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Prospects for Internet Telephony: Toy for Multimedia Hobbyists or Next-Generation Technology?

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MSc Dissertation

Prospects for Internet Telephony: Toy for Multimedia Hobbyists or Next-Generation Technology?

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SUMMARY

The sustained rate of technological change in the telecommunications industry has opened up significant windows of opportunities for telecommunications networks operators to develop value-added services and multimedia applications. The growth of the Internet raises the issue of a possible migration from traditional circuit-switched networks designed for basic voice communication towards shared packet transport handling a mix of applications. In this context, telephony over the Internet Protocol (IP) network - the transmission of voice over the public Internet or over a private Intranet - has attracted considerable attention as an appealing alternative to traditional telephony. However, instead of being a tariff arbitrage mechanism for telephony, Internet telephony is likely to develop as a component within an integrated system of video, data and voice applications. The potential offered by IP networks for computer-telephony integration and the continuing technological development in this area suggest that this will not be a transient phenomenon. However, most uncertainties reside on the demand side and the diffusion of Internet telephony is still at an early stage.

This paper analyses the current demand and market potential for Internet telephony. It examines users' attitudes and behaviour towards this service, and develops possible market scenarios for the future. The study investigates technical, economic and social factors supporting and hindering the adoption of Internet telephony. The results of the analysis show that a high penetration of voice services over the IP still has to be reached and that potential users have very heterogeneous perceptions towards new communication applications.

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INTRODUCTION

The sustained rate of technological change in the telecommunications industry has opened up significant windows of opportunities for telecommunications networks operators to develop value-added services and multimedia applications. The growth of the Internet raises the issue of a possible migration from traditional circuit-switched networks designed for basic voice communication towards shared packet transport handling a mix of applications. In this context, telephony over the Internet Protocol (IP) network - the transmission of voice over the public Internet or over a private Intranet - has attracted considerable attention as an appealing alternative to traditional telephony. Although the quality of the service is very variable and cost efficiency still remains to be proved, this technology and its applications have captured the attention of several operators who are evaluating technological and economic opportunities for all-service provision.

The potential offered by IP networks for computer-telephony integration and the continuing technological developments in this area suggest that this will not be a transient phenomenon. However, most uncertainties reside on the demand side and the diffusion of Internet telephony is still at an early stage. Consumers and businesses can benefit from this service because it offers cost savings on international calls and enhanced applications facilitating network management and on-line transactions. However, technical shortcomings and established habits and practices at present inhibit the adoption of Internet telephony, especially among residential users.

Most of the existing literature on Internet telephony has examined the economic and technical efficiency of this service almost exclusively from a supply perspective. Furthermore, it has only partially considered that, instead of being a tariff arbitrage mechanism for telephony, Internet telephony is likely to develop as a component within an integrated system of video, data and voice applications. The Internet can certainly provide an alternative telephone network, but it can serve many other purposes as well.

This paper analyses the current demand and market potential for Internet telephony. It examines users' attitudes and behaviour towards this service, and develops possible market scenarios for the future.

For this purpose, the following research questions are addressed:

- What is the current demand for Internet telephony?
- What technical, economic and social factors are supporting or hindering its adoption?
- What is the potential for Internet telephony and what are the market scenarios in which this potential may develop?

Four sections constitute the core of this paper. A brief concluding section is appended along with appendices defining the acronyms used and documenting the survey of Internet telephony companies that provides the basis for chapter 4.

- *Chapter 1* examines Internet telephony technology and its potential applications.
- *Chapter 2* analyses the existing barriers and opportunities for different providers for the supply of this service.
- *Chapter 3* provides a theoretical framework for the demand for Internet telephony. It explores the process of adoption of innovations from both an economic and a sociological perspective.
- *Chapter 4* investigates the current demand and market potential for Internet telephony in the light of the theoretical framework, drawing upon the results of an empirical survey.

CHAPTER 1 - Technical overview of Internet telephony

1.1 Internet telephony technology

Internet telephony is the transmission of voice and fax over the IP data network. Originating and terminating devices may be traditional telephones and fax machines, multimedia PCs, or a new class of "Internet aware" fax machines and telephones.

