penetration have improved, both in quantitative and qualitative measurements. Competition in the long distance telecommunication sector has been introduced in January 1997. However, even now the public telecommunication revenue per capita and the public telecommunication investment per capita in 1995 are among the lowest among the OECD countries. The density of telephones was about 9.7 lines per 100 inhabitants in 1996. This number is the lowest in the list of OECD members.[4] The estimated value of the telephone market in 1996 was close to US $5 billion. Among the

[3] Gonzalez, Gupta and Deshpande, "Telecommunications in Mexico", Telecommunications Policy, UK. To be published, May1998

[4] Gonzalez, Gupta and Deshpande, "Telecommunications in Mexico", Telecommunications Policy, UK. To be published - May1998.

emerging markets, only Brazil surpassed this number with revenues close to US $9 billion.[5] Revenues from international traffic account for more than 40% of total sales, which is a very high percentage; in developed countries, the percentage is under 15%.

The Telmex network is, and will continue to be, for many more years, to be the largest in terms of coverage and capacity in Mexico. The new competitors will depend on the Telmex network to offer services in places not covered by their own networks. This means that even when Telmex loses customers, it will continue to receive payments for part of the traffic. As in US, UK and Chile, the original monopoly will maintain its leadership position for several years.

### 3.1.2. Internet and Internet Telephony

The Internet began to expand in Mexico in 1987. Mexnet AC, an organization of educational institutions dedicated to promoting the development of an Internet backbone in Mexico, introduced service in 1992. They designed and operated the first national 64 Kbps Internet backbone in Mexico. Mexnet launched an initiative in 1994 to develop and promote WWW services in Mexico.

Since 1994, there has been an explosion in new private ISPs in Mexico. CompuServe (recently acquired by AOL), Infosel, Datanet and Internet de Mexico are some of the largest in terms of sheer subscriber numbers. Almost all of these are concentrated around Mexico City. TELMEX (ILEC) is launching a major Internet initiative, however, through its Uninet subsidiary, and even the new basic service concessionaires (CLECS) are having a major impact on the industry. Finally, a handful of cable television (CATV) operators are cutting over the high-speed Internet service over the hybrid fiber coaxial networks.

There are approximately 400,000 Internet users in Mexico. The Internet market in Mexico is relatively small given the population of Mexico, but has experienced rapid growth over the past few years. The phenomenal growth was primarily due to the Internet's status as a start-up in accordance with the classic "S" shaped growth curve. After the introduction of the Internet via

[5] Analysis Consultancy Homepage (1997)

the academic market in the early 1990s the next growth wave happened in the middle and upper-income residential market. During 1995-1996, the growth in executive domain names (.net – mostly ISPs) has remained relatively flat. The bulk of the Internet growth is coming largely from telecommuters or professionals such as architects, accountants, and lawyers that have private practices. Internet use for strictly non-business purposes is still relegated to the upper and the upper-middle classes which comprise a very small proportion of the total population because of Mexico's skewed income distribution.

In terms of Internet hosts, Mexico’s host count grew from approximately 6,700 at the year-end 994 to nearly 30,000 at the year-end 1996, a compound annual growth of 112%. The Internet market in Mexico for 1997 was valued at $ 50 million. Only a few of the ISPs have started providing Internet telephony services on a very small scale.

### 3.1.3. Regulation

In order to promote new investments, enhance telephone penetration, improve service quality, and reduce prices, the government decided to radically change the structure of the telecommunications industry and its regulatory bodies in 1990. The new telecommunication regulations, announced in October 1990, aimed to provide clear rules to offer a fair industry structure for all participants.

Since then, the deregulation process has touched all aspects of the telecommunications industry. In May 1995, the Mexican Legislature enacted a new telecommunications law, which became effective on June 8, 1995. The law regulates the use of frequencies, telecommunication networks, and communication via satellite. The law and its implementing regulations replaced the former 1990 regulations and the 1940 Communication Law. Full competition in long-distance started on January 1, 1997 with the participation of eight companies. Deregulation in local services was announced in 1990, but the first concessions were granted only in April 1997. A new satellite agreement allows the reciprocal use of international satellites for transmission of DTH signals. The Mexican Satellite system will also be privatized in 1998, though the exact terms and future service concessions are still under review by both the SCT and Telecomm. In

February 1997, the Mexican Government picked four companies to receive the nation's first licenses to operate the public telephone services. The laws have not yet addressed the issue of Internet services, as they are still in the incipient stage of development. Eventually ISPs will become a significant portion of the telecommunication market, and may become subject to regulatory scrutiny.[1]

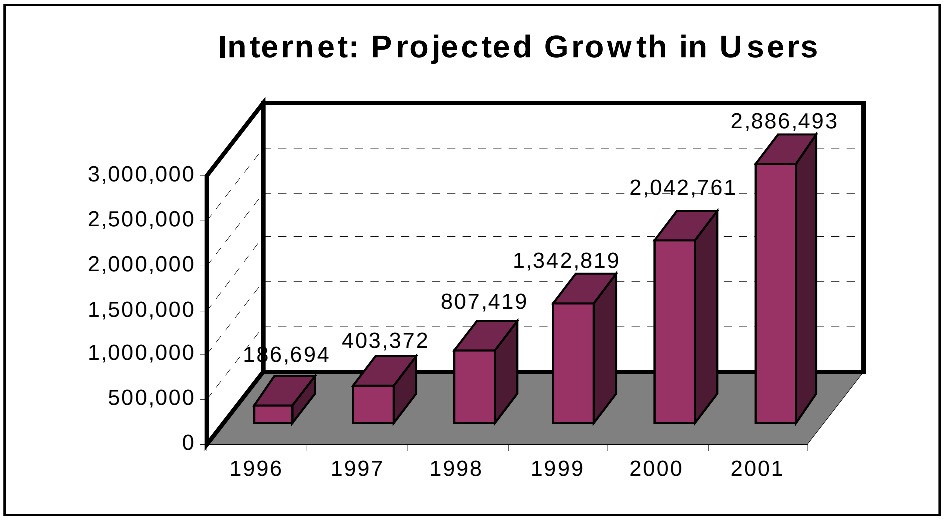
On August 8 1996, the government issued a decree establishing an independent autonomous regulatory body called Comision Federal de Telecomunicaciones, COFETEL, or Federal Commission for Telecommunications (FTC), to function as the equivalent of the FCC in the US. This agency is responsible for overseeing that all participants in the market honor the terms and conditions, included within each license/permit/concession, and also that smooth transition to competition-based telecommunication policy occurs in Mexico. The SCT still retains the decisive powers over the concessions, licenses and permits (including terrestrial and satellite).

### 3.1.4. Future Prospects Of The Internet In Mexico

Moving forward, it is estimated that the Internet hosts in Mexico will grow from a base of over 35,000 at the year end 1997 to nearly 552,000 by the year end 2002, a compound annual growth rate of 73%.

The bulk of the growth in the Internet services in the coming years will come from the business market. This is due to the large and increasing number of PCs in the Mexican businesses and because of the falling price of the PCs and modems in Mexico. Many market participants from both the operators and vendor sides of the market are extremely excited by the potential of electronic commerce in Mexico. Although, this has not yet taken off, there is much hope in its room for upside expansion.

**Figure 3.1 – Projected Growth of Internet Users in Mexico**




*(Source: Communications Outlook, 1997 Vol. 1)*

One of the primary factors which will drive the growth in Mexico's Internet market in the coming years is falling prices for dial-up and dedicated access as competition increases. One of the most important impetuses behind this drop in the prices is the entry of public carriers into the market. TELMEX has already launched an offensive in the market, and many of the newly licensed long distance and local basic service concessionaires will do likewise. In the business segment, an increase in the number of enterprises with LANs will drive demand for LAN connectivity to the Internet.

## 3.2. Europe

### 3.2.1. The European Telecommunications Market

Before 1990, the telecommunications industry in European countries was under the sole dominance of government controlled and regulated PTTs that provided both local and long distance service. The major PTTs include France Telecom of France, Deutsche Telecom of Germany, British Telecom of the UK, Telefonica of Spain, Alitalia of Italy and Telia of Sweden. However, in 1990, on June 28$^{th}$, the EU issued Directive 90/388/EEC ordering deregulation of the telecommunications markets in 10 of its 15 member countries by January 1, 1998. Member countries were directed to establish independent regulatory bodies, assign frequencies and pass legislation and implement measures to adopt competitive standards and access for leased lines voice telephony licensing and interconnection.

As a result the telecommunications market in Europe has begun to open up to competition from other national and international providers, as well as competitors from the utilities and cable industries. The key difference between telecommunications deregulation in the in Europe and the U.S. is that deregulation is occurring simultaneously in local, long-distance and international services in the EU. The EC's Directorate General XIII is responsible for telecommunications issues surrounding the directive in EU Member countries. Monitoring of liberalization practices in the Member countries is needed to make sure that all markets are open to new entrants. According to a report issued by the Economic Commission in February, 1998, all of the countries met requirements for establishing independent regulatory bodies and assigning frequencies, but some nations, especially Greece, Portugal and Spain, were slow in making changes on issues such as leased lines, licensing and interconnection.

**3.2.1.1. France**

Telecommunication development is quite advanced in France. At the end of 1997 there were a total installed based of over 31 million conventional lines, yielding 53.7 telephone lines per one hundred inhabitants. At the same time there were over 2 million ISDN lines, yielding 3.7 ISDN lines per 100 inhabitants.[6] In France, telecommunications related issues are overseen by the Ministry of Economy, Finance and Industry and the Secretariat of State for Industry. In July of 1996, the law on Telecommunications regulation delineated the new sharing of regulatory tasks within the State. The DGPT (Direction Générale des Postes et Télécommunications) was replaced by three separate organizations:

- ♦ ART (Authority of Telecommunications Regulation) which monitor competitive conditions in France. With the opening of the telecommunications industry in France, ART's primary focus has been in providing telephony licenses to new market entrants;

[6] "Basic Indicators – France," EC Information Society Project Office. Full report available at www.ispo.cec.be/esis/Basic/Frbasic98.htm.

- ANF (National Agency of Frequencies) which serves as an administrative and public organ responsible for radio spectrum management;
- Ministry in charge of telecommunication that retains general regulatory power.

In compliance with the EU directive to liberalize the telecommunications industry, fixed telephony licenses have been granted to Lyonnaise Cable, Cégétel, Bouygyes Telecom, Omnicom, Siris, and Esprit Telecom to allow them to compete with the incumbent France Telecom.

#### 3.2.1.2. Spain

Telecommunications is less developed in Spain than in France. At the end of 1996 there were over fifteen million conventional lines in Spain, yielding 39.3 lines per one hundred inhabitants. In addition there were approximately 96,040 ISDN subscriptions, which translates into .24 ISDN subscriptions per 100 inhabitants.[7]The EU has given Spain an extension until December 21, 1998 to completely open up its telecommunications market to competition.

Telefonica de España is the incumbent telecommunications PTT in Spain. Retevision, the second fixed-line Spanish telecom company, entered the Spanish telecommunications market in January 1998 and has begun to compete aggressively with Telefonica in the area of providing both telecommunications and Internet service. To date Retevision has claimed three per cent of the Spanish market for inter-provincial and international calls, selling approximately 1,000,000 minutes per day.

### 3.2.2. The European Internet Market

The European market is the newest and largest growth area for the Internet. Online subscriptions are increasing at a rate of 30% annually despite the fact that unlimited monthly access costs

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[7] "Basic Indicators – Spain," EC Information Society Project Office. Full report available at www.ispo.cec.be/esis/Basic/ESbasic98.htm.

averages $75, almost three times the rate in the United States.[8] Throughout the European Union there are approximately 70 million PCs and 2165 Internet access providers.[9] Currently there are more than twenty million Internet users throughout all of Europe.[10] Approximately eighteen of the twenty million Internet users lie within the economies of the European Union.[11] As a result of the deregulation of the telecommunications markets in the EU countries, phones, cable and other infrastructure costs should fall, making the Internet market even more competitive. Figure 3.2 illustrates the forecasted growth of Internet Users in the European Union.

***Figure 3.2 – Growth of Internet Usage in the European Union***

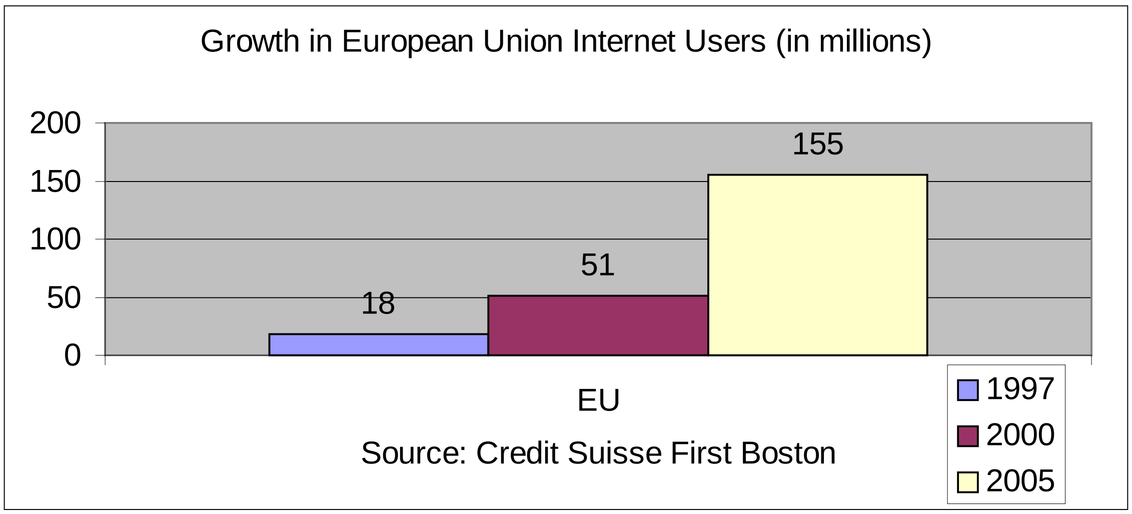


Figure 3.3 depicts the growth in Internet hosts for selected countries in Europe.

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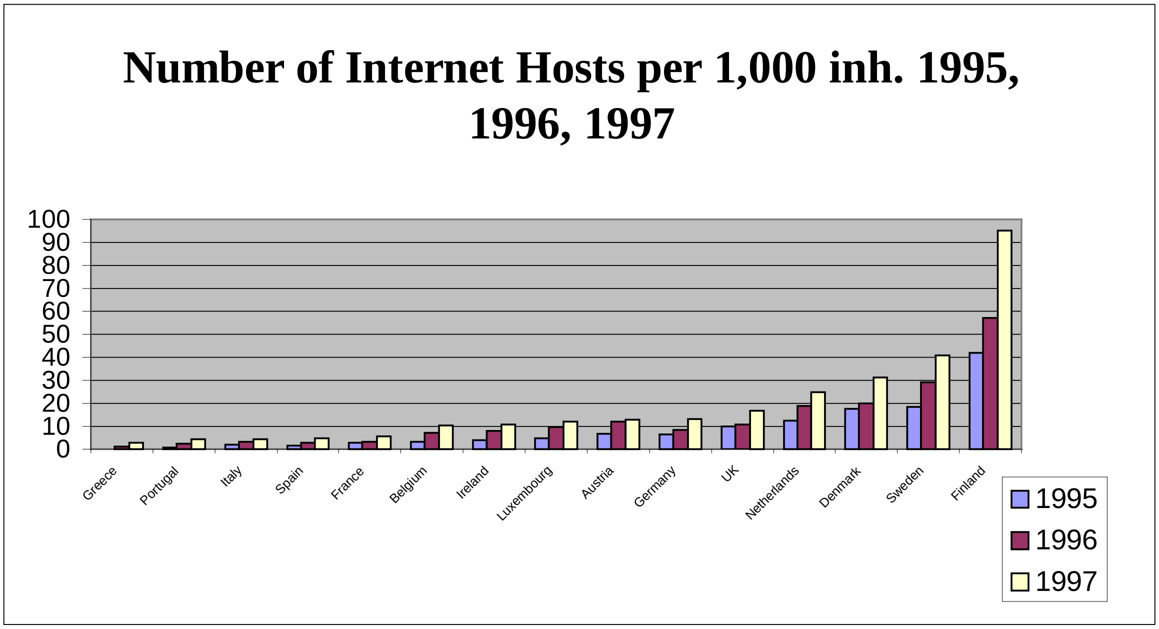
[8] Stephen Baker, "Finally, Europeans are Storming the Internet," *Business Week*, May 12,1998, p. 47.
[9] "Basic Indicators – Europe," EC Information Society Project Office. Full report available at www.ispo.cec.be/eses/Basic/Eubasic3.htm.
[10] Source: Credit Suisse First Boston, "Internet: UK/Europe – Industry Report," February 17, 1998.
[11] IBID.

***Figure 3.3 - Number of Internet Hosts per 1000 inb - 95,96, 97***




*(Source: EC Information Society Project Office)*

The largest online service providers in Europe are France Telecom, America Online, CompuServe, Deutsche Telekom, Prodigy, AT&T and Netcom. AOL is a dominant international ISP. It currently has 1.5 million subscribers in Europe after two years of operation there.

**3.2.2.1. France**

The online population in France is relatively small compared to the U.S. and the Nordic European Countries. Penetration of PCs in France at the end of 1997 was 19%. Only 11% of those computers were connected to the Internet. Therefore, roughly 2% of the French population is online.

The cost components of Internet service consist of the provision of the local access and the provision of the Internet service itself. According to the OECD, local call charges account for 80% of an Internet user's cost. This is typical of most of the European Union as a result of the long-standing monopoly enjoyed by the ILECs.

As of April 1998, there were between 800,000 and 950,000 Internet users in France. France Telecom's Wanadoo has over 220,000 subscribers, an estimated 25% share of the online service market. Industry analysts predict that the online user base in France will reach 1.2 million by the end of the year.

The ISP market is very competitive in France. In France, the primary Internet service providers are France Telecom and AOL. More than 697,000 online accounts have been opened with AFA members.[12] In July of 1997 there were 192 ISPs in France up from 36 in 1996. AOL and the telecommunications firm Cégétel SA are embarking on an alliance with Bertelesman AG and Canal Plus SA to bring new services to France's Internet market, serving both residential and small businesses customers. The major supplier of business Internet service is EUnet which has operated throughout the European Union since 1982. EUnet serves more than 60,000 customers throughout Europe with a network spanning more than 42 countries and has over 400 PoPs. EUnet was purchased by the U.S. based Qwest Communications International, in April 1998.

Cable operators also provide Internet access in France. Lyonnaise Cable currently offers telephone service over its Annecy cable network and has lodged a complaint arguing for the right to provide telephone service over their Paris cable network. At the same time, ART has refused requests by France Telecom to offer special tariffs to Internet users. ART believes that such a concession would be anti-competitive, allowing France Telecom to take customers from the competition who at this time can not propose such tariff modifications.

#### 3.2.2.2. Spain

In Spain, approximately 11% of households have a computer. The lower penetration rate in Spain is attributed to lower income levels and differences in perception of cost of PCs. Of the population with a computer only 12% are connected to the Internet in 1996.

The Spanish ISP market is very competitive. There are approximately 330 Internet access

[12] AFA is the French ISP association consisting of AOL, CompuServe, Cégétel/Havas On Line, Club Internet, FranceNet, FrancePratique, Imaginet, Infonie, Lyonnaise Cable, Uunet France and Wanadoo.

providers in Spain. This has resulted in lower costs for Internet service. Currently there are roughly seven million computer users Spain, growing at an annual rate of 12%.[13] The two leading Internet service providers in Spain are Jet Internet and Telefonica's Infovia and Retevision. Telefonica's Infovia has approximately 500,000 customers.[14] The other primary international providers of Internet service in Spain are RedIRIS and IBM.

Retevision has signed contracts with Global One, Goya Servicios Telematicos, British Telecom and ICL-Medusa to position itself to better compete for the Pta 1,000 mn market in Spain. In addition, in March of 1998, Retevision acquired Spanish ISPs Servicom and Redes TB and plans to begin offering Internet service April, 1998. With the acquisition, Retevision gains 76,000 customers. In order to compete with Retevision, Telefonica has begun discounting its Internet connection for its basic, student and professional Internet connection packages. A Spanish cable operator, Valencia de Cable began offering basic telephony services in April 1998.

### 3.2.3. Internet Telephony Regulation

On January 15, 1998 the European Commission declared that Internet telephony service was outside of the scope of the current telecom legislation. They based their decision on their assessment that the systems that allow telephone calls to be made over the Internet are not sophisticated enough to fall under EC rules and legislation that apply to telecom services in Europe.[15] The conditions required in order to be considered voice telephony subject to EU Member's regulations are:

- the communications are the subject of a commercial offer
- the service is provided for the public
- the service is provided to and from public switched network termination points on the fixed telephony network, and
- involves direct transport and speech in real time[16]

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[13] Source: NUA's Internet Surveys. Available at 222.nua.ie.
[14] "Telecoms: Spain's Retivision Buys Two Internet Providers," *Network Briefing*, March 20, 1998.
[15] Sylvia Dennis, "Internet Phone Technology Outside of EC Telephony Rules 01/15/98", *Newsbytes*, January 15, 1998, Available on Lexis/Nexis.
[16] The full text of the directive, "Status of Voice Communications on Internet Under Community Law, and In Particular, Under Directive 90/399/EEE" is available at www.ispo.cec.be.

However, the development of IP telephony is subject to review on an annual basis in anticipation that as the technology for IP telephony improves, Internet telephony service may become subject to the same regulations as other telecom providers in Europe. The EC ruling applies only to ISPs who offer telecom services over the Internet. Therefore, anyone with a computer, Internet connection and capital can establish themselves as an Internet Telephony Service Provider without the additional cost of abiding by telecommunications regulations. As European telcos such as ACC in the UK and Deutsche Telekom in Germany and France Telecom begin offering Internet voice telephony later in 1998, it is unclear as to how the EC will interpret telcos, rather than ISPs, launching Internet phone services.

### 3.2.4. Future Prospects for Internet Telephony

Europe is the fastest growing and second largest market for Internet telephony. It is that estimated by 2002, the European Internet telephony market for equipment, services and software will be $5.5 billion. According to a report by the Global Pricing Congress located in Geneva, by 2001 8% of Italy's calls will use Internet Telephony, leading the US and other European. By that time Internet telephony is expected to account for 4.3% of Germany's, 7.5% of France and 7.2% of the UK's international calls.[17] In April 1998, Deutsche Telekom started a pilot of its phone to phone T-Net Call service. This service allows small businesses in Germany and the US to place calls to twenty countries.

Internet telephony will significantly cut into the revenues of the traditional ILECs. Internet based services will reduce the combined international call revenues of British Telecommunications, Deutshe Telekom and France Telekom by $372 million in 2001.[18] This reduction is caused by the fact that callers will only use these PTT's local loops to reach their ISP and the long distance portion of the call will be charged at the ISP's rates and not the PTT's rates. This may force the PTTs to raise their cost of the local calls to compensate for the lost international call revenue. Similarly, in the long run, the ILECs may cut their international call rates to become more competitive with local call rates and Internet telephony.

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[17] "Italy Leads The Way with Internet Calling," *Computergram International*, November 12, 1997.
[18] "The Net Effect: The Impact of the Internet on World Telecommunications Markets," as reported in *Communications Week*, May 5, 1997 p. S35.

# 4. MARKET STRUCTURE AND ASSUMPTIONS

## 4.1. Introduction

For each region, a cost model was developed to quantify an Internet Service Provider’s costs and their evolution if customers use Internet telephony. These models are based on Brett Leida’s model developed in his Master’s thesis at MIT: *A Cost Model Of Internet Service Providers: Implications For Internet Telephony And Yield Management.*

Leida models a U.S.-based Internet Service Provider that controls a nationwide Internet backbone with 9 Points of Presence in the 9 largest U.S. cities and 450 Points of Presence through the entire country. This ISP provides Internet service to 5 types of subscribers: residential dial-in, business dial-in, 128 Kb dial-in ISDN, 56 kb leased-line, and T1 leased-line.
The model considers five cost categories of an ISP: capital equipment, transport, customer service, operations and other expenses (sales, marketing, general and administrative). Each of these costs is estimated based on the current practice of Internet Service Providers in the U.S.
The Internet telephony scenario models the impact of computer-to-computer use of Internet telephony. Among other, Internet telephony increases both the bandwidth needed and the average holding time of each customer, which requires a larger network.

## 4.2. A Cost Model for Mexican Internet Service Providers

### 4.2.1. Introduction

This chapter represents a cost model for Internet service providers. Specifically, the model aims to quantify the impact on an ISP's costs that result from an increased use in Internet telephony. The model contains two scenarios: a baseline scenario representing current ISPs where the principal use of the network is for web browsing and there is essentially no Internet telephony; an Internet telephony (IT) scenario in which the ISP sees a substantial increase in the use of computer-to-computer Internet telephony by its subscribers. The basic model structure is the same as that proposed by Leida (1998). We have made necessary changes in the model structure and values to reflect the conditions faced by a typical ISP in Mexico.

The model breaks down the ISP's cost into five principal categories:

*Capital Equipment* - the hardware and software of the network

*Transport* - the leased lines of the network and interconnection costs

*Customer Service* - staff and facilities for supporting the customers

*Operations* - billing, equipment and facilities maintenance and operations personnel

*Other Expenses* - sales, marketing, general and administrative

***Mexico's fact sheet***

| | |
|---|---|
| Population | 95.5 million/~15 million in the metropolitan area |
| Households | 18.5 million/ ~3.75 in the city |
| People/household | 5/ ~4 in the city |
| Computer penetration | 10% in households, overall there are 2.5 million computers |
| Telephone penetration | ~50% household based |
| Telephone lines break-up | 75% residential<br>25% business<br>Among the business lines, just a small fraction have dedicated lines (~1/3) |
| Internet connections (end of1997) | 154,000<br>• 85,100 businesses<br>• 48,700 residential<br>• 16,700 universities<br>• 3,500 government |
| Internet connections (estimated 1998) | 337,000 |
| Internet users (end of 1997) | 403,000 |
| Telmex's dial-up connections (end of 1997) | 30,000 this number represents the connections made by Telmex as an internet service provider. However, it is very likely that they provide the backbone for most of the connections |
| Internet market in Mexico | 50 million USD in 1997, 63% comes from dial up connections |
| Average usage | 12-15 hours per month, this means an average of 24-30 minutes per day per connection. However, NextGen, which is an ISP, focused only on corporate clients in Mexico City estimates an average duration of a dial-up internet call for their clients of 45 minutes. Leida's model assumes an average of 41 minutes per day per connection. |
| Equipment | CISCO is the market leader, prices are international |

| | |
|---|---|
| providers-routers | |
| Leased-line tariffs | Telmex's tariff book is on the web : www.cft.gob.mx<br>Dedicated lines rage in bandwidth from 64 kbps (E-0) to 2 Mbps (E-1) |
| Tariffs to the user | Tariffs are from NextGen (Mexico city provider):<br>Dial-up access monthly rate<br>25 hours included $25.00<br>50 $35.00<br>100 $50.00<br>Dedicated access monthly rate<br>64 Kbps $1,900.00<br>128 Kbps $2,400.00 |

#### 4.2.2. Assumptions For Developing The Cost Model:

- We considered the biggest nine cities distributed over Mexico as having the 9 Tier 2 POPS.
- The number of Tier 1 POPS per Tier 2 POP has been scaled down based on the relative size of Mexico as compared to the USA. Also, Mexico is still in the early stages of development. ISPs have concentrated so far only on cities. In addition, suburbs in Mexico are inherently different from those in the US.
- There is no NAP in Mexico; all traffic between different backbone providers is exchanged at a NAP in San Antonio, Texas.
- Import restrictions are down to almost nil on various telecom and networking equipment after NAFTA, hence the price of equipment is essentially the same as their prices in the US.
- Six largest ISP's have the largest share of the market. The remaining 10% share is held by fringe players. Here we are modeling the costs of one of the big six ISPs.
- The average holding time (w/o) Internet Telephony is estimated to be 20 minutes. IT increases this by 5%.
- Calling pattern of the customers remains the same as in the US case.
- The number of O-D pairs have been estimated based on the relative number of hosts in Mexico and US to be 5%.
- Subscribers/Modem works out to be ~15, the reason being a lower holding time compared to the US.
- Most of the Mexican ISPs outsource billing operations to US companies and hence the billing costs are essentially the same as faced by an ISP in the US.

- In each urban region, which corresponds to a major city, a Tier 2 POP is located, and in each rural area surrounding a city, a Tier 1 POP is located.
- Because the model represents a backbone ISP and access ISPs, the ensemble is assumed to have an equal market share in all categories of user markets.
- It is assumed that all customers are current consumers; therefore no installation and other one-time startup charges are included (no concept of customer churn exists in the model).
- Because the Internet telephony scenario represents an ISP whose subscribers are embracing Internet telephony, rather than a long distance telephone company using IP technology to complete calls, the call patterns are assumed to remain similar to ISP patterns and not-to-resemble long-distance-telephone-usage patterns.
- There are no ISDN subscribers in Mexico.
- It is assumed that a leased line subscriber will operate his line at the same capacity for both scenarios.
- Erlang-B formulation has been used to determine the appropriate number of modems needed to satisfy a blocking probability.
- It is assumed that all leased-line subscribers are connected to the Tier 2 POPs and none to Tier 1 POPs. There is one CSU/DSU allocated for each subscriber's leased line.
- It is assumed that routers are sized sufficiently based solely on the number and size of network connections needed. This implies that the packet routing rate is not a limitation.
- Because the ISP is leasing lines from a telecommunications provider-as opposed to owning them itself- it is assumed that the reliability and redundancy in the underlying physical network are the responsibility of the telecommunications provider, not the ISP.
- There are no bulk discounts given in transport costs.
- It is assumed that all traffic on this network has a single origin and destination (i.e. the effect of broadcast and multicast are negligible).
- Customer service and operation personnel salaries are roughly 20-25 % that in the US.

Based on the information resources cited above, the inputs to the cost model are shown in Appendix A.

### 4.3. A Cost Model for European Internet Service Providers

#### 4.3.1. Assumptions of the European model

***Internet Service Provider infrastructure***

In his master's thesis, Brett Leida modeled the costs incurred by a typical U.S. *national* Internet Service Provider. This ISP controlled a large nationwide backbone and links to 450 points of presence throughout the country.

To adapt this model to the European case, it is first tempting to model the situation of a traditional single-country ISP such as Wanadoo in France or Infovia in Spain. This would be relatively difficult to model:

- These ISPs have much smaller networks than the U.S. ISP (2 Tier 2 POPs maximum).
- A lot of their traffic crosses borders and are handled through interconnection agreements. The exact content of these agreements is confidential and their costs are thus very difficult to estimate.

Besides, the prospects for Internet Telephony are limited on the national level since national phone rates are low (10 to 20 cents per minute).

In consequence, the case of a pan-European ISP is modeled in this paper. Such ISPs are not yet existing as modeled, but the current concentration of the ISP market makes them likely to develop[19].

***Geographic organization***

We keep the same architecture, based on 9 Tier 2 POPs and 50 Tier 1 POPs per Tier 2 POP. This corresponds to the number of POPs generally provided by national ISPs in Europe: between 30 and 50 for instance in France. The 9 Tier 2 POPs would be located in the largest European centers. For instance, UUNet global backbone currently includes London, Paris, Brussels, Amsterdam, Frankfurt, Stockholm, Monaco and Milan.

[19] EUnet, now controlled by Qwest, is a good example although it focuses more on business customers. AOL has also a strong customer base in many European countries (1.5 million).

Conserving the same ratio of population between Tier 1 and Tier 2 average populations (75% of the population lives in urban areas in both U.S. and Europe), we obtain 770,000 inhabitants per Tier 1 POP and 3,100,000 inhabitants per Tier 2 POP.

Tier 2 POPs are dispersed on a smaller area than in the U.S. The average E/W distance between 2 Tier 2 POPs is modified to take this into account, from 1,500 miles down to 400 miles.

***Market profile***

Eurostat data confirm that European households have on average 2.6 people (146 million households for 374 million inhabitants). The percentage of households with analog dial-in service is difficult to estimate. The following figures serve as basis for our estimate.

- 7% of European population has access from home[20].
- 18 million Internet Users[21].
- 4.5 million home PCs in France[22], 15% with modem.
- Wanadoo has 220,000 accounts, 63% of which are residential, a 25% market-share (around 800,000 accounts in France)
- AOL has 1.5 M accounts in Europe (400,000 in UK, 200,000 in France). T-online (Deutsche Telekom) has 2 million customers.
- 253,000 households with Internet access in France[23].
- 12% people have access at work in Europe.

Considering the disparity between more connected countries like Germany, the United Kingdom or the Netherlands (in which an estimate of 5 to 7% percent households are connected) and less connected countries of Southern Europe (1-2% households), an overall 3% appears reasonable, representing around 4.5 million residential accounts in Europe.

The ratio of on-line households to on-line businesses is similarly difficult to estimate. In the model, a T1 business counts for one customer, but may connect hundreds of users within each company. Among the rare data collected on this point, we have:

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[20] According to Business Week and Forrester Research.
[21] According to a study by Credit Suisse First Boston.
[22] According to the European Commission ESIS project.
[23] According to the European Commission ESIS project.

♦ 20%-24% SMEs (between 20 and 500 employees) are connected to the Internet in France[24]. Most of them are connected through dial-in service.

♦ 37% of Wanadoo's[25] customers are businesses.

♦ 25% of large French companies have a web site[26].

♦ 4.8 million PCs in French companies[27].

Based on these figures, it is reasonable to consider the average ISP to have 1/3 business customers, most of them connected through dial-in service. The ratio is thus 2.

Finally, the market shares of the 4 potential connections are modified considering that:

♦ Many companies are only connected through dial-in connection.

♦ ISDN lines are frequent, especially in Germany and France (3 million ISDN clients in France, similar figures in Germany)

♦ Large companies are connected through dedicated lines (56 Kb) or T1, and although they generate large traffic, they count as single customers.