It is important to distinguish between Internet telephony and voice over IP (VoIP), since these two services, although overlapping, are not synonymous[1]. Internet telephony is the use of the public Internet for voice applications: in this case, the users usually connect via a dial up connection, even within an Internet session. VoIP may be implemented over any form of the IP network, including local area networks (LANs) and corporate Intranets[2]. Internet telephony converts the voice from analogue signals to a series of digits, bundles the data into packets and transmits these packets over the network. Early Internet phones evolved either as by-products from the videoconference industry or from companies like VocalTec, the first company to use VoIP in a computer application in 1995. This service was initially available only to users with a computer connected to the Internet. However, following the continuous technological evolution, the cost saving benefits of Internet telephony have become available to any user with a telephone connected to the public switched telephone network (PSTN) (Babbage et al., 1997; Ono and Aoki, 1998)[3].

1.1.1 Internet telephony applications

Currently, there are three classes of Internet telephony: PC-to-PC; phone-to-PC (or PC-to-phone); phone-to-phone (Clark, 1997). In the PC-to-PC configuration, both computers are linked directly to the Internet and voice packets travel entirely over a packet-switched network. The phone-to-PC and PC-to-phone models of Internet telephony require the

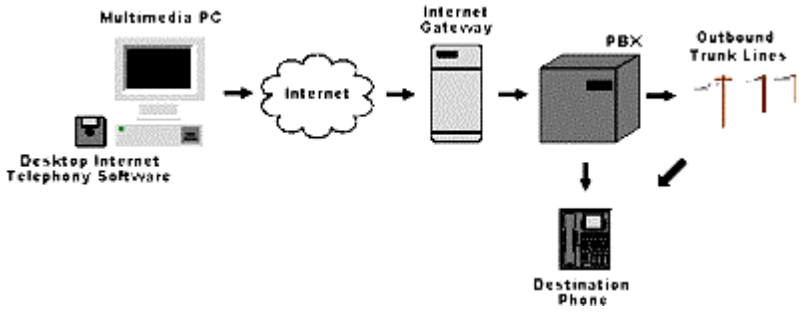
[1] Throughout the paper however, these two terms are used indistinctly.

[2] Although the IP network is the most common means of transmitting packetised voice, this technology has also been implemented on other packet-switched networks (e.g. frame relay or asynchronous transfer method - ATM).

[3] In 1996, IDT announced the introduction of an Internet telephony service (Net2Phone) which allowed calls on normal telephones (OECD, 1998).

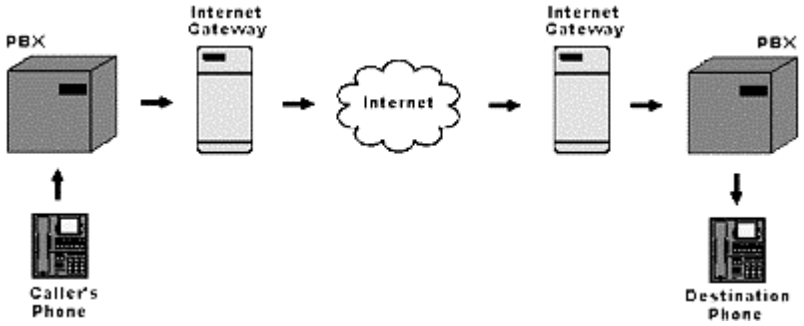
installation of a gateway which links the Internet to the PSTN and sets up a connection with a remote gateway at the other end of the call, in order to ensure compatibility between the two networks (Figure 1.1). The term gateway refers to devices that provide a connectivity function, while servers perform some value-added applications in addition to providing connectivity. The gateway or the server links traditional phone devices to IP networks.

Figure 1.1 PC-to-phone Internet telephony



Outgoing calls from a PC to a phone are simpler than calls travelling in the opposite direction, since it is relatively easy for an Internet phone application to find a phone number and the IP address of the gateway, while it is impractical to require the PSTN users to dial first the telephone number of a gateway and then the numeric IP address of the called party (Babbage et al., 1997; Krupinski, 1997). Phone-to-PC users receive regular phone calls during an Internet session. A window notifies an on-line user of an incoming call and they take the call over the PC while remaining connected to the Internet (VocalTec, 1998; Adelson, 1998). Demand for additional bandwidth from residential users to support Internet sessions is growing and is stimulating the growth of broadband access technologies and IP traffic. The third configuration of Internet telephony is phone-to-phone (Figure 1.2).