We thus assumed the following repartition:

| **Customer** | **Percentage usage** | **Number** |
|---|---|---|
| residential dial-in | | 432,000 |
| business dial-in | 60% | 133,920 |
| ISDN dial-in | 25% | 64,800 |
| 56 kb | 3% | 10,757 |
| T1 | 5% | 17,928 |

Table 1: Repartition of business customers by connection type, European model

[24] Following two polls by Les Échos and UFB Locabail.
[25] The largest French ISP, owned by France Telecom.
[26] Data Le Monde Informatique.

*Service prices:*

Public prices shown on various ISPs in Europe show the following figures:

| **Service** | **Monthly price ($)** |
|---|---|
| Unlimited residential/business/ISDN dial-in (most French ISPs) | Between $10 and $20 |
| 3 hours/month residential dial-in | $7.5+ $3/hour |
| 64Kb access (Transpac, France Telecom) | $1,000 ($2,000 installation) |
| 256Kb access (Transpac) | $2,000+ distance-based price ($630 for 1 km, $1,700 for 50km) |

Low bandwidth services are priced at a comparable level as in the U.S. This is explained by the lower average holding time per customer in Europe. As appears above, high-bandwidth services (56 Kb and T1) are priced sensibly higher than in the U.S.[28] These figures need to be at least doubled for the European model. A T1 is thus priced $2,400 and a 56Kb line is priced $1,000.

***Internet telephony assumptions***

When using an Internet connection to bypass high international rates, it is reasonable to expect users to pay less attention to their phone bills since local phone calls replace international ones. We thus consider a 10-minute increase in dial-in connections, from 15 to 25 minutes.

***Capital equipment***

We assume that, since the Internet equipment market is international, a European ISP has access to the same prices as an U.S.-based one.

***Transport***

Transport costs are known to be higher in Europe as in the U.S., especially when they involve international links. As a basis, we assume that T1 are twice more expensive in Europe than in the U.S. France Telecom charges $1,000 per month for a 23-B channels ISDN primary line. This does not include the distance-based rate, which often depends on the countries involved.

[27] According to the European Commission ESIS project.
[28] Leida considers that a T1 connection to the Internet is priced $1,200, and a 56Kb line, $500.

This leads us to double the costs of most transport services. OC-3 costs are only increased by 50% because the high-capacity links market is likely to be more competitive.

***Customer service, operations, other expenses***

These costs are kept similar because there are no compelling reasons why they should be different from the U.S. values.

***Residential dial-in profile***

The 700,000 customers of the main French ISPs spent 5.2 million hours connected per month in the last months. This yields an average 15 minutes holding time per day. This figure is not surprising since residential customers pay their phone connection by the minute. Their average 7 hours per month cost them between $10 and $20 more dollars[29]. Peak usage, although it may occur later than in the U.S., must be comparable.

***Business dial-in and ISDN user profile***

Their average holding time is assumed to be the same as for residential customers in the U.S. model although this may not be accurate in either regions.

Other user profiles are the same as in the U.S. case.

[29] Depending on the percentage of their connections made during off-peak hours.

## 5. COST MODEL RESULTS

This chapter presents the results from the Mexican and European cost models, including the sensitivity of the results to key assumptions. The next chapter will compare and analyze our results.

### 5.1 Mexico

Since the Internet is in its early stages of development in Mexico, ISPs have been able to "cherry pick" the market. The Internet has a strong presence among business users and only small penetration into the residential market. In this section, we show the impact of this market on the cost structure of a Mexican ISP. We also present the results of a sensitivity analysis over a number of variables like market growth, user mix and Internet telephony usage.

#### 5.1.1. Baseline results

This scenario describes the cost structure of an ISP whose users are primarily browsing the web. We assume that most of the traffic goes to the NAP and only a small percentage remains within the ISP network.[30]

The average total cost structure is shown in Figure 5.1. As expected, the higher cost contributors are the transport cost and the commercial and administrative costs. Since Mexico has a high concentration of leased line users, the transport cost represents a large fraction of the overall costs. In addition, transport costs are much higher[31] in Mexico than in the US and bulk discounts are not a common practice.

The low labor costs are also reflected in these results. Mexican ISPs have an advantage in this area compared to other countries, since its wages are at least three times lower than in the US or Europe. This fact has a significant impact on the share of operation and customer service costs. However, this labor cost advantage is not reflected thoroughly in the administrative and

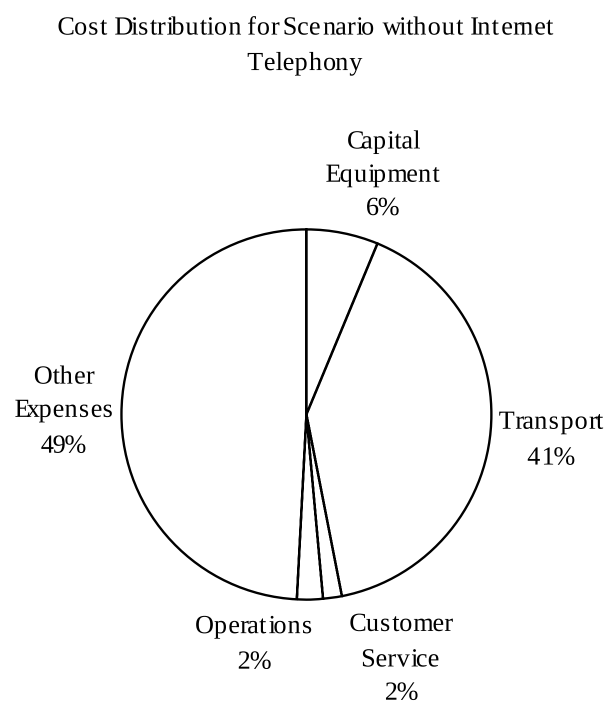
[30] It is assumed that only 5% of the traffic remain within the network.

[31] Transport costs have a different pricing structure in Mexico and in the US. In Mexico, only a fixed fee is charged every month whereas in the US, there is a fixed and variable fee according to the distance. However, even taking into consideration the variable part, Mexican prices for transport are almost the double than US prices.

commercial costs, and these costs are the second most important cost item for an ISP. Although it may seem unrealistic that almost 50% of the costs are in sales and marketing and administrative costs, a comparison with the typical cost structure for Telmex[32] showed that our result was reasonable. Another reason for high costs in this area is the revenue figure. Since sales and marketing costs are taken as a percentage of total revenues, and revenues per customer are much higher in Mexico than in the US due to the tariff structure, this cost item represents an important piece of the overall cost.

Capital equipment is to be less important than for the U.S. case. Mexican users have a lower usage and so companies can afford to size their networks with a higher subscriber per modem ratio. This fact is reflected in lower equipment requirements and consequently, lower costs in this area.

***Figure 5.1. Cost structure without Internet telephony***

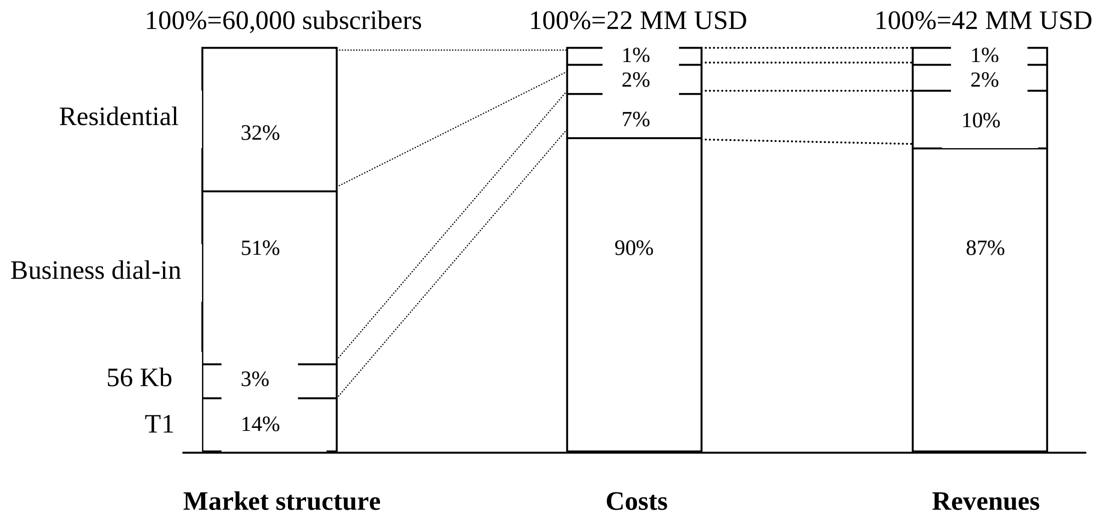



It is also important to note that contrary to the US case, in Mexico the service operates profitably. There are two main reasons: user tariffs are higher than U.S. levels for some

[32] See Telmex Annual Report for 1997.

segments such as businesses with leased lines and, the Internet provision is heavily concentrated on this segment. Tariffs for corporate customers with leased lines are on average[33] almost the double than in the U.S. Figure 2 shows the contribution of each segment to total costs and total revenues.

***Figure 5.2. Costs and revenues per segment and segment sizes- without Internet***




In conclusion, transport, administrative and, sales and marketing costs proved to be most important cost drivers for a Mexican ISP. The concentration in the business segment is reflected on the revenues and the profitability of the ISP.

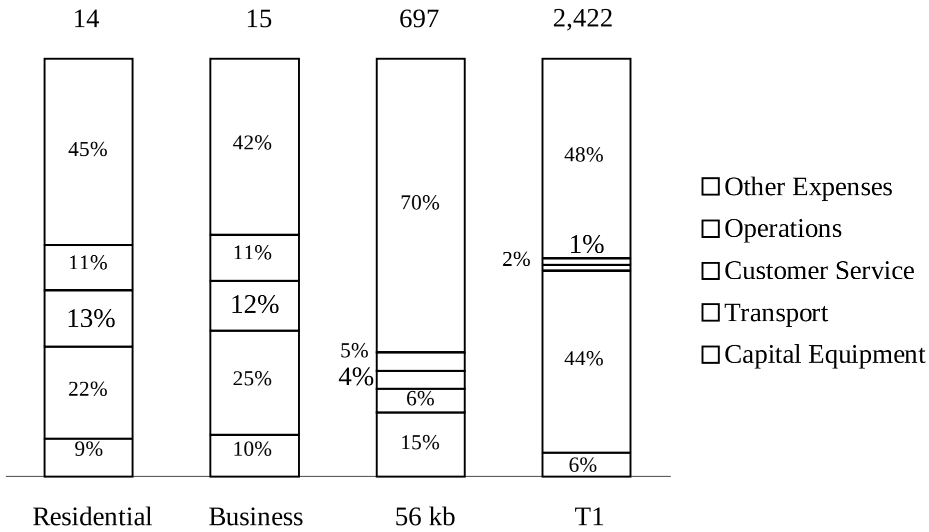
***Cost components per segment***

As mentioned before, transport and "other expenses" –sales and administrative- are the two main cost components across the users' segments. Figure 3 shows the cost breakdown per segment as well as the per user cost.

---

[33] Average tariffs were calculated from a sample of ISPs. NextGen, Compuserve and, InterVan were some of the companies included.

*Figure 5.3. Total cost per user per category-without Internet telephony*



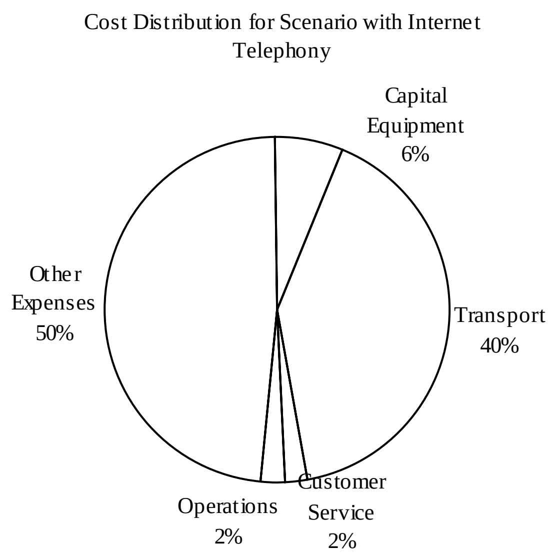

***Mexico Summary***

- A mix of users heavily concentrated on the business segment characterizes the Mexican market. This characteristic together with low labor costs and low usage delineates a cost structure dominated by transport and sales and administrative costs.
- Mexican ISPs operate profitably due in great part to the high fees imposed on users.
- While dial-in per user costs is lower than in the US, costs for leased line users are almost the double that of their U.S. counterparts. Again, this is due to the high leased line tariffs prevailing in the Mexican market.

### 5.1.2. Scenario with Internet Telephony

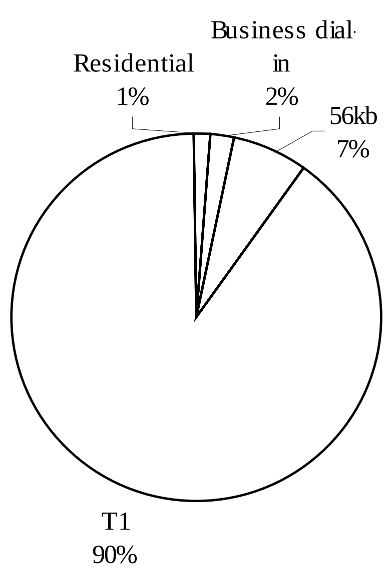
As of today, Internet telephony is not a common practice in Mexico. For purposes of this analysis, we assume that a small percentage (5%) of the overall time on-line was in fact spent in Internet telephony. Our results show that the overall cost structure would not be affected. Overall costs per user would indeed rise but the contribution per cost item would remain unchanged. Revenue would also increase although the increase in costs is higher than the increase in revenues –9% for revenues, 10% for costs. Figure 5.4 illustrates the point.

*Figure 5.4. Cost structure with Internet telephony*



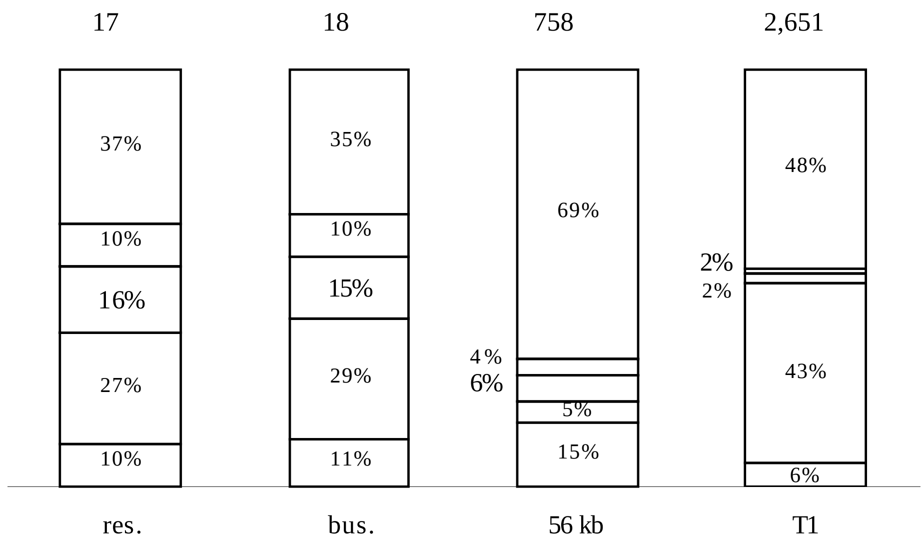

Per segment, the highest cost increase is for the dial-in users. Leased-lines users have an increase in costs on the order of 10% while dial-in users have an increase of about 20%. Figure 5.5 shows the cost per user for both scenarios.

*Figure 5.5 Total costs per segment with Internet telephony*



The cost structure per segment changes for dial-in users as well. As showed in figure5. 6, for residential and business dial-in users, transport costs gain higher importance followed by customer service and capital equipment. In the case of leased-line users, the cost structure remains essentially the same as in the baseline scenario.

***Figure 5.6. Costs structure per segment***




As seen in the figure, transport and other expenses are the most important cost items for dial-in users and T1 users. Capital equipment and other expenses are, similarly, the most important pieces for 56Kb users.

***Summary***

- With a small amount of Internet telephony activity in Mexico, costs increased in almost the same proportion as revenues.
- The overall cost structure remains essentially the same as the baseline scenario. Per segment, there are some changes in costs for dial-in users; however, this is not thoroughly reflected in the final structure.
- Non-technical costs still remain a large portion of per-user costs for each type of subscribers.

## 5.2. Europe

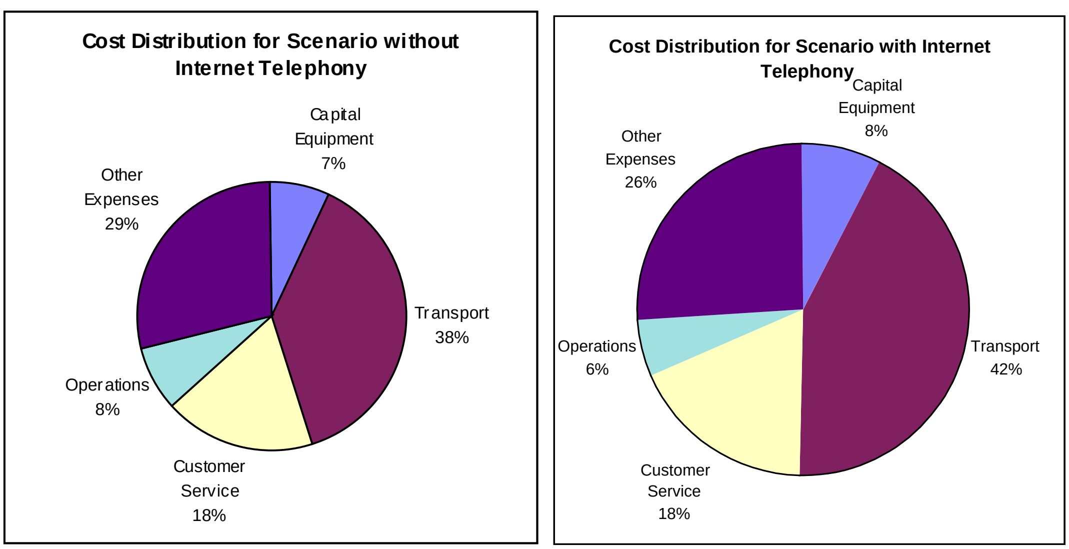
In Europe, ISPs per user costs are comparable to those in the U.S. Although transport costs are considerably higher than in the U.S., low-bandwidth users do not spend as much time on-line because of phone connection charges. For the same reasons, high bandwidth users have a higher cost in Europe. The impact of Internet telephony is larger in Europe for two reasons:

- Residential and business dial-in customers are less concerned by the per minute cost since they are compensated by the savings on the international phone calls.
- Transport costs are higher in Europe.

***Table 5.1 Per user costs in Europe***

| Europe | res. | bus. | ISDN | 56 kb | T1 |
|---|---|---|---|---|---|
| Without Internet Telephony | $ 20 | $ 21 | $ 55 | $ 489 | $ 1,793 |
| *US* | *$ 23* | *$ 24* | *$ 85* | *$ 469* | *$ 1,450* |
| With Internet telephony | $ 30 | $ 30 | $ 78 | $ 765 | $ 2,942 |
| *US* | *$ 30* | *$ 32* | *$ 126* | *$ 745* | *$ 2,375* |
| Evolution | 52% | 45% | 43% | 57% | 64% |

***Figure 5.7. Cost distribution, Europe***




The ISP is barely profitable in Europe, as appears on the table below. T1 and 56Kb customers are profitable but margins on the mass market are non-existent.

*Table 5.2 Per user cost and price in Europe*

| | res. | bus. | ISDN | 56 kb | T1 |
|---|---|---|---|---|---|
| Prices | $ 20 | $ 20 | $ 100 | $ 500 | $ 2,400 |
| Costs | $ 20 | $ 21 | $ 55 | $ 489 | $ 1,793 |

## 5.3 Sensitivity Analysis

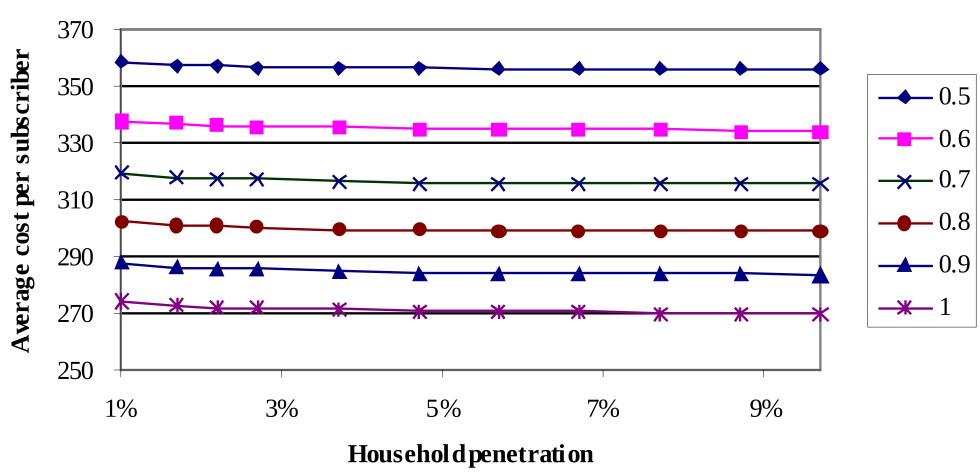
In this section, we analyze the model's sensitivity to market growth, usage patterns, shifts in the mix of subscribers and other scenarios. The base scenario is extracted from the Mexican case but the findings apply to both models.

***Market growth and user mix***

Internet connections are expected to grow dramatically over the next years in Mexico. At the same time, it is plausible that a great part of this growth be in the residential dial-in segment. The cost impact on an ISP was analyzed under the assumptions of different market penetration and ratio of on-line households to on-line businesses.

From Figure 7, we can appreciate that the average cost per subscriber tends to decrease as penetration increases, similarly, as the ratio of on-line households to on-line subscribers increases, the average cost per connection goes down as well.

***Figure 5.8. Average cost per subscriber for higher penetration and household/business** ratio*



*Higher usage of Internet telephony*

While a higher percentage of Internet telephony over the total time on-line has a significant impact on costs, an increase in the holding time does not seem to be a key cost driver. Figure 8 illustrates how cost increases dramatically with a higher use of Internet telephony while a significant increase on the holding time has a small impact.

Similarly, a sensitivity analysis was conducted in order to determine the importance of the change in the % of O-D pairs as Internet reaches a higher penetration. It is assumed that as more people use the Internet, more local sites would be developed and, more traffic might remain within the network. As shown in figure 9, there are some economies of scale as more people access the Internet. However, the reduction in cost would be surpassed by the increase in the average cost per user due to a higher percentage of O-D pairs.

***Figure 5.9. Percentage of cost increase with higher Internet telephony use relative to total on-line time***

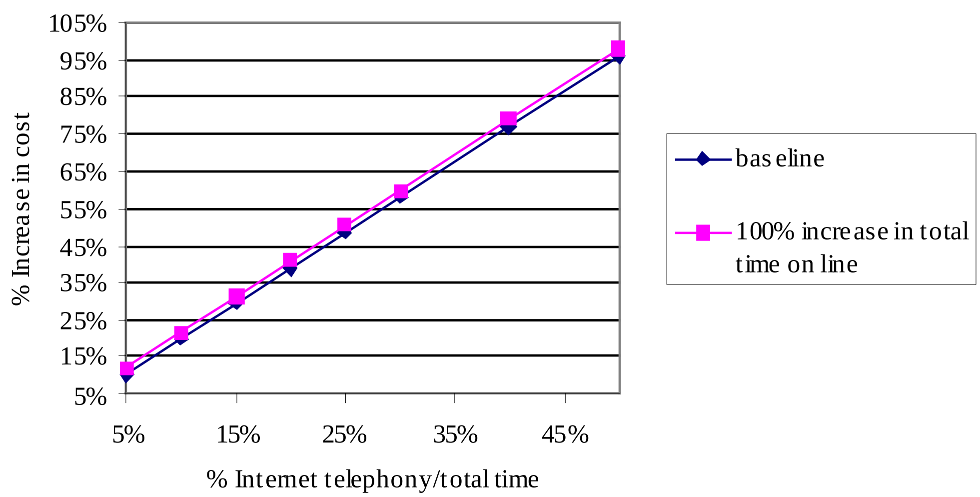
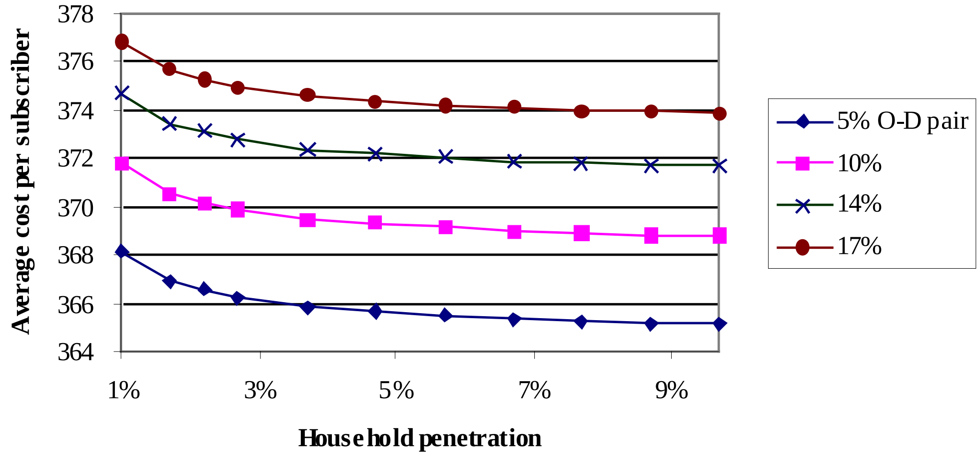


*Figure 5.10. Average cost per subscriber under different scenarios of %O-D pairs*




***Summary***

- The expected growth in Internet connections is expected to decrease the average cost per subscriber. At the same time, a shift in the residential-business ratio, while it would change the cost structure, it would actually reduce the average cost per user.
- A more intense usage of Internet telephony is expected to have a significant impact on the average cost per user. On the other hand, an increase in the holding time does not have an important effect over the average cost.
- An increase in the traffic remaining within the ISP network has a large impact on the average cost per user.

## 6. COMPARATIVE ANALYSIS OF THE RESULTS

The cost of providing Internet and Internet telephony service varies significantly across regions, as illustrated in Figures 6.1 and 6.2. A number of factors contribute to these differences, including regulatory framework, income, labor costs, geography, patterns of use and, most importantly, the tariffs for leased-lines shape in a great manner the cost structure and level of each country.

***Figure 6.1. Cost per user per month without Internet telephony (USD)***

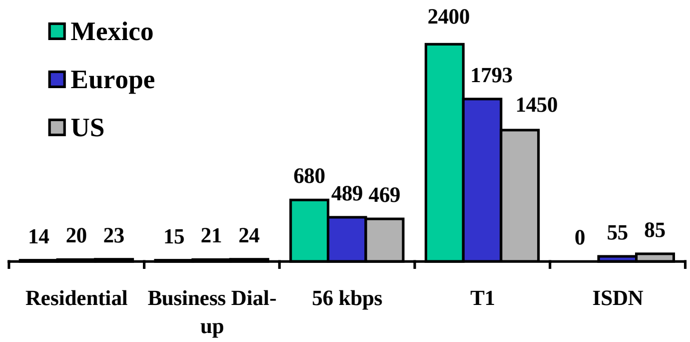
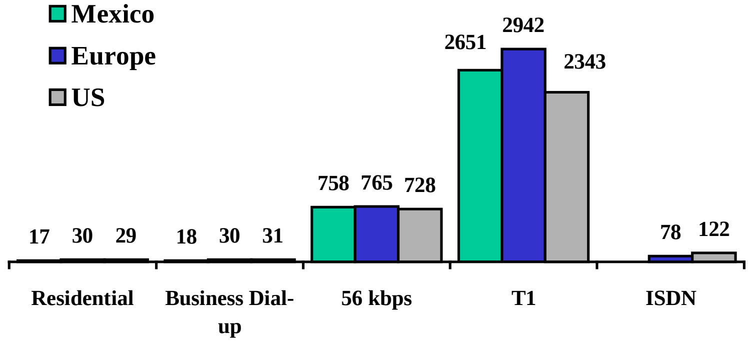



***Figure 6.2. Cost per user per month with Internet telephony (USD)***




As we can see, Mexico and Europe have lower costs than the U.S. in the dial-up segments while in the leased-line segments both regions are consistently above U.S. levels.

The following is an analysis of the key factors defining and shaping the Internet industry in the regions considered.

### 6.1. The Costs Of ISPs Are Highly Variable Across Countries

The cost of providing Internet Service in across different countries is highly variable due to a combination of factors.

- First, the different market structure make it easier for ISP in countries with higher online penetration to reach a critical number of consumers.
- Secondly, transports cost can vary over a broad range. For instance, the cost for a 100 mile DS3 connection (the 45 Mbps that connects the Tier 2 nodes in the model) is about $4000 in the U.S., which corresponds to cost of a 100 mile E1 connection in Europe (2 Mbps). This means that capacity is about 20 times more expensive in Europe than in the US. For Mexico, the situation is very similar. After the deregulation of the long distance market in 1997, the incumbent Telmex raised its transport tariffs considerably to deter competition. Therefore, this huge difference is mainly due to incipient competition in European and Mexican infrastructure. Although both regions are currently going through the deregulation process, most of the transport capacity still belongs to the national incumbents who do not have particular incentives to lower their costs or invest in building more infrastructure. In addition, the licensing regulations in Europe still make it very difficult for ISPs to build their own infrastructure.
- Third, the customer behavior is different across countries. There is a language barrier and limited available local content in some countries. This contributes to the fact that Mexican and European users spend less time on-line that their American counterparts. In addition, the fact that in Europe the on-lime time is charged at local rates by the telephone provider makes Europeans less likely to spend too much time connected to the Internet.
- Other factors such as lower labor costs in Mexico than in Europe and the U.S. also account for some of the differences. Service prices, at least in Mexico, contribute to sales and marketing costs since these are defined as a fraction of the total revenues.

- Finally, the users mix is also quite different across these regions. In the U.S. the market is heavily concentrated in residential users, whereas in Mexico business users dominate. Europe has a more balanced market structure.

### 6.2. The Internet Backbone Is Underdeveloped Outside The US

Compared to the market potential of the regions, the Internet backbone is still underdeveloped in Europe and Mexico. In Europe, the broad routes between the main nodes are 34 Mb/s and some parts of the network are as thin as 2 Mb/s. In Mexico the routes are even thinner. These numbers offer a sharp contrast with the US where 622 Mbps backbones are typical.

Most of the backbone is still owned or managed by the telcos in each of the countries, who usually also own the major ISP. The number and size of interconnection points or NAPs (Network Access Points) is still limited and, more significantly, do not always interconnect all of the ISPs in a region. In fact, often the telco's ISP chooses not to connect to the national NAP.

Additionally, although the deregulation provisions authorize new entrants to build their own infrastructure, this is occurring at a very low pace. New entrants usually target more lucrative market segments such as mobile or long distance before considering setting their own internet infrastructure. As a result of these factors, most of the Inter-European or Inter-Mexican traffic is still routed through the US backbone, with the subsequent loss in efficiency and an increase in costs for European providers.

**Figure 6.3. Geographical Configuration** (*Source: EuroISPA*)

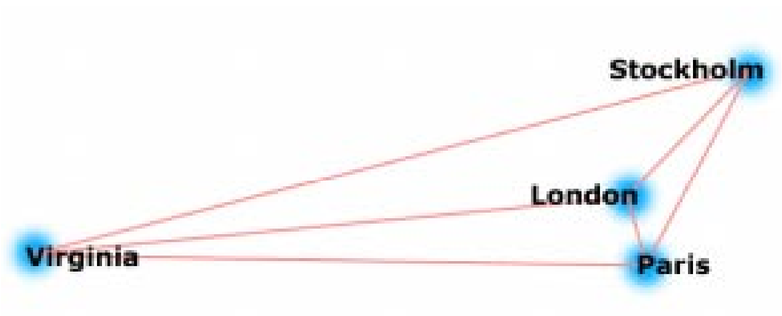
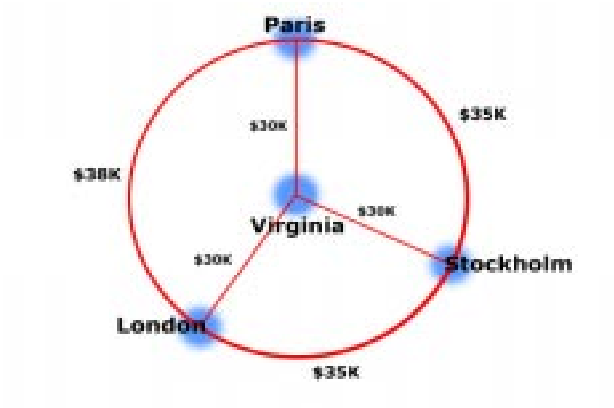


**Figure 6.4. Monthly Telecommunication Cost, 2 Mb/s circuits** (*Source: EuroISPA*)



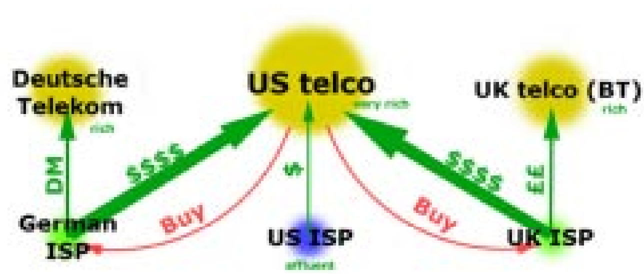

### 6.3. A 'Perverse' Implicit Subsidy System Exists

The status of regional Internet backbones has important economic implications for both non-US and US telcos, ISP's, and users. The very fact that the Internet backbone remains very much US centric globally and telco centric in Europe and Mexico determines an implicit system of subsidies that can be summarized as follows for the European case:

- European Internet users increase local traffic and telco income: because most European telco's use per call pricing (instead of flat rate) for local access, the increase in traffic due to internet usage directly implies an increase in revenue for the telcos. For this reasons most European telcos have created incentives for users to connect to the Internet.
- However, non-telco European ISP's have to lease expensive capacity from the telcos (or from their new competitors).
- European ISP's route their traffic through the US, thus paying for international connectivity that is often split between European and US Telcos because of interconnection agreements.
- Those same international lines are used at almost no cost by US ISP's to route traffic from the US to Europe. This was justified by the fact that a previously, most of the Internet content was in the US and so most of the intercontinental traffic was in response to European request of US content. But this asymmetry argument is weakened as European content expands.