Figure 1.2 Phone-to-phone Internet telephony



In this type of model, the caller's phone is connected to a gateway which transforms voice into IP packets and sends them over the Internet to another gateway. This gateway converts the digital signals into analogue signals and routes the call through the local PSTN, which in turn transmits the call to the telephone of the called party.

IP telephony gateways and servers perform the functions of voice/fax compression and packetisation, formatting the compressed data into IP packets which contain routing and sequence information. They also perform higher level functions including call routing (identifying the remote gateway or server that is closest to the destination phone/fax number), quality management (through buffering, interleaving and bandwidth reservation), and applications interface management (allowing the server to support value-added applications, such as Web-accessed call centres).

1.2 Evaluating opportunities for IP telephony implementation

A number of products and services are now offered under the heading of IP telephony. The different solutions may be characterised in terms of:

- The intrinsic value of the solution, going from simple dial-tone to value-added applications
- The implementor of the solution (telecommunications carrier vs. enterprise)

These characteristics allow a classification of the value that different solutions have for the final users and of the technological requirements of the system that is deployed, as depicted in Table 1.1.

Generally, systems for value-added solutions may operate (economically) at a smaller scale than systems for dial-tone solutions, since just a subset of subscribers use the value-added functions at any given time. However, these solutions need to be very flexible to support rapid developments and modifications and must incorporate billing and accounting functions that direct the appropriate service usage data into the carrier's billing systems.

Table 1.1 IP Telephony solutions by implementor and status

Status/Implementor	**Carrier**	**Enterprise**
Applications (value-added service)	*Internet Call-Waiting* *Messaging*	*Voice-enabled Web Pages* *Teleconferencing*
Dial-Tone (commodity service)	*Real-time Fax* *Alternative Long-Distance*	*Toll Bypass*

Source: Adelson (1998)

Carrier-Based Dial-Tone Solutions - consumer dialling plans and calling cards - are similar to existing PSTN voice and fax services and use the network for transport. They may also be offered to enterprises on VoIP backbones, similar to circuit-switched virtual private networks (VPNs). From a user perspective, carrier-based dial-tone IP solutions have to be virtually indistinguishable from the PSTN services in terms of voice quality. Consumers may be willing to tolerate a lower quality of service if they receive significant price reductions, while business users will expect a transparent application.

These applications can also enrich existing telephony services by making complex call-handling features more readily accessible. These features include more reliable identification of the incoming caller than is possible using the standard calling line identifier within the PSTN, which can identify callers only if they are using their regular phone and if the system can associate the number with the name. With VoIP, providers may offer caller identification, transmitting the name of the caller in the form of IP packets, so that it can be displayed on a PC screen. Directories can be used to map the phone numbers of a particular person into technological devices, so that they can be reached through different equipment - standard/mobile telephone and IP address.

Enterprise Dial-Tone Solutions aim at saving toll charges by transmitting long-distance calls over dedicated lines between different company offices. Even external calls may be routed over the company's VPN to the network location nearest the call-destination. These systems must support existing functions, such as call-forwarding and conference-calling. In terms of quality and user experience, the requirements of these solutions are similar to those of carrier-based dial-tone solutions.

Carrier-Based Value-Added Solutions identify applications offered by service providers in which the main benefit is not the connectivity per se, but some value-added functions. Internet call-waiting, for example, allows residential users to receive incoming calls while surfing the Web, without the need for second lines. In this case, a window appears on the screen, announcing the incoming call and offering different options to deal with it.

Enterprise Value-Added Solutions are value-added applications implemented within the enterprise, or between an enterprise and its customers. Call-enabled web pages are currently being developed by some of the major Internet telephony service providers (ITSPs) such as Nortel, eFusion and VocalTec. These applications allow users who visit a company's Web site to click on a button and automatically establish a call into a corporate location.

Call centre applications have a great potential as services facilitating electronic commerce. According to a recent survey two-thirds of all on-line shopping calls are abandoned because potential customers can not obtain answers to their questions on-line (Internet Magazine, 1999). Value-added services can enhance customer satisfaction. For example, when shopping on-line for a mortgage, rather than going to their local bank, consumers can use an on-line service to find the best option available from different institutions across the country and speak to someone there about their detailed situation, even if they had not previously known that mortgage provider existed.