The result of this is that European ISP's are in general smaller, financially weaker than their American counterparts, and don't own their own infrastructure Therefore many of them are bound to bankruptcy or are often bought by larger providers..

**Figure 6.5. Implicit Subsidies** (*Source: EuroISPA*)




### 6.4. User Incentives For Adopting Internet Telephony Vary

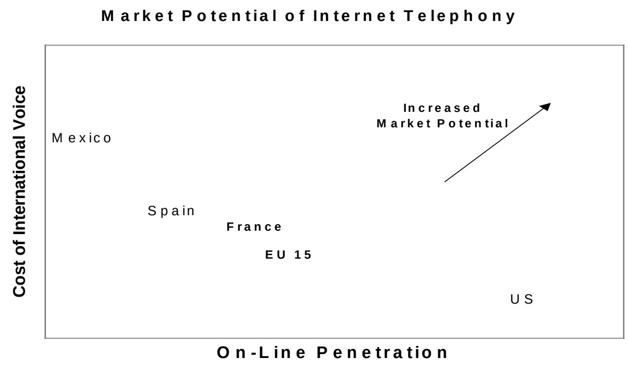
The main incentive for European and Mexican users of Internet Telephony today is bypassing expensive international and long distance rates. ISPs are not considered carriers and do not contribute to the Universal Service Fund (cross subsidy from long distance to local access). The incentive is still higher for other related applications such and mail and particularly fax, as those services do not have the same real time Quality of Service requirements. This is particularly relevant taking into account that about 40% of international PSTN traffic today is in fact fax traffic.

| Route | Standard Rate | Economy Rate | PC – PC |
|---|---|---|---|
| UK to US | $0.38 | $0.34 | $0.04 |
| France to US | $0.30 | $0.24 | $0.08 |
| Germany to US | $0.72 | $0.67 | $0.11 |
| Finland to US | $0.79 | $0.62 | $0.03 |

*Source: Credit Suisse First Boston

The use of the internet for long distance or international voice communications tampers the disincentive of per minute charges for Internet access in Europe: the user worries about avoiding the high long distance cost but doesn't care about a marginal cost of accessing it's ISP.

*Figure 6.6. Market Incentives for Internet Telephony*




## 6.5. Barriers To Internet Telephony Are Still High In Europe And Mexico

European ISPs and Mexican ISPs are been much less active than their American counterparts in offering Internet telephony services to their customers. The main reasons for such delay have been explained above:

- Thin, inefficient IP network
- High transport costs and interconnection costs
- Weakness of ISPs
- Small Internet Penetration

## 6.6. Internet Telephony Will Have A Broader Impact In ISPs Outside The US

However, the diffusion of Internet Telephony would have a bigger impact in Europe and Mexico than in the US. High international calling prices create a significant incentive for using Internet Telephony. Because the current average holding time is lower in Mexico and Europe than in the US, the relative increase in traffic will be higher. Thus, there is a significant need for the international ISPs to add more capacity, by means of leasing additional expensive, high capacity links.

# 7. POLICY RECOMMENDATIONS

Mexico, Europe and the US represent regions at very different stages of Internet and telecommunications development. Some of the policies directed at fostering growth in the telecommunications market should be country-specific. However, since all three regions are involved in a deregulatory process aiming at globalization and competition, the ultimate policy objectives should be common to all of them. This section analyzes the policy implications behind IT in each of the three regions, and concludes with general policy recommendations relevant to all three areas.

## 7.1. Mexico

Mexico is in the early stages of Internet development and telecommunications infrastructure in general. The current goal of the government, reflected in its universal service coverage, is to make telephony available to the entire population. Currently only 50% of the households in Mexico have access to telephony.

Under these circumstances, considering Internet telephony might seem ambitious and unrealistic. However, the Internet has grown considerably during its first years in Mexico. Most of this growth has been concentrated in the high-income households and, more importantly, among businesses. Level of income is the most important differentiating factor determining computer penetration rates and Internet use. Computer literacy and location of the household or business are other factors that contribute to shape the demand for these products and services.

Today Internet telephony is not a reality in Mexico despite significant benefits for consumers. Long distance tariffs are quite high in Mexico, and the recent liberalization of the market creates opportunities for new businesses to challenge TelMex’s position via both packet and circuit switched networks. However, regulatory changes have also reduced long distance rates recently, potentially attenuating the incentives for customers to find alternative ways to place long distance calls.

ISP's are a profitable business in Mexico. Among the factors that contribute to their profitability are low labor costs and service tariffs comparable to, and even higher than, U.S. levels. In addition, ISP's benefit from regulatory system that excludes them from any universal service obligation or access charges. This places the ISP's in a strong position for introducing Internet telephony.

Before January 1997, Mexico's telecommunication infrastructure was controlled entirely by Telmex. With the liberalization of the long distance market, new market entrants are providing service and contributing to a universal service fund to promote the development of local telephony. These companies have already started constructing new infrastructure in Mexico and the possibility of alternative backbone service is becoming a reality. However, until these backbones are complete, Telmex will charge stiff tariffs for transport links. These tariffs are not subject to regulation and Telmex uses them to deter long distance competition. The effect of these costs is reflected in the long distance tariffs and in the restriction of the growth of dial-up and leased-line Internet accesses.

The government faces a dilemma, since re-regulation of these tariffs seems not to be a plausible option, but Telmex's market action slows the development of a truly competitive market. In view of all its potential benefits, should regulators intervene to foster the growth of internet telephony? Should the immediate focus be on providing telephony service for the majority of the population? Or can these issue be addressed in tandem?

Regulators must balance the interests of all players within the industry within the context of national policy goals. In addition, policy choices should be addressed in both a short and long-term perspective. In the long term the policy maker's role should be visionary. Mexico does not have an information technology policy as other countries do. It is urgent that Mexico start developing a comprehensive policy in this area. Issues to be addressed should include Internet access and use. The government should create a set of policies that aim to evaluate alternative and economically viable technologies, such as wireless and cable, for providing telephony and Internet access. In the longer term, the government should consider fostering implementation of technologies such as gateways that allow access to the Internet, including Internet telephony, to those users without a computer. Finally, an information policy should address funding and scheduling of these ambitious projects.

Increasing the use of internet services may be an enormous challenge. Computer literacy and the development of local sites that help eliminate the language barrier are crucial milestones. In this respect, Mexico could follow the model of other countries that had made available on-line many of the government information sources and administrative procedures.

In the short run, Mexico must concentrate on developing infrastructure and promoting competition to attract investment. In order to see a real drop in long distance tariffs and a boom in Internet services, new entrants must challenge Telmex. At the current stage of development, the focus of the government should be to promote infrastructure investment. Only competition in this area will force Telmex to lower its transport tariffs, allowing the market for network services, and Internet telephony in particular, to expand.

As new backbones are created, the government should push for interconnection agreements between Mexican IP networks. Currently Mexican ISPs carry network traffic up to the U.S. While our cost modeling has shown this to be economically feasible at today's prices, the current set up is inefficient and has a significant impact on the quality of service.

In conclusion, policy makers in Mexico should aim to ensure accessibility to the information highway and to the services it will provide. In the short term, the focus should be on promoting competition and encouraging infrastructure development. Only when this is achieved will Mexico enjoy of the economic and social benefits foreseen in the development of an information society.

### 7.2. Europe

While both France and Spain have a well developed telecommunications infrastructure, neither country is particularly strongly represented online. There is a competitive market for ISPs and Internet telephony has made a stronger entrance than in Mexico's developing market.

Furthermore, online subscriptions have been increasing at an aggressive rate in recent months, suggesting that access to the Internet is likely to accelerate in the near future. Internet telephony may not be the impetus behind this increase, but the attractiveness of low international rates is likely to draw additional entrants to the market.

One crucial policy problem in the EU mimics that of Mexico: the need to create additional backbones for further development of the internet and internet telephony. Given the large potential market in Europe, it seems unlikely that governmental incentives will be necessary to bring about this investment. However, the EU should play a role to ensure interconnection agreements between different backbones, and can assist new market entrants with understanding the intricacies of business in a unified Europe.

While infrastructure is an important issue in Europe as well as Mexico, the changing role of regional and international competition is also an important issue. The market for internet telephony in Europe is likely to be in the international arena. Both businesses and residential customers are strongly represented in the market, and a significant portion of the calls made are international, suggesting that Internet telephony has a strong role to play within the EU.

Further crucial issues for EU regulators will include decisions regarding the settlement of tariff and accounting rates between the US and the EU. As the EU develops more and more online content, this will become particularly important given the current financial setup, which is quite favorable to the US. One important government role might be representing new market entrants in discussions about accounting tariffs between the US and Europe.

The EU has a well developed information policy, but is still struggling to realize that policy in an environment still strongly controlled by former PTTs. Successful creation of backbone infrastructure and a watchful eye on the market to discourage monopolistic behavior can ensure that this policy, large scale Internet use, and Internet telephony become realities in Europe’s near term.

### 7.3. Common Policy Recommendations

Internet telephony is just one of the many services that the Internet can provide. The real issue in examining Internet telephony is the power and financial balance between the telcos and ISPs, and between Europe, Mexico and the US. Governments may be inclined to fear a dramatic change in the status quo of the telco's traditional markets. The telcos are confronted with the difficult decision of either defending their traditional markets, and in doing so asking for the regulator's support, or moving into IP markets with the threat of lower profitability. The regulator should not be lured: Internet telephony is a test of the shit towards competition and deregulation. While some revenue may be transferred from telcos to ISPs, the objective of achieving more affordable and competitive services for the consumer can only be met by encouraging competition.

Governments should also monitor the competitive advantage of the Telcos as they become ISPs themselves. Competitors should be on equal grounds in terms of customer access and transport costs. The issue of high upstream connection costs for ISPs is still unresolved.

Internet telephony will encourage investment in additional IP infrastructure. Governments should realize the importance of the development of this infrastructure locally, and try to provide incentives to facilitate both competitive backbone expansion and new NAPs.

In the near future, Internet telephony will grow at limited pace due to penetration limits and slow reduction in transport cost. At this time, it is reasonable to consider internet telephony an 'enhanced service' (US) or 'non real time service' (EU). In particular, we believe that claims in the line of the ACTA petition should be disregarded by regulatory authorities at this time.[34] Only if and when internet telephony's share becomes significant should the Universal Access provisions be modified to include contributions from all voice service providers. Doing this too early will place a heavy burden on ISPs at prevent development of new market entrants.

[34]The ACTA petition was filed before the FCC by a US organization of long-distance resellers asking for regulation of Internet Telephony Software as traditional circuit-switched phone network.

## 8. CONCLUSION

The results of the cost model and policy analysis have varying implications for Internet telephony in Mexico, Spain and France. Access to the Internet has been increasing recently in all three countries and cost models show that cost/subscriber decreases as the number of subscribers increases. But a lack of a sufficient infrastructure, asymmetric tariffs between Europe and the US, and the strong influence of formerly nationalized telcos all work to create significant barriers to entry for new ISP and Internet telephony providers. The concurrent development of new backbones for long distance and regional telephony may ease the transition for internet providers. Furthermore, both the EU and Mexico have stated significant government interest in ensuring access to telephony and, in the future, the Internet.

Internet telephony is an excellent example of a technology that might, depending on local market and regulatory structure, create incentives for companies to engage in significant infrastructure investment. In particular, the high costs of international calls in Europe and Latin America make internet telephony attractive, even if the price advantage is solely a regulatory artifact. In fact, the pressure created by internet telephony to change local and international tariff agreements may have the desirable effect of creating cheaper, more open international markets for telecommunications services. Furthermore, the creation of new companies that are providing both internet telephony and internet services may hasten the development of truly competitive markets within the European Union and Mexico.

While PTT's currently retain their competitive advantage by controlling the major backbones, the opening of markets at a time late enough in the development of the internet for most in the telecommunications marketplace to see the power of the Internet may imply that a new form of telecom organization, one particularly well suited to linking data, communications, and computing power, may become dominant in emerging and European markets.

There are many areas of study that might shed additional light on the varying implications of this report. Extending the cost model to include gateways between the Internet and PSTN would provide considerable additional insight into the potential profitability of Internet telephony providers. Future models might examine the sensitivity of international IP-based calls to different tariff agreements between the European Union, Mexico, and the US.

The months ahead will certainly bring about significant changes that we could not have anticipated in this report. The pace of both market and technology development in the Internet arena taxes almost anyone's ability to keep up with it. This report attempts to provide some perspective on the development of an important technology in both European and emerging markets.

# APPENDIX A

## Input parameters for Mexican Internet telephony

**Cost Model Tables:**

**User Inputs**

This worksheet shows all user-modifiable inputs. Values in italics are computed; do not change these.

You may change values in blue and then set the "use default" option to "N" to see the effect of the change on the outputs.

| Input Name | **Scenario Without Internet Telephony** Default (from mod) | Manual (from user) | Use Default (Y or N) | Input | **Scenario With Internet Telephony** Manual (from user) | Use other scenario input (Y or N) | Input |
|---|---|---|---|---|---|---|---|
| **Geographic** | | | | | | | |
| # of Tier2 POPs | 9 | | | 9 | | | 9 |
| # of Tier1 POPs / Tier2 POP | 50 | 5 | n | 5 | | | 5 |
| *# of Tier1 POPs* | | | | *45* | | | *45* |
| # of NAP Interconnection points | 3 | | | 3 | | | 3 |
| Tier1 POP avg. population | 500,000 | 500,000 | Y | 500,000 | | | 500,000 |
| Tier2 POP avg. population | 2,000,000 | 1,750,000 | n | 1,750,000 | | | 1,750,000 |
| avg. dist. Tier1 POP to Tier2 POP (miles) | 75 | 25 | n | 25 | | | 25 |
| avg. E/W dist. between 2 Tier2 POPs | 1500 | 730 | n | 730 | | | 730 |
| avg. N/S dist. between 2 Tier2 POPs | 500 | 1000 | n | 1000 | | | 1000 |
| avg. dist. from POP to closest central office (miles) | 1.0 | 1.0 | Y | 1.0 | | | 1.0 |
| distance to NAP from closest Tier 2 POP | 5 | 5 | Y | 5 | | | 5 |
| **Market Profile** | | | | | | | |
| Residential | | | | | | | |
| ratio of people/household | 2.6 | 4.5 | n | 4.5 | | | 4.5 |
| % of households with analog dial-in service | 10.0% | 1.4% | n | 1.4% | | | 1% |
| ISP market share of analog dial-in users | 10.0% | 17.0% | n | 17.0% | | | 17% |
| Business | | | | | | | |
| ratio of on-line households to on-line businesses | 65 | 0.46 | n | 0.46 | | | 0.46 |
| % of on-line businesses with dial-in service | 25.0% | 75.0% | n | 75.0% | | | 75% |
| % of on-line businesses with ISDN service | 25.0% | 0.0% | n | 0.0% | | | 0% |
| % of on-line businesses with 56K service | 10.0% | 5.0% | n | 5.0% | | | 5% |
| % of on-line businesses with T1 service | 40.0% | 20.0% | n | 20.0% | | | 20.0% |
| ISP market share of bus. dial-in users | 10.0% | 17.0% | n | 17.0% | | | 17% |
| ISP market share of bus. ISDN service | 10.0% | 0.0% | n | 0.0% | | | 0% |
| ISP market share of bus. 56K users | 10.0% | 17.0% | n | 17.0% | | | 17% |
| ISP market share of bus. T1 users | 10.0% | 17.0% | n | 17.0% | | | 17% |
| Content Hosting | | | | | | | |
| % bus. dial-in subscribers w/ basic Web hosting | 0% | 0% | Y | 0% | | | 0% |
| % bus. dial-in subscribers w/ enhanced Web hosting | 0% | 0% | Y | 0% | | | 0% |
| % 56K subscribers w/ basic | 0% | 0% | Y | 0% | | | 0% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Web hosting | | | | | | | | |
| % 56K subscribers w/ enhanced Web hosting | 0% | 0% | Y | 0% | | | 0% | |
| % T1 subscribers w/ basic Web hosting | 0% | 0% | Y | 0% | | | 0% | |
| % T1 subscribers w/ enhanced Web hosting | 0% | 0% | Y | 0% | | | 0% | |
| **Service Prices** | | | | | | | | |
| monthly residential dial-in | $20 | $25 | n | $25 | $25 | n | $25 | |
| monthly business dial-in | $20 | $25 | n | $25 | $25 | n | $25 | |
| monthly ISDN | $100 | $0 | n | $0 | $0 | n | $0 | |
| monthly 56k | $500 | $1,900 | n | $1,900 | $1,900 | n | $1,900 | |
| monthly T1 | $1,200 | $4,500 | n | $4,500 | $4,500 | n | $4,500 | |
| basic content hosting | $0 | $0 | Y | $0 | $0 | n | $0 | |
| enhanced content hosting | $0 | $0 | Y | $0 | $0 | n | $0 | |
| currency conversion multiplier | 1 | 1 | Y | 1 | | | 1 | |
| **Internet Telephony Assumptions** | | | | | | | | |
| Internet telephony b/w increase vs. Web b/w | | | | | 300% | | 300% | |
| % using telephony (compared to Web) | | | | | 5% | | 5% | |
| **Capital Equipment (cost installed)** | | | | | | | | |
| round up lumpy quantities (transport and related capital eqpt.)? | N | N | Y | N | | | N | |
| Discount factor (received from vendors for bulk purchase) | 30% | 30% | Y | 30% | | | 30% | |
| concurrent analog dial-in users per POP server | 2000 | 2000 | Y | 2000 | | | 2000 | |
| concurrent ISDN dial-in users per POP server | 2000 | 2000 | Y | 2000 | | | 2000 | |
| # of 56 kb businesses per POP server | 1000 | 1000 | Y | 1000 | | | 1000 | |
| # of T1 businesses per POP server | 1000 | 1000 | Y | 1000 | | | 1000 | |
| 48 port analog modem banks | $42,000 | $42,000 | Y | $42,000 | | | $42,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| Ascend Max 4004 access router w/ ISDN software | $18,000 | $18,000 | Y | $18,000 | | | $18,000 | |
| # of B channels per 4004 | 92 | 92 | Y | 92 | | | 92 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| blocking probability for sizing # of modems | 1.00% | 1.00% | Y | 1.00% | | | 1.00% | |
| POP server (Web/news/email) | $25,000 | $25,000 | Y | $25,000 | | | $25,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| Content Hosting server | $10,000 | $10,000 | Y | $10,000 | | | $10,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| 10 Mbps ethernet switch per port | $100 | $100 | Y | $100 | | | $100 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| 100 Mbps ethernet switch per port | $500 | $500 | Y | $500 | | | $500 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| 56 kb CSU/DSU | $500 | $500 | Y | $500 | | | $500 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| T1 CSU/DSU | $1,400 | $1,400 | Y | $1,400 | | | $1,400 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| Cisco 2500 router | $2,800 | $2,800 | Y | $2,800 | | | $2,800 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| 8 port serial card for Cisco 7513, CX-FSIP8 | $16,000 | $16,000 | Y | $16,000 | | | $16,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| # of serial ports per card | 8 | 8 | Y | 8 | | | 8 | |
| ATM adapter card for Cisco 7513, CX-AIP-DS3 | $18,000 | $18,000 | Y | $18,000 | | | $18,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| Cisco 7513 router chassis w/ fast | $60,000 | $60,000 | Y | $60,000 | | | $60,000 | includes: router, |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ethernet card | | | | | | | | Power Sup., redundant Power Sup., RSP2, fast ethernet card, 32 MB Main RAM, IP and ATM software |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| # of available slots per chassis | 9 | 9 | Y | 9 | | | 9 | 13 total - 2 for the processors - 1 for the fast ethernet card |
| Fore 4 port DS3 card | $14,000 | $14,000 | Y | $14,000 | | | $14,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| # of DS3 ports per card | 4 | 4 | Y | 4 | | | 4 | |
| Fore 4 port OC-3 card | $14,000 | $14,000 | Y | $14,000 | | | $14,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| # of OC-3 ports per card | 4 | 4 | Y | 4 | | | 4 | |
| Fore ASX-200BX ATM switch chassis | $16,000 | $16,000 | Y | $16,000 | | | $16,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| # of slots per switch | 4 | 4 | Y | 4 | | | 4 | |
| **Transport** | | | | | | | | |
| % capacity at which to operate transport | 70% | 70% | Y | 70% | | | 70% | |
| 56 kb capacity (kbps) | 56 | 64 | n | 64 | | | 64 | |
| T1 capacity (Mbps) | 1.5 | 2.0 | n | 2.0 | | | 2.0 | |
| T3 capacity (Mbps) | 44.2 | 44.2 | Y | 44.2 | | | 44.2 | |
| OC-3 capacity (Mbps) | 150 | 150 | Y | 150 | | | 150 | |
| % O-D pairs found on ISP's network | 10% | 5% | N | 5% | | | 5% | |
| % Tier 1 traffic destined for Tier 2 | 11% | 11% | Y | 11% | 11% | Y | 11% | |
| % Tier 1 traffic destined for backbone | 89% | 89% | Y | 89% | 89% | Y | 89% | |
| % Tier 2 traffic destined for backbone | 89% | 89% | Y | 89% | 89% | Y | 89% | |
| % backbone traffic going 1 node distance | 25% | 25% | Y | 25% | 25% | Y | 25% | |
| % backbone traffic going 2 node distance | 25% | 25% | Y | 25% | 25% | Y | 25% | |
| % backbone traffic going 3 node distance | 25% | 25% | Y | 25% | 25% | Y | 25% | |
| % backbone traffic going 4 node distance | 25% | 25% | Y | 25% | 25% | Y | 25% | |
| NAP monthly interconnection charges | | | | | | | | |
| cost per DS-3 port | $5,500 | $5,500 | Y | $5,500 | $5,500 | Y | $5,500 | |
| cost per OC-3 port | $8,000 | $8,000 | Y | $8,000 | $8,000 | Y | $8,000 | |
| T1 - analog dial-in lines | | | | | | | | |
| $ per month (fixed) | $370 | $870 | n | $870 | | | $870 | |
| $ per mile per month | $48 | $0 | n | $0 | | | $0 | |
| ISDN PRI - digital dial-in lines | | | | | | | | |
| $ per month (fixed) | $548 | $0 | n | $0 | | | $0 | |
| $ per mile per month | $48 | $0 | n | $0 | | | $0 | |
| T1 (data) | | | | | | | | |
| $ per month (fixed) | $3,225 | $14,600 | n | $14,600 | | | $14,600 | |
| $ per mile per month | $3.85 | $0.00 | n | $0.00 | | | $0.00 | |
| T3 | | | | | | | | |
| $ per month (fixed) | $22,000 | $22,000 | Y | $22,000 | | | $22,000 | |
| $ per mile per month | $50 | $50 | Y | $50 | | | $50 | |
| OC-3 | | | | | | | | |
| $ per month (fixed) | $55,000 | $55,000 | Y | $55,000 | | | $55,000 | |
| $ per mile per month | $125 | $125 | Y | $125 | | | $125 | |
| Bulk transport discount (monthly cost) | | | | | | | | |
| $0 - $25,000 | 10% | 0% | N | 0% | 0% | n | 0% | |
| $25,001 - $100,000 | 20% | 0% | N | 0% | 0% | n | 0% | |
| $100,001 - $200,000 | 25% | 0% | N | 0% | 0% | n | 0% | |
| $200,001 - $350,000 | 35% | 0% | N | 0% | 0% | n | 0% | |
| $350,001 - $500,000 | 45% | 0% | N | 0% | 0% | n | 0% | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $500,001 + | 50% | 0% | N | 0% | 0% | n | 0% |
| **Customer Service** | | | | | | | |
| residential dial-in customer service | | | | | | | |
| calls/month/customer | 0.25 | 0.25 | Y | 0.25 | 0.30 | n | 0.30 |
| minutes/call | 15 | 15 | Y | 15 | 18 | n | 18 |
| cost/min | $2.00 | $0.50 | n | $0.50 | $0.40 | y | $0.50 |
| business dial-in customer service | | | | | | | |
| calls/month/business | 0.25 | 0.25 | Y | 0.25 | 0.30 | n | 0.30 |
| minutes/call | 15 | 15 | Y | 15 | 18 | n | 18 |
| cost/min | $2.00 | $0.50 | n | $0.50 | $0.40 | y | $0.50 |
| ISDN customer service | | | | | | | |
| calls/month/business | 0.25 | 0 | n | 0 | 0.00 | n | 0.00 |
| minutes/call | 15 | 0 | n | 0 | 0.00 | n | 0 |
| cost/min | $2.00 | $0.00 | n | $0.00 | $0.00 | n | $0.00 |
| 56 kb customer service | | | | | | | |
| calls/month/customer | 2 | 2 | Y | 2 | 2.4 | n | 2.40 |
| minutes/call | 15 | 15 | Y | 15 | 18 | n | 18 |
| cost/min | $4.00 | $1.00 | n | $1.00 | $0.40 | Y | $1.00 |
| T1 dial-in customer service | | | | | | | |
| calls/month/business | 2 | 2 | Y | 2 | 2.4 | n | 2.40 |
| minutes/call | 15 | 15 | Y | 15 | 18 | n | 18 |
| cost/min | $4.00 | $1.00 | n | $1.00 | $0.40 | Y | $1.00 |
| basic Web hosting customer service | | | | | | | |
| calls/month/customer | 0 | 0 | Y | 0 | 0.00 | y | 0.00 |
| minutes/call | 0 | 0 | Y | 0 | 0 | y | 0 |
| cost/min | $0.00 | $0.00 | Y | $0.00 | $0.00 | Y | $0.00 |
| enhanced Web hosting customer service | | | | | | | |
| calls/month/business | 0 | 0 | Y | 0 | 0 | y | 0 |
| minutes/call | 0 | 0 | Y | 0 | 0 | y | 0 |
| cost/min | $0.00 | $0.00 | Y | $0.00 | $0.00 | Y | $0.00 |
| **Operations** | | | | | | | |
| network operations | | | | | | | |
| SW/HW maint. (% of equipment costs) | 20% | 20% | Y | 20% | 20% | Y | 20% |
| # of Tier 1 POPs/Operations persons | 1.7 | 1.7 | n | 1.7 | 1.7 | Y | 1.7 |
| # of Tier 2 POPs/Operations persons | 0.5 | 0.5 | n | 0.5 | 0.5 | Y | 0.5 |
| ops person's salary | $50,000 | $15,000 | n | $15,000 | $15,000 | Y | $15,000 |
| web hosting operations | | | | | | | |
| # of basic sites / web person | 0 | 0 | Y | 0 | | | 0 |
| # of enhanched / web person | 0 | 0 | Y | 0 | | | 0 |
| web person's salary | $0 | $0 | Y | $0 | | | $0 |
| facilities | | | | | | | |
| $ per Tier 1 POP per month | $830 | $500 | n | $500 | $500 | Y | $500 |
| $ per Tier 2 POP per month | $4,125 | $4,125 | n | $4,125 | $4,125 | Y | $4,125 |
| billing and collections | | | | | | | |
| residential dial-in subs. | $1.25 | $1.25 | Y | $1.25 | $1.25 | Y | $1.25 |
| business dial-in subs. | $1.25 | $1.25 | Y | $1.25 | $1.25 | Y | $1.25 |
| ISDN dial-in subs. | $1.25 | $0.00 | n | $0.00 | $0.00 | Y | $0.00 |
| 56 kb subs. | $1.25 | $1.25 | Y | $1.25 | $1.25 | Y | $1.25 |
| T1 subs. | $1.25 | $1.25 | Y | $1.25 | $1.25 | Y | $1.25 |
| basic Web hosting subs. | $1.25 | $0.00 | n | $0.00 | $1.25 | Y | $0.00 |
| enhanced Web hosting subs. | $1.25 | $0.00 | n | $0.00 | $1.25 | Y | $0.00 |
| **Other Expenses** | | | | | | | |
| **sales and marketing (% rev)** | 20% | 20% | Y | 20% | 20% | Y | 20% |
| **general and admin (% costs)** | 11% | 11% | Y | 11% | 11% | Y | 11% |
| **Cost of Capital Factors** | | | | | | | |
| Debt Percent | 30.0% | 30.0% | Y | 30.0% | | | 30.0% |
| Cost of Debt | 9.0% | 9.0% | Y | 9.0% | | | 9.0% |
| Cost of Equity | 25.0% | 25.0% | Y | 25.0% | | | 25.0% |
| *Cost of Capital* | *20.2%* | 26.0% | Y | 20.2% | | | 20.2% |