1.3 Internet telephony and the international telephony system

Although value-added applications of Internet telephony are constantly upgraded, the possibility of making cheap international calls remains an important attraction especially for residential users. Accordingly, the strategy of major service and network providers has been to promote VoIP among residential users as an alternative way to make phone calls, while emphasising the more enhanced functions of the service among business users.

Internet telephony is a potential competitor for traditional telephony because it is cheap. First, Internet service providers (ISPs) avoid regulatory charges which are imposed on the telecommunications operators (TOs); second, Internet telephony is characterised by a subscription-based, distance-independent tariff structure, which makes the service effectively free at the margin for users with direct links, and limited to local service charges for dial-up users; third, the technology employed by the Internet allows significant reductions in transmission costs (Clark, 1995; European Commission, 1998; OECD, 1998). The greatest advantage of Internet telephony is that it bypasses the existing international accounting rate system, since ISPs are not liable to pay a settlement charge to TOs in the foreign country.

1.3.1 The international telephony system

In the international telephony system, an agreement between two TOs (A and B) in different countries specifies that A pays B an amount [$\alpha_b x$] per minute of traffic for calls originating in country A and terminating in country B. For calls in the reverse direction, B pays A [$\alpha_a x$] per minute of traffic – where x is the *accounting rate* and $\alpha_a+\alpha_b = 1$. For an international call, the originating operator receives a collection charge – the *tariff* – and pays the terminating operator a fraction of the total accounting rate - the *settlement rate*. The accounting rate between TOs is determined through bilateral negotiations and rarely reflects the actual cost of the call termination. Payments are made between countries only if there is an imbalance in traffic flows and usually significant imbalances combined with high accounting rates lead to large settlement payments being made by a single country. Therefore countries have little or no incentives to lower tariffs, because this would increase the traffic imbalance (assuming that users are price-sensitive). Finally it is important to notice that the accounting rate system applies only to telecommunications services delivered over international networks operated by TOs. If the international traffic travels over leased lines, no accounting rate applies (Mason, 1998).

The international accounting rate system has been recently put under pressure by three main forces: regulators concerned with the high price of international calls for end users, TOs facing large traffic imbalance (especially in the US and in the UK), and new technologies which bypass the traditional system of payments. Beyond Internet telephony, users can avoid high international tariffs using resale and call-back services[4]. In the US resellers and call-back operators accounted respectively for 34% and 1% of international traffic minutes in 1996 (Young and Narendran, 1998).

1.3.2 Price and cost of Internet telephony

The cost of using the Internet is structured in a different way from the cost of making ordinary voice calls and the only cost occurring to the originator is for accessing the Internet – typically the cost of a local call. The current flat-rate pricing structure of Internet telephony is such that users face a marginal usage cost of zero. Peering agreements between backbone and service providers support this model. Generally users of PC-to-PC Internet telephony do not incur any additional charges beyond the price of the local call to the ITSP, while other Internet telephony configurations are more expensive because of the gateway provider.

Is the price going to remain at this level in the future? Several studies have recently shown that the price for Internet telephony does not reflect its cost (Babbage et al., 1997; McKnight and Leida, 1998; Ono and Aoki, 1998). It is worth noticing that the actual cost of carrying an international call over the Internet differs very little from the cost of carrying an international distance-dependent call, if a similar bandwidth is used (Babbage et al., 1997). The real difference in the tariff structure lies precisely in the lack of complex billing and support systems and in the lack of any international settlement agreement.

The interesting issue is whether the difference in prices and costs will remain stable over time, considering the pressure on international telephony tariffs and the fact that the price of Internet telephony does not really reflect its cost. Many recognise that the initial advantage of Internet telephony for users lies in its low price, but low quality due to network congestion requires investments in capacity and service management, which eventually will cause an increase in costs and prices (Clark, 1996; McKnight and Leida, 1998). It is likely that quality and costs will go up in the

[4]A call-back operator provides discounted international telephony, by making low priced international calls available to customers in all countries. Resale operators purchase a telecommunications product or service with the aim of selling it to other entities (Young and Narendran, 1998).

future and that different systems for international telephony will compete on a similar base. In this context, Internet telephony will compete more on its enhanced service features - efficient network management and integrated applications - than on price.