The annualization factor is used to

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Residential dial-in user profile** | | | | | | | | convert capital investments to a levelized annual cost . |
| avg. downstream bandwidth per user being 100% active (kbps.) | *5.0* | *5.0* | *Y* | *5.0* | | | *5.5* | |
| % active (applies to all analog and ISDN dial-in) | 100% | 100% | Y | 100% | 100% | n | 100% | |
| *effective avg. bandwidth per user* | | | | *5.0* | | | *5.5* | |
| avg. holding time (minutes) | 30 | 20 | N | 20 | 24 | N | 24 | |
| *# of residential subs per Tier 1 POP* | | | | 255 | | | 255 | |
| *# of residential subs per Tier 2 POP* | | | | 893 | | | 893 | |
| % of subscribers requesting service during given hour: | | | | | | | | |
| 12:00 AM | 4% | 0% | Y | 4% | 5% | n | 5% | |
| 1:00 AM | 2% | 0% | Y | 2% | 2% | n | 2% | |
| 2:00 AM | 1% | 0% | Y | 1% | 1% | n | 1% | |
| 3:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% | |
| 4:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% | |
| 5:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% | |
| 6:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% | |
| 7:00 AM | 2% | 0% | Y | 2% | 2% | n | 2% | |
| 8:00 AM | 2% | 0% | Y | 2% | 2% | n | 2% | |
| 9:00 AM | 2% | 0% | Y | 2% | 2% | n | 2% | |
| 10:00 AM | 1% | 0% | Y | 1% | 1% | n | 1% | |
| 11:00 AM | 1% | 0% | Y | 1% | 1% | n | 1% | |
| 12:00 PM | 1% | 30% | Y | 1% | 1% | n | 1% | |
| 1:00 PM | 1% | 0% | Y | 1% | 1% | n | 1% | |
| 2:00 PM | 2% | 0% | Y | 2% | 2% | n | 2% | |
| 3:00 PM | 6% | 0% | Y | 6% | 7% | n | 7% | |
| 4:00 PM | 8% | 0% | Y | 8% | 10% | n | 10% | |
| 5:00 PM | 10% | 0% | Y | 10% | 12% | n | 12% | |
| 6:00 PM | 12% | 0% | Y | 12% | 14% | n | 14% | |
| 7:00 PM | 12% | 0% | Y | 12% | 14% | n | 14% | |
| 8:00 PM | 15% | 0% | Y | 15% | 18% | n | 18% | |
| 9:00 PM | 20% | 0% | Y | 20% | 24% | n | 24% | |
| 10:00 PM | 20% | 0% | Y | 20% | 24% | n | 24% | |
| 11:00 PM | 15% | 0% | Y | 15% | 18% | n | 18% | |
| *average % of subscriber access* | | | | *6%* | | | *7%* | |
| **Business dial-in user profile** | | | | | | | | |
| *effective avg. bw per user (kbps.)-must be same as for res. dial-in* | | | | 5.0 | | | 5.5 | |
| *avg. holding time (minutes)-must be same as for res. dial-in* | | | | *20* | | | 24 | |
| *# of business dial-in subs per Tier 1 POP* | | | | *416* | | | 416 | |
| *# of business dial-in subs per Tier 2 POP* | | | | *1455* | | | 1455 | |
| % of subscribers requesting service during given hour: | | | | | | | | |
| 12:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% | |
| 1:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% | |
| 2:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% | |
| 3:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% | |
| 4:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% | |
| 5:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% | |
| 6:00 AM | 2% | 2% | Y | 2% | 2% | n | 2% | |
| 7:00 AM | 4% | 4% | Y | 4% | 5% | n | 5% | |
| 8:00 AM | 10% | 10% | Y | 10% | 12% | n | 12% | |
| 9:00 AM | 12% | 12% | Y | 12% | 14% | n | 14% | |
| 10:00 AM | 15% | 15% | Y | 15% | 18% | n | 18% | |
| 11:00 AM | 20% | 20% | Y | 20% | 24% | n | 24% | |
| 12:00 PM | 15% | 15% | Y | 15% | 18% | n | 18% | |
| 1:00 PM | 10% | 10% | Y | 10% | 12% | n | 12% | |
| 2:00 PM | 15% | 15% | Y | 15% | 18% | n | 18% | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3:00 PM | 20% | 20% | Y | 20% | 24% | n | 24% |
| 4:00 PM | 15% | 15% | Y | 15% | 18% | n | 18% |
| 5:00 PM | 12% | 12% | Y | 12% | 14% | n | 14% |
| 6:00 PM | 6% | 6% | Y | 6% | 7% | n | 7% |
| 7:00 PM | 3% | 3% | Y | 3% | 4% | n | 4% |
| 8:00 PM | 1% | 1% | Y | 1% | 1% | n | 1% |
| 9:00 PM | 1% | 1% | Y | 1% | 1% | n | 1% |
| 10:00 PM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 11:00 PM | 0% | 0% | Y | 0% | 0% | n | 0% |
| *average % of subscriber access* | | | | *7%* | | | *8%* |
| **ISDN dial-in user profile** | | | | | | | |
| ratio of per user ISDN bw to per user dial-in bw | 500% | 500% | Y | 500% | 500% | n | 500% |
| *effective avg. bw per user (kbps.)* | | | | *25.0* | | | *27.5* |
| avg. holding time (minutes) | 30 | 30 | Y | 30 | 36 | n | 36 |
| *# of business dial-in subs per Tier 1 POP* | | | | *0* | | | *0* |
| *# of business dial-in subs per Tier 2 POP* | | | | *0* | | | *0* |
| % of subscribers requesting service during given hour: | | | | | | | |
| 12:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 1:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 2:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 3:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 4:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 5:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 6:00 AM | 2% | 2% | Y | 2% | 2% | n | 2% |
| 7:00 AM | 4% | 4% | Y | 4% | 5% | n | 5% |
| 8:00 AM | 10% | 10% | Y | 10% | 12% | n | 12% |
| 9:00 AM | 12% | 12% | Y | 12% | 14% | n | 14% |
| 10:00 AM | 15% | 15% | Y | 15% | 18% | n | 18% |
| 11:00 AM | 20% | 20% | Y | 20% | 24% | n | 24% |
| 12:00 PM | 10% | 10% | Y | 10% | 12% | n | 12% |
| 1:00 PM | 12% | 12% | Y | 12% | 14% | n | 14% |
| 2:00 PM | 15% | 15% | Y | 15% | 18% | n | 18% |
| 3:00 PM | 20% | 20% | Y | 20% | 24% | n | 24% |
| 4:00 PM | 15% | 15% | Y | 15% | 18% | n | 18% |
| 5:00 PM | 12% | 12% | Y | 12% | 14% | n | 14% |
| 6:00 PM | 6% | 6% | Y | 6% | 7% | n | 7% |
| 7:00 PM | 3% | 3% | Y | 3% | 4% | n | 4% |
| 8:00 PM | 1% | 1% | Y | 1% | 1% | n | 1% |
| 9:00 PM | 1% | 1% | Y | 1% | 1% | n | 1% |
| 10:00 PM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 11:00 PM | 0% | 0% | Y | 0% | 0% | n | 0% |
| *average % of subscriber access* | | | | *7%* | | | *8%* |
| **56 kb user profile** | | | | | | | |
| *# of 56 kb subs per Tier 2 POP* | | | | 236 | | | 236 |
| Number of leased lines / business | 1 | 1 | Y | 1 | | | 1.1 |
| % that leased line is full during given hour | | | | | | | |
| 12:00 AM | 5% | 1% | Y | 5% | | | 5% |
| 1:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 2:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 3:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 4:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 5:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 6:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 7:00 AM | 10% | 10% | Y | 10% | | | 10% |
| 8:00 AM | 30% | 30% | Y | 30% | | | 30% |
| 9:00 AM | 50% | 50% | Y | 50% | | | 50% |
| 10:00 AM | 70% | 70% | Y | 70% | | | 70% |
| 11:00 AM | 70% | 70% | Y | 70% | | | 70% |
| 12:00 PM | 70% | 70% | Y | 70% | | | 70% |
| 1:00 PM | 70% | 70% | Y | 70% | | | 70% |
| 2:00 PM | 70% | 70% | Y | 70% | | | 70% |
| 3:00 PM | 60% | 60% | Y | 60% | | | 60% |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4:00 PM | 60% | 60% | Y | 60% | | 60% |
| 5:00 PM | 50% | 50% | Y | 50% | | 50% |
| 6:00 PM | 50% | 50% | Y | 50% | | 50% |
| 7:00 PM | 40% | 40% | Y | 40% | | 40% |
| 8:00 PM | 30% | 30% | Y | 30% | | 30% |
| 9:00 PM | 30% | 30% | Y | 30% | | 30% |
| 10:00 PM | 20% | 20% | Y | 20% | | 20% |
| 11:00 PM | 10% | 10% | Y | 10% | | 10% |
| *average % that leased lin is full* | | | | *34%* | | *34%* |
| **T1 user profile** | | | | | | |
| *# of T1 subs per Tier 2 POP* | | | | 942 | | 942 |
| Number of leased lines / business | 1 | 1 | Y | 1 | | 1.1 |
| % that leased line is full during given hour | | | | | | |
| 12:00 AM | 5% | 0% | Y | 5% | | 5% |
| 1:00 AM | 5% | 0% | Y | 5% | | 5% |
| 2:00 AM | 5% | 0% | Y | 5% | | 5% |
| 3:00 AM | 5% | 0% | Y | 5% | | 5% |
| 4:00 AM | 5% | 0% | Y | 5% | | 5% |
| 5:00 AM | 5% | 0% | Y | 5% | | 5% |
| 6:00 AM | 5% | 0% | Y | 5% | | 5% |
| 7:00 AM | 10% | 0% | Y | 10% | | 10% |
| 8:00 AM | 30% | 0% | Y | 30% | | 30% |
| 9:00 AM | 50% | 0% | Y | 50% | | 50% |
| 10:00 AM | 70% | 0% | Y | 70% | | 70% |
| 11:00 AM | 70% | 0% | Y | 70% | | 70% |
| 12:00 PM | 70% | 100% | Y | 70% | | 70% |
| 1:00 PM | 70% | 0% | Y | 70% | | 70% |
| 2:00 PM | 70% | 0% | Y | 70% | | 70% |
| 3:00 PM | 60% | 0% | Y | 60% | | 60% |
| 4:00 PM | 60% | 0% | Y | 60% | | 60% |
| 5:00 PM | 50% | 0% | Y | 50% | | 50% |
| 6:00 PM | 50% | 0% | Y | 50% | | 50% |
| 7:00 PM | 40% | 0% | Y | 40% | | 40% |
| 8:00 PM | 30% | 0% | Y | 30% | | 30% |
| 9:00 PM | 30% | 0% | Y | 30% | | 30% |
| 10:00 PM | 20% | 0% | Y | 20% | | 20% |
| 11:00 PM | 10% | 0% | Y | 10% | | 10% |
| *average % that leased lin is full* | | | | *34%* | | *34%* |
| **Basic Web Hosting** | | | | | | |
| *# of basicWeb hosting subs per Tier 2 POP* | 0 | 0 | Y | 0 | | 0 |
| # of basic subscribers per server | 0 | 0 | Y | 0 | | 0 |
| **Enhanced Web Hosting** | | | | | | |
| *# of enhanced Web hosting subs per Tier 2 POP* | 0 | 0 | Y | 0 | | 0 |
| # of enhanced subscribers per server | 0 | 0 | Y | 0 | | 0 |

# APPENDIX B

## Input parameters for European Internet telephony

### User Inputs

This worksheet shows all user-modifiable inputs. Values in italics are computed; do not change these.
You may change values in blue and then set the "use default" option to "N" to see the effect of the change on the outputs.

| Input Name | Scenario Without Internet Telephony<br>Default (from mod) | Manual (from user) | Use Default (Y or N) | Input | Scenario With Internet Telephony<br>Manual (from user) | Use other scenario input (Y or N) | Input |
|---|---|---|---|---|---|---|---|
| **Geographic** | | | | | | | |
| # of Tier2 POPs | 9 | | | 9 | | | 9 |
| # of Tier1 POPs / Tier2 POP | 50 | 50 | Y | 50 | | | 50 |
| *# of Tier1 POPs* | | | | *450* | | | *450* |
| # of NAP Interconnection points | 3 | | | 3 | | | 3 |
| Tier1 POP avg. population | 500,000 | 770000 | n | 770000 | | | 770,000 |
| Tier2 POP avg. population | 2,000,000 | 3100000 | n | 3100000 | | | 3,100,000 |
| avg. dist. Tier1 POP to Tier2 POP (miles) | 75 | 60 | n | 60 | | | 60 |
| avg. E/W dist. between 2 Tier2 POPs | 1500 | 400 | n | 400 | | | 400 |
| avg. N/S dist. between 2 Tier2 POPs | 500 | 500 | n | 500 | | | 500 |
| avg. dist. from POP to closest central office (miles) | 1.0 | 1.0 | Y | 1.0 | | | 1.0 |
| distance to NAP from closest Tier 2 POP | 5 | 5 | Y | 5 | | | 5 |
| **Market Profile** | | | | | | | |
| Residential | | | | | | | |
| ratio of people/household | 2.6 | 2.6 | Y | 2.6 | | | 2.6 |
| % of households with analog dial-in service | 10.0% | 3.0% | n | 3.0% | | | 3% |
| ISP market share of analog dial-in users | 10.0% | 10.0% | n | 10.0% | | | 10% |
| Business | | | | | | | |
| ratio of on-line households to on-line businesses | 65 | 2 | n | 2 | | | 2 |
| % of on-line businesses with dial-in service | 25.0% | 62.0% | n | 62.0% | | | 62% |
| % of on-line businesses with ISDN service | 25.0% | 30.0% | n | 30.0% | | | 30% |
| % of on-line businesses with 56K service | 10.0% | 3.0% | n | 3.0% | | | 3% |
| % of on-line businesses with T1 service | 40.0% | 5.0% | n | 5.0% | | | 5.0% |
| ISP market share of bus. dial-in users | 10.0% | 0.0% | Y | 10.0% | | | 10% |
| ISP market share of bus. ISDN service | 10.0% | 0.0% | Y | 10.0% | | | 10% |
| ISP market share of bus. 56K users | 10.0% | 0.0% | Y | 10.0% | | | 10% |
| ISP market share of bus. T1 users | 10.0% | 0.0% | Y | 10.0% | | | 10% |
| Content Hosting | | | | | | | |
| % bus. dial-in subscribers w/ basic Web hosting | 0% | 0% | Y | 0% | | | 0% |
| % bus. dial-in subscribers w/ enhanced Web hosting | 0% | 0% | Y | 0% | | | 0% |
| % 56K subscribers w/ basic Web hosting | 0% | 0% | Y | 0% | | | 0% |
| % 56K subscribers w/ enhanced Web hosting | 0% | 0% | Y | 0% | | | 0% |
| % T1 subscribers w/ basic Web hosting | 0% | 0% | Y | 0% | | | 0% |
| % T1 subscribers w/ enhanced Web hosting | 0% | 0% | Y | 0% | | | 0% |
| **Service Prices** | | | | | | | |
| monthly residential dial-in | $20 | $20 | Y | $20 | $20 | Y | $20 |
| monthly business dial-in | $20 | $20 | Y | $20 | $20 | Y | $20 |
| monthly ISDN | $100 | $100 | Y | $100 | $100 | Y | $100 |
| monthly 56k | $500 | $1,000 | Y | $500 | $500 | Y | $500 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| monthly T1 | $1,200 | $1,200 | n | $1,200 | $2,100 | Y | $1,200 | |
| basic content hosting | $0 | $0 | Y | $0 | $100 | Y | $0 | |
| enhanced content hosting | $0 | $0 | Y | $0 | $3,000 | Y | $0 | |
| currency conversion multiplier | 1 | 1 | Y | 1 | | | 1 | |
| | | | | | | | | |
| **Internet Telephony Assumptions** | | | | | | | | |
| Internet telephony b/w increase vs. Web b/w | | | | | 300% | | 300% | |
| % using telephony (compared to Web) | | | | | 33% | | 33% | |
| | | | | | | | | |
| **Capital Equipment (cost installed)** | | | | | | | | |
| round up lumpy quantities (transport and related capital eqpt.)? | N | N | Y | N | | | N | |
| Discount factor (received from vendors for bulk purchase) | 30% | 30% | Y | 30% | | | 30% | |
| concurrent analog dial-in users per POP server | 2000 | 2000 | Y | 2000 | | | 2000 | |
| concurrent ISDN dial-in users per POP server | 2000 | 2000 | Y | 2000 | | | 2000 | |
| # of 56 kb businesses per POP server | 1000 | 1000 | Y | 1000 | | | 1000 | |
| # of T1 businesses per POP server | 1000 | 1000 | Y | 1000 | | | 1000 | |
| 48 port analog modem banks | $42,000 | $42,000 | Y | $42,000 | | | $42,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| Ascend Max 4004 access router w/ ISDN software | $18,000 | $18,000 | Y | $18,000 | | | $18,000 | |
| # of B channels per 4004 | 92 | 92 | Y | 92 | | | 92 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| blocking probability for sizing # of modems | 1.00% | 1.00% | Y | 1.00% | | | 1.00% | |
| POP server (Web/news/email) | $25,000 | $25,000 | Y | $25,000 | | | $25,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| Content Hosting server | $10,000 | $10,000 | Y | $10,000 | | | $10,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| 10 Mbps ethernet switch per port | $100 | $100 | Y | $100 | | | $100 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| 100 Mbps ethernet switch per port | $500 | $500 | Y | $500 | | | $500 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| 56 kb CSU/DSU | $500 | $500 | Y | $500 | | | $500 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| T1 CSU/DSU | $1,400 | $1,400 | Y | $1,400 | | | $1,400 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| Cisco 2500 router | $2,800 | $2,800 | Y | $2,800 | | | $2,800 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| 8 port serial card for Cisco 7513, CX-FSIP8 | $16,000 | $16,000 | Y | $16,000 | | | $16,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| # of serial ports per card | 8 | 8 | Y | 8 | | | 8 | |
| ATM adapter card for Cisco 7513, CX-AIP-DS3 | $18,000 | $18,000 | Y | $18,000 | | | $18,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| Cisco 7513 router chassis w/ fast ethernet card | $60,000 | $60,000 | Y | $60,000 | | | $60,000 | includes: router, Power Sup., redundant Power Sup., RSP2, fast ethernet card, 32 MB Main RAM, IP and ATM software |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| # of available slots per chassis | 9 | 9 | Y | 9 | | | 9 | 13 total - 2 for the processors - 1 for the fast ethernet card |
| Fore 4 port DS3 card | $14,000 | $14,000 | Y | $14,000 | | | $14,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| # of DS3 ports per card | 4 | 4 | Y | 4 | | | 4 | |
| Fore 4 port OC-3 card | $14,000 | $14,000 | Y | $14,000 | | | $14,000 | |
| economic life (months) | 36 | 36 | Y | 36 | | | 36 | |
| # of OC-3 ports per card | 4 | 4 | Y | 4 | | | 4 | |
| Fore ASX-200BX ATM switch chassis | $16,000 | $16,000 | Y | $16,000 | | | $16,000 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| economic life (months) | 36 | 36 | Y | 36 | | | 36 |
| # of slots per switch | 4 | 4 | Y | 4 | | | 4 |
| **Transport** | | | | | | | |
| % capacity at which to operate transport | 70% | 70% | Y | 70% | | | 70% |
| 56 kb capacity (kbps) | 56 | 56 | Y | 56 | | | 56 |
| T1 capacity (Mbps) | 1.5 | 1.5 | Y | 1.5 | | | 1.5 |
| T3 capacity (Mbps) | 44.2 | 44.2 | Y | 44.2 | | | 44.2 |
| OC-3 capacity (Mbps) | 150 | 150 | Y | 150 | | | 150 |
| % O-D pairs found on ISP's network | 10% | 10% | Y | 10% | | | 10% |
| % Tier 1 traffic destined for Tier 2 | 11% | 11% | Y | 11% | 11% | Y | 11% |
| % Tier 1 traffic destined for backbone | 89% | 89% | Y | 89% | 89% | Y | 89% |
| % Tier 2 traffic destined for backbone | 89% | 89% | Y | 89% | 89% | Y | 89% |
| % backbone traffic going 1 node distance | 25% | 25% | Y | 25% | 25% | Y | 25% |
| % backbone traffic going 2 node distance | 25% | 25% | Y | 25% | 25% | Y | 25% |
| % backbone traffic going 3 node distance | 25% | 25% | Y | 25% | 25% | Y | 25% |
| % backbone traffic going 4 node distance | 25% | 25% | Y | 25% | 25% | Y | 25% |
| NAP monthly interconnection charges | | | | | | | |
| cost per DS-3 port | $5,500 | $5,500 | Y | $5,500 | $5,500 | Y | $5,500 |
| cost per OC-3 port | $8,000 | $8,000 | Y | $8,000 | $8,000 | Y | $8,000 |
| T1 - analog dial-in lines | | | | | | | |
| $ per month (fixed) | $370 | $740 | n | $740 | | | $740 |
| $ per mile per month | $48 | $96 | n | $96 | | | $96 |
| ISDN PRI - digital dial-in lines | | | | | | | |
| $ per month (fixed) | $548 | $548 | Y | $548 | | | $548 |
| $ per mile per month | $48 | $48 | Y | $48 | | | $48 |
| T1 (data) | | | | | | | |
| $ per month (fixed) | $3,225 | $6,450 | n | $6,450 | | | $6,450 |
| $ per mile per month | $3.85 | $7.70 | n | $7.70 | | | $7.70 |
| T3 | | | | | | | |
| $ per month (fixed) | $22,000 | $33,000 | n | $33,000 | | | $33,000 |
| $ per mile per month | $50 | $75 | n | $75 | | | $75 |
| OC-3 | | | | | | | |
| $ per month (fixed) | $55,000 | $82,500 | n | $82,500 | | | $82,500 |
| $ per mile per month | $125 | $187.50 | n | $188 | | | $188 |
| Bulk transport discount (monthly cost) | | | | | | | |
| $0 - $25,000 | 10% | 10% | Y | 10% | 10% | Y | 10% |
| $25,001 - $100,000 | 20% | 20% | Y | 20% | 20% | Y | 20% |
| $100,001 - $200,000 | 25% | 25% | Y | 25% | 25% | Y | 25% |
| $200,001 - $350,000 | 35% | 35% | Y | 35% | 35% | Y | 35% |
| $350,001 - $500,000 | 45% | 45% | Y | 45% | 45% | Y | 45% |
| $500,001 + | 50% | 50% | Y | 50% | 50% | Y | 50% |
| **Customer Service** | | | | | | | |
| residential dial-in customer service | | | | | | | |
| calls/month/customer | 0.25 | 0.25 | Y | 0.25 | 0.30 | n | 0.30 |
| minutes/call | 15 | 15 | Y | 15 | 21 | n | 21 |
| cost/min | $2.00 | $2.00 | Y | $2.00 | $1.50 | Y | $2.00 |
| business dial-in customer service | | | | | | | |
| calls/month/business | 0.25 | 0.25 | Y | 0.25 | 0.30 | n | 0.30 |
| minutes/call | 15 | 15 | Y | 15 | 18 | n | 18 |
| cost/min | $2.00 | $2.00 | Y | $2.00 | $1.50 | Y | $2.00 |
| ISDN customer service | | | | | | | |
| calls/month/business | 0.25 | 0.25 | Y | 0.25 | 0.30 | n | 0.30 |
| minutes/call | 15 | 15 | Y | 15 | 18.00 | n | 18 |
| cost/min | $2.00 | $2.00 | Y | $2.00 | $2.40 | Y | $2.00 |
| 56 kb customer service | | | | | | | |
| calls/month/customer | 2 | 2 | Y | 2 | 2.4 | n | 2.40 |
| minutes/call | 15 | 15 | Y | 15 | 18 | n | 18 |
| cost/min | $4.00 | $4.00 | Y | $4.00 | $1.50 | Y | $4.00 |
| T1 dial-in customer service | | | | | | | |
| calls/month/business | 2 | 2 | Y | 2 | 2.4 | n | 2.40 |
| minutes/call | 15 | 15 | Y | 15 | 18 | n | 18 |
| cost/min | $4.00 | $4.00 | Y | $4.00 | $1.50 | Y | $4.00 |
| basic Web hosting customer service | | | | | | | |
| calls/month/customer | 0 | 0 | Y | 0 | 0.00 | y | 0.00 |
| minutes/call | 0 | 0 | Y | 0 | 0 | y | 0 |
| cost/min | $0.00 | $0.00 | Y | $0.00 | $0.00 | Y | $0.00 |
| enhanced Web hosting customer service | | | | | | | |
| calls/month/business | 0 | 0 | Y | 0 | 0 | y | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| minutes/call | 0 | 0 | Y | 0 | 0 | y | 0 |
| cost/min | $0.00 | $0.00 | Y | $0.00 | $0.00 | Y | $0.00 |
| **Operations** | | | | | | | |
| network operations | | | | | | | |
| SW/HW maint. (% of equipment costs) | 20% | 20% | Y | 20% | 20% | Y | 20% |
| # of Tier 1 POPs/Operations persons | 1.7 | 1.7 | Y | 1.7 | 1.7 | Y | 1.7 |
| # of Tier 2 POPs/Operations persons | 0.5 | 0.5 | Y | 0.5 | 0.5 | Y | 0.5 |
| ops person's salary | $50,000 | $50,000 | Y | $50,000 | $50,000 | Y | $50,000 |
| web hosting operations | | | | | | | |
| # of basic sites / web person | 0 | 0 | Y | 0 | | | 0 |
| # of enhanched / web person | 0 | 0 | Y | 0 | | | 0 |
| web person's salary | $0 | $0 | Y | $0 | | | $0 |
| facilities | | | | | | | |
| $ per Tier 1 POP per month | $830 | $500 | Y | $830 | $830 | Y | $830 |
| $ per Tier 2 POP per month | $4,125 | $4,125 | Y | $4,125 | $4,125 | Y | $4,125 |
| billing and collections | | | | | | | |
| residential dial-in subs. | $1.25 | $1.25 | Y | $1.25 | $1.25 | Y | $1.25 |
| business dial-in subs. | $1.25 | $1.25 | Y | $1.25 | $1.25 | Y | $1.25 |
| ISDN dial-in subs. | $1.25 | $1.25 | Y | $1.25 | $1.25 | Y | $1.25 |
| 56 kb subs. | $1.25 | $1.25 | Y | $1.25 | $1.25 | Y | $1.25 |
| T1 subs. | $1.25 | $1.25 | Y | $1.25 | $1.25 | Y | $1.25 |
| basic Web hosting subs. | $1.25 | $1.25 | Y | $1.25 | $1.25 | Y | $1.25 |
| enhanced Web hosting subs. | $1.25 | $1.25 | Y | $1.25 | $1.25 | Y | $1.25 |
| **Other Expenses** | | | | | | | |
| **sales and marketing (% rev)** | 20% | 20% | Y | 20% | 20% | Y | 20% |
| **general and admin (% costs)** | 11% | 11% | Y | 11% | 11% | Y | 11% |
| **Cost of Capital Factors** | | | | | | | |
| Debt Percent | 30.0% | 30.0% | Y | 30.0% | | | 30.0% |
| Cost of Debt | 9.0% | 9.0% | Y | 9.0% | | | 9.0% |
| Cost of Equity | 25.0% | 25.0% | Y | 25.0% | | | 25.0% |
| *Cost of Capital* | *20.2%* | 26.0% | Y | 20.2% | | | 20.2% |
| **Residential dial-in user profile** | | | | | | | |
| avg. downstream bandwidth per user being 100% active (kbps.) | *5.0* | *5.0* | *Y* | *5.0* | | | *8.3* |
| % active (applies to all analog and ISDN dial-in) | 100% | 100% | Y | 100% | 100% | n | 100% |
| *effective avg. bandwidth per user* | | | | *5.0* | | | *8.3* |
| avg. holding time (minutes) | 30 | 15 | n | 15 | 25 | n | 25 |
| *# of residential subs per Tier 1 POP* | | | | 888 | | | 888 |
| *# of residential subs per Tier 2 POP* | | | | 3577 | | | 3577 |
| % of subscribers requesting service during given hour: | | | | | | | |
| 12:00 AM | 4% | 0% | Y | 4% | 5% | n | 5% |
| 1:00 AM | 2% | 0% | Y | 2% | 2% | n | 2% |
| 2:00 AM | 1% | 0% | Y | 1% | 1% | n | 1% |
| 3:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 4:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 5:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 6:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 7:00 AM | 2% | 0% | Y | 2% | 2% | n | 2% |
| 8:00 AM | 2% | 0% | Y | 2% | 2% | n | 2% |
| 9:00 AM | 2% | 0% | Y | 2% | 2% | n | 2% |
| 10:00 AM | 1% | 0% | Y | 1% | 1% | n | 1% |
| 11:00 AM | 1% | 0% | Y | 1% | 1% | n | 1% |
| 12:00 PM | 1% | 30% | Y | 1% | 1% | n | 1% |
| 1:00 PM | 1% | 0% | Y | 1% | 1% | n | 1% |
| 2:00 PM | 2% | 0% | Y | 2% | 2% | n | 2% |
| 3:00 PM | 6% | 0% | Y | 6% | 7% | n | 7% |
| 4:00 PM | 8% | 0% | Y | 8% | 10% | n | 10% |