The technical issues of this chapter provide the basis for an economic analysis of Internet telephony, which constitutes the subject of the next chapter.

CHAPTER 2 - Barriers and incentives for the supply of Internet telephony

Even though different providers are already investing in Internet telephony, some technical and economic factors may hinder its development. In particular, the problem of congestion and the uncertainties surrounding the emerging network architecture have significant economic implications for the competition between different network and service providers.

2.1 Technical shortcomings and the problem of congestion

Although the technology has been constantly improved, some technical problems still remain for the provision of VoIP. Packet-switched networks do not dedicate a path between sender and receiver and therefore cannot guarantee quality of service. During silences in an IP voice conversation no packets are sent and the available bandwidth is used by other IP applications. This means that each packet of information shares the available bandwidth with other packets. The packets sent through the Internet may arrive at destination by a variety of sources and in any chronological order: they are accepted on a best-effort basis and can be delayed or lost. The computer at the receiving end of the call processes the information according to the particular application for which the packets are required. Internet telephony software interpolates on the basis of the surrounding packets in order to "guess" the content of the lost ones. The more packets are lost, the more interpolation is needed and the more likely that the receiver of the call will hear distortion. Latency - the delay between when one party speaks and the other hears the voice – also represents an important technical shortcoming (Howard et al., 1998)[5].

Congestion is a major problem with the use of the IP network: delay and latency are both increased by congestion and congestion increases as more and more users are connected to the network. Users of any common and freely accessible good service use it until the private marginal cost equals the private marginal benefit. They do not consider the social marginal cost, which is higher than the private marginal cost. This behaviour results in an excessive use of the good/service, which is not Pareto-efficient from a social perspective. This problem is known as "the tragedy of the commons":

[5] Other factors such as the network's ability to recover the original signals, quality of computing resource, voice processor and output transducer, technical methods to establish connection between users are likely to affect the performance of Internet telephony (Foo and Hui, 1998).

> "*Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. ...The commons, if justifiable at all, is justifiable only under conditions of low-population density.*" (Hardin, 1968, p. 20 and p. 28)

The Internet "population density" is increasing more rapidly than the "commons" can be extended. The result is congestion. An important dimension, particularly relevant for real-time applications such as Internet telephony, is the extent to which the user is dissatisfied if the demand for a certain quality of service is not met. In the case of voice applications, the utility of the data drops sharply and is basically useless if the delivery target is missed.

2.1.1 Technical and pricing solutions to congestion

How can the threat of low quality of service be solved? What are the mechanisms available? The risk of congestion calls for a combination of engineering and pricing solutions, which control the allocation of bandwidth and regulate the use of this allocation (Clark, 1995 and 1996; Mason, 1998). It is important to upgrade the technology before taking any decision on prices, since investments in technical mechanisms are irreversible, while pricing schemes can be changed more easily.

So far the Internet has mostly used technical mechanisms aimed at increasing bandwidth availability and at controlling usage and allocation of resources in time of overload. The guaranteed minimum capacity service offers an assured worst case rate along any path from source to destination. Although quite appealing, this mechanism is not very effective, since it assumes a constant traffic per user, whereas usually this is extremely variable (Clark, 1996). An alternative solution is to provide a fair allocation service, which ensures the same treatment to users offering equal load. However, it is quite difficult to define the concept of fairness in order to meet users' requirements. In the case of many users with similar characteristics, fairness at the packet level - sending one packet of each user in turn - may not lead to the best service in terms of total elapsed data transfer time. When different users transfer files of different sizes, a more basic question is whether giving equal access to bandwidth is the fairest solution[6]. A third possible scheme is priority scheduling, which creates service classes of different priority to serve users with different needs. The problem is that there is no way to balance the demand of different classes since the highest priority can, in the worst case, drive all lower

[6] Fairness could be better defined as each user being allowed to send a large file as needed rather than each user being given a simultaneous equal share.

priorities to no usage, and users cannot express directly a desired network behaviour (Clark, 1996; Cawley, 1997).

In order to reduce congestion, pricing schemes are needed together with technical mechanisms. Users are likely to have different expectations on the quality of service and be willing to pay differential rates for different services. The flat-rate pricing structure of the Internet has already been challenged by more sophisticated pricing schemes which rationalise the utilisation of network resources: usage-based/dynamic pricing, pricing related to expected capacity requirements and pricing linked to particular bandwidth reservations (Clark, 1996; McKnight and Leida, 1998). From a supplier perspective, the costs of dynamic pricing in terms of tracking, allocating and billing exceed the revenues. However, there may be effective ways to differentiate prices in the Internet environment, such as small pre-payments, as with the postal service, or contractual arrangements, as with electricity networks (Cawley, 1997). Usage-based pricing schemes drive away large users, who can build VPNs out of fixed price lines, leaving only small users, who will be willing to pay only reduced fees. Furthermore, these mechanisms impose costs on the users whether the network is congested or not, and this charging constitutes a distortion.

Pricing the expected capacity utilisation of users probably provides the most satisfactory mechanism to solve congestion problems. It defines the behaviour of a particular user when the system is congested, but does not give them any restriction when the net is underloaded. Expected capacity is a measure not of actual use, but of users' expectations of potential usage: the related pricing scheme is the result of a negotiation between the user and the provider (Clark, 1995 and 1996). Providers need to ascertain the expected capacity utilisation of a particular user, so that WWW-only users do not have to pay for capacity needed to serve the average, which includes Internet telephony and video phone users[7]. Although users with different capacity profiles will see different costs, the costs do not vary with actual usage, and thus meet the needs for fixed or predictable charges (Clark, 1995). From a user perspective, the resulting prices are like access subscription prices, which relate to a complex expected usage profile monitored by the provider.

[7] Technical mechanisms are currently being developed that monitor the actual use of individual users.

2.2 The economic implications of Internet telephony

The technical characteristics of Internet telephony have important economic implications. In particular, the specific architectural features of the Internet and of the PSTN translate into different market structures. In this context, the outcome of competition between different networks for the provision of voice service depends not only upon the specifications of Internet telephony itself, but also upon future developments in network management. In order to outline the economic consequences of Internet telephony technology, competition is examined at two different levels: at the network level, evaluating the costs and benefits of economies of scale vs. decentralisation for the provision of voice service; at the market level, analysing the interplay between different network and service providers.

2.2.1 Economies of scale vs. decentralisation in the communications industry

Voice telephony used to be defined as a service provided over telecommunications carriers' dedicated networks. The most relevant feature of Internet telephony is that it is developed over a distributed, non-dedicated packet-switched network. In general, one can say that the distributed configuration, modularised components, inter-operability, dependence on software and general purpose functionality of the Internet generate a market with high flexibility, rapid innovation, low barriers to entry/exit, distributed costs and high level of competition. Conversely, the features of the PSTN lead to a market with significant degrees of vertical integration, high barriers to entry and low competition. However, recent technological developments in transmission techniques and investments in ATM technology for the PSTN have raised interesting questions with respect to the integrated configuration of the network as being the best available alternative (Mansell, 1993). It is worth noticing that the advantages of a vertical integrated network stem not only from cost efficiency, but also from the avoidance of possible inefficiencies due to local access duplication (Sears, 1996; Cawley, 1997). The development of incentive structures with respect to technology, investments and prices can solve the access bottleneck, allowing at the same time more competition.

Technological and market factors have affected the network architecture of the telecommunications industry. At present there exist both centrifugal forces, leading to a geodesic, decentralised network configuration such as the IP, and centripetal forces enforcing a hierarchical, centralised model, similar to the traditional PSTN (Noam, 1987 and 1994; Davies, 1996). With cheap switching and expensive

transmission technologies, the most efficient architecture is a geodesic one. The intelligence of the system is located in computer terminals and private branch exchanges dispersed within the network, which communicate directly with the nodes of the architecture, so that transmission is kept to a minimum (see Figure 2.1).

Figure 2.1 Different network configurations

Geodesic architecture *Centralised architecture*

Source: Davies (1996)

However technological developments, and in particular the introduction of new transmission technologies – fibre optics and cellular radio – have reduced transmission costs even more than switching costs. Consequently, a new centralised architecture may emerge, with fewer high-capacity exchange nodes and more transmission paths. On the other hand, advanced packet-switching technologies (IP, ATM and frame relay) are becoming more and more efficient. They enforce a decentralised, multilayered structure, where the traditional monopolistic system is superseded by interconnecting subsystems.