The annualization factor is used to convert capital investments to a levelized annual cost .

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5:00 PM | 10% | 0% | Y | 10% | 12% | n | 12% |
| 6:00 PM | 12% | 0% | Y | 12% | 14% | n | 14% |
| 7:00 PM | 12% | 0% | Y | 12% | 14% | n | 14% |
| 8:00 PM | 15% | 0% | Y | 15% | 18% | n | 18% |
| 9:00 PM | 20% | 0% | Y | 20% | 24% | n | 24% |
| 10:00 PM | 20% | 0% | Y | 20% | 24% | n | 24% |
| 11:00 PM | 15% | 0% | Y | 15% | 18% | n | 18% |
| *average % of subscriber access* | | | | *6%* | | | *7%* |
| | | | | | | | |
| **Business dial-in user profile** | | | | | | | |
| *effective avg. bw per user (kbps.)-must be same as for res. dial-in* | | | | 5.0 | | | 8.3 |
| *avg. holding time (minutes)-must be same as for res. dial-in* | | | | *15* | | | 25 |
| *# of business dial-in subs per Tier 1 POP* | | | | *275* | | | 275 |
| *# of business dial-in subs per Tier 2 POP* | | | | *1109* | | | 1109 |
| % of subscribers requesting service during given hour: | | | | | | | |
| 12:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 1:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 2:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 3:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 4:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 5:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 6:00 AM | 2% | 2% | Y | 2% | 2% | n | 2% |
| 7:00 AM | 4% | 4% | Y | 4% | 5% | n | 5% |
| 8:00 AM | 10% | 10% | Y | 10% | 12% | n | 12% |
| 9:00 AM | 12% | 12% | Y | 12% | 14% | n | 14% |
| 10:00 AM | 15% | 15% | Y | 15% | 18% | n | 18% |
| 11:00 AM | 20% | 20% | Y | 20% | 24% | n | 24% |
| 12:00 PM | 15% | 15% | Y | 15% | 18% | n | 18% |
| 1:00 PM | 10% | 10% | Y | 10% | 12% | n | 12% |
| 2:00 PM | 15% | 15% | Y | 15% | 18% | n | 18% |
| 3:00 PM | 20% | 20% | Y | 20% | 24% | n | 24% |
| 4:00 PM | 15% | 15% | Y | 15% | 18% | n | 18% |
| 5:00 PM | 12% | 12% | Y | 12% | 14% | n | 14% |
| 6:00 PM | 6% | 6% | Y | 6% | 7% | n | 7% |
| 7:00 PM | 3% | 3% | Y | 3% | 4% | n | 4% |
| 8:00 PM | 1% | 1% | Y | 1% | 1% | n | 1% |
| 9:00 PM | 1% | 1% | Y | 1% | 1% | n | 1% |
| 10:00 PM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 11:00 PM | 0% | 0% | Y | 0% | 0% | n | 0% |
| *average % of subscriber access* | | | | *7%* | | | *8%* |
| | | | | | | | |
| **ISDN dial-in user profile** | | | | | | | |
| ratio of per user ISDN bw to per user dial-in bw | 500% | 500% | Y | 500% | 500% | n | 500% |
| *effective avg. bw per user (kbps.)* | | | | *25.0* | | | *41.5* |
| avg. holding time (minutes) | 30 | 30 | Y | 15 | 25 | n | 25 |
| *# of business dial-in subs per Tier 1 POP* | | | | *133* | | | *133* |
| *# of business dial-in subs per Tier 2 POP* | | | | *537* | | | *537* |
| % of subscribers requesting service during given hour: | | | | | | | |
| 12:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 1:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 2:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 3:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 4:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 5:00 AM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 6:00 AM | 2% | 2% | Y | 2% | 2% | n | 2% |
| 7:00 AM | 4% | 4% | Y | 4% | 5% | n | 5% |
| 8:00 AM | 10% | 10% | Y | 10% | 12% | n | 12% |
| 9:00 AM | 12% | 12% | Y | 12% | 14% | n | 14% |
| 10:00 AM | 15% | 15% | Y | 15% | 18% | n | 18% |
| 11:00 AM | 20% | 20% | Y | 20% | 24% | n | 24% |
| 12:00 PM | 10% | 10% | Y | 10% | 12% | n | 12% |
| 1:00 PM | 12% | 12% | Y | 12% | 14% | n | 14% |
| 2:00 PM | 15% | 15% | Y | 15% | 18% | n | 18% |
| 3:00 PM | 20% | 20% | Y | 20% | 24% | n | 24% |
| 4:00 PM | 15% | 15% | Y | 15% | 18% | n | 18% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5:00 PM | 12% | 12% | Y | 12% | 14% | n | 14% |
| 6:00 PM | 6% | 6% | Y | 6% | 7% | n | 7% |
| 7:00 PM | 3% | 3% | Y | 3% | 4% | n | 4% |
| 8:00 PM | 1% | 1% | Y | 1% | 1% | n | 1% |
| 9:00 PM | 1% | 1% | Y | 1% | 1% | n | 1% |
| 10:00 PM | 0% | 0% | Y | 0% | 0% | n | 0% |
| 11:00 PM | 0% | 0% | Y | 0% | 0% | n | 0% |
| *average % of subscriber access* | | | | *7%* | | | *8%* |
| | | | | | | | |
| **56 kb user profile** | | | | | | | |
| *# of 56 kb subs per Tier 2 POP* | | | | 720 | | | 720 |
| Number of leased lines / business | 1 | 1 | Y | 1 | | | 1.66 |
| % that leased line is full during given hour | | | | | | | |
| 12:00 AM | 5% | 1% | Y | 5% | | | 5% |
| 1:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 2:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 3:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 4:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 5:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 6:00 AM | 5% | 5% | Y | 5% | | | 5% |
| 7:00 AM | 10% | 10% | Y | 10% | | | 10% |
| 8:00 AM | 30% | 30% | Y | 30% | | | 30% |
| 9:00 AM | 50% | 50% | Y | 50% | | | 50% |
| 10:00 AM | 70% | 70% | Y | 70% | | | 70% |
| 11:00 AM | 70% | 70% | Y | 70% | | | 70% |
| 12:00 PM | 70% | 70% | Y | 70% | | | 70% |
| 1:00 PM | 70% | 70% | Y | 70% | | | 70% |
| 2:00 PM | 70% | 70% | Y | 70% | | | 70% |
| 3:00 PM | 60% | 60% | Y | 60% | | | 60% |
| 4:00 PM | 60% | 60% | Y | 60% | | | 60% |
| 5:00 PM | 50% | 50% | Y | 50% | | | 50% |
| 6:00 PM | 50% | 50% | Y | 50% | | | 50% |
| 7:00 PM | 40% | 40% | Y | 40% | | | 40% |
| 8:00 PM | 30% | 30% | Y | 30% | | | 30% |
| 9:00 PM | 30% | 30% | Y | 30% | | | 30% |
| 10:00 PM | 20% | 20% | Y | 20% | | | 20% |
| 11:00 PM | 10% | 10% | Y | 10% | | | 10% |
| *average % that leased lin is full* | | | | *34%* | | | *34%* |
| | | | | | | | |
| **T1 user profile** | | | | | | | |
| *# of T1 subs per Tier 2 POP* | | | | 1200 | | | 1200 |
| Number of leased lines / business | 1 | 1 | Y | 1 | | | 1.66 |
| % that leased line is full during given hour | | | | | | | |
| 12:00 AM | 5% | 0% | Y | 5% | | | 5% |
| 1:00 AM | 5% | 0% | Y | 5% | | | 5% |
| 2:00 AM | 5% | 0% | Y | 5% | | | 5% |
| 3:00 AM | 5% | 0% | Y | 5% | | | 5% |
| 4:00 AM | 5% | 0% | Y | 5% | | | 5% |
| 5:00 AM | 5% | 0% | Y | 5% | | | 5% |
| 6:00 AM | 5% | 0% | Y | 5% | | | 5% |
| 7:00 AM | 10% | 0% | Y | 10% | | | 10% |
| 8:00 AM | 30% | 0% | Y | 30% | | | 30% |
| 9:00 AM | 50% | 0% | Y | 50% | | | 50% |
| 10:00 AM | 70% | 0% | Y | 70% | | | 70% |
| 11:00 AM | 70% | 0% | Y | 70% | | | 70% |
| 12:00 PM | 70% | 100% | Y | 70% | | | 70% |
| 1:00 PM | 70% | 0% | Y | 70% | | | 70% |
| 2:00 PM | 70% | 0% | Y | 70% | | | 70% |
| 3:00 PM | 60% | 0% | Y | 60% | | | 60% |
| 4:00 PM | 60% | 0% | Y | 60% | | | 60% |
| 5:00 PM | 50% | 0% | Y | 50% | | | 50% |
| 6:00 PM | 50% | 0% | Y | 50% | | | 50% |
| 7:00 PM | 40% | 0% | Y | 40% | | | 40% |
| 8:00 PM | 30% | 0% | Y | 30% | | | 30% |
| 9:00 PM | 30% | 0% | Y | 30% | | | 30% |
| 10:00 PM | 20% | 0% | Y | 20% | | | 20% |
| 11:00 PM | 10% | 0% | Y | 10% | | | 10% |
| *average % that leased lin is full* | | | | *34%* | | | *34%* |

| | | | | | |
|---|---|---|---|---|---|
| **Basic Web Hosting** | | | | | |
| *# of basicWeb hosting subs per Tier 2 POP* | 0 | 0 | Y | 0 | 0 |
| # of basic subscribers per server | 0 | 0 | Y | 0 | 0 |
| **Enhanced Web Hosting** | | | | | |
| *# of enhanced Web hosting subs per Tier 2 POP* | 0 | 0 | Y | 0 | 0 |
| # of enhanced subscribers per server | 0 | 0 | Y | 0 | 0 |

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