According to Noam (1994), a combination of centrifugal forces (technological and institutional) has been shifting the network configuration to a more competitive, open and loosely connected network of networks, each controlled by several companies. System integrators have emerged, that connect various parts of local and long-distance networks to provide users with a single access to a variety of services. However, it is unlikely that each company is able to offer the whole range of services - from transmission to multimedia applications - to all customers. The next step in the telecommunications could be a system of systems configuration of the network, in which system integrators link with each other (Noam, 1994; Davies, 1996).

The outcome of the evolution of network architecture is linked to the evolution of service provision. Different operators benefit from different outcomes of the competition between network architecture.

TOs have started upgrading the PSTN investing in packet-switching technologies, such as ATM. They will try to capture returns on their investments by exploiting their infrastructure and by offering as many services as possible on that platform. ISPs and other operators are building IP-based networks which bypass the PSTN as much as possible - so that they will not be dependent on TOs. In doing so, they pose a serious challenge on the incumbents, but, at the same time, engage in a fierce competition with them.

The interplay between incumbents and new entrants is likely to affect the result of the competition between different network configurations as much as technical developments and regulations. The amount of resources that operators are willing to commit to different network technologies and the market potential for new value-added applications such as Internet telephony will determine the emergence of either a decentralised or a centralised network configuration. The next section will examine the different strategic options for service providers with respect to VoIP in order to provide insights on the prospects for enhanced services over the IP network.

2.2.2 Business strategy of different operators

Internet telephony was initiated by small companies in the computer industry such as VocalTec, IDT, Netscape and Microsoft, who were new entrants in the telecommunications services sector, but has increasingly stimulated the interest of large operators. Many of the major international TOs - AT&T, MCI-WorldCom, Deutsche Telekom - are experimenting with Internet telephony technology. They usually offer the service but occasionally develop their own software or, as a more common strategy, acquire a software company, which produces innovative multimedia applications[8]. The market however is still dominated by calling card companies and other resellers, which have seen their margin squeezed as PSTN prices continue to fall. Some of the biggest operators are Delta Three, IDT, and USA Global Link. Internet telephony offers these companies the opportunity to cut costs and improve margins and provides a fast route into the market for new entrants such as Bertelsmann, Qwest, OzEmail and Level3. For new operators such as these, that are deploying high-capacity Internet applications, Internet telephony is an additional service they can offer to their corporate customers and to the residential and small office - home office (SOHO) markets. ISPs are finding that

[8] For example, Nokia, a top supplier of mobile and fixed telecom networks and services has recently acquired Vienna Systems, a leader in the global IP telephony market, which designs and manufactures hardware and software products for the distribution of voice, fax and video communication over IP networks.

Internet access provision is less profitable that they had hoped, because of the decrease of Internet access rates and the rise of TOs charges as percentage of the total basket (see Table 2.1). Internet telephony gives them the opportunity to offer value-added applications, differentiate their supply and generate new revenues. Beyond ISPs, Internet equipment manufacturers and software developers for World Wide Web applications are becoming interested in the provision of this service. In this group, Nortel, Lucent, Cisco and Ericsson are exploring and developing innovative applications (Howard et al., 1998; OECD, 1998).

Table 2.1 Peak and off-peak rate Internet access basket, 1995 and 1998 – OECD average *(in US$ PPP)*

	Peak rate		***Off-peak rate***	
	1995	***1998***	***1995***	***1998***
ISP charge	65.55	20.26	61.97	20.26
PSTN charge	41.98	37.87	28.93	26.36
Total basket	107.53	58.13	90.90	46.62
PSTN charge as % of total basket	39.04	65.14	31.82	56.50

Source: Author's elaboration on data from OECD (1999).

Currently, the most intensive activity among incumbent operators is in Europe and in the US. Scandinavian companies are particularly well positioned, due to the high competition and the widespread diffusion of the Internet in those countries. Finland is the OECD country with the highest number of Internet hosts per 1000 inhabitants – 99.9 – compared to European average of 32.5 (OECD, 1999). Sonera was the first European incumbent to implement IP telephony solutions, integrating them with its multimedia Internet service for customers. Deutsche Telekom is also quite innovative: in late 1997, the company purchased a stake in VocalTec and started offering Internet telephony with the launch of a pilot project called T-NetCall. Recently, British Telecom and France Telecom have also engaged in trials of VoIP services (Lakelin, 1999; Young and Narendran, 1998).

TOs have different strategic options in response to IP telephony. First, they can avoid investing in Internet telephony, hoping that the price differential will gradually shrink and the problems of quality of service will prove too difficult to solve. They may rely upon technical advancements in the traditional circuit-switched network – such as the development of intelligent network services – and upon the ubiquity of the PSTN. However this is a dangerous strategy, since the revenues from

traditional voice services are already being forced down by competition from other services such as call-back and resale. If TOs realise too late the usefulness of the IP platform, they could find themselves struggling in a market where new entrants have already gained a significant customer base and are competing on lower costs.

A second strategy for TOs is to promote Internet telephony to on-line PC users but not to the general users of the telephone. This preserves the quality of the phone service and allows the phone companies to compete directly with other ISPs or at least to prevent some of the revenue loss. It is important to stress that even if this strategy is quite appealing, it implies that part of the voice traffic will migrate away from the PSTN. TOs must strengthen their ability to provide bandwidth more cheaply than their competitors as well as switch to IP-based networks in the long-term.

A third option for TOs is to explore the value-added aspects of IP telephony by offering it to their corporate customers. This could be coupled with the development of systems integration and content provision. However, Internet telephony applications are very different from the core business of TOs and it is still not clear how they can combine their expertise in network management with the ability to address each client's individual needs. As the packet-switched Internet service is using the circuit-switched not very efficiently, a possible strategy for TOs would be to separate packet data from connection-oriented data before the local switch. This would allow them to keep the appropriate quality of service for the circuit-switched network and to manage the extra traffic from Internet as efficiently as possible (Sears, 1996).

A specific value chain is emerging in the Internet telephony market: global network operators and settlement brokers provide interconnection agreements, billing information and network management for ITSPs, which may or may not own the networks over which the services are offered. The majority of ITSPs buy Internet telephony solutions from software providers, although some companies develop applications in-house and offer them directly to the end users. The structure of the market allows a relatively easy entry even for inexperienced service providers. For players that already have access capacity or an existing customer base, Internet telephony services provision can be set up in a very short time, with minimal investments.

The extent to which the distributed network is likely to prevail over the integrated one will also affect the role of ISPs. With respect to Internet telephony, they are in the position of access providers and are also carrying most of the traffic. The demand for better quality of service is likely to create a real business opportunity for ISPs who are able to provide it, for example, by offering end-to-end service.

This will probably drive a consolidation of ISPs, since they need to deal with guaranteed transferability of traffic and quality of service and the accounting arrangements that these imply. A few ISPs are likely to survive at the top of the hierarchy: continuous demand for specialised service and network maintenance requirements will provide good business opportunities for niche and localised ISPs (Krupinski, 1997, Howard et al., 1998).

It is important to stress the fact that still a large portion of the Internet exists on the PSTN owned by long-distance carriers of this network. This is a key factor because the basic costs for Internet transmission include the costs of leasing these lines and the equipment costs for routers and network equipment (McKnight and Leida, 1998). Although the existence of a stable oligopoly has for several years prevented prices of leased lines from being close to costs, some reductions in the level of prices have recently occurred and this has had a great impact on the diffusion of the Internet (OECD, 1999). With a distributed network, there is a problem of balance between access charges to ISPs and compensation for investments of TOs aimed at increasing the capacity of the existing network. TOs bear costs in connecting ISPs to their networks and in handling larger traffic flows. They need to be compensated through interconnection fees but these fees should not be so high as to represent a barrier to entry in the market for the provision of voice service.

2.2.3 Service paths for the supply of VoIP

The transition from circuit to packet-switched networks is a relevant factor for the future of real-time applications. Conventional perception on convergence considers cost savings in toll charges as the most compelling initial benefit of VoIP. However, this is a problematic hurdle for the industry. A more progressive revenue path can be determined if companies start thinking about Internet telephony according to the following variables:

- Mission critical - How important and profitable is the service today?
- New value to the user - What increase in efficiency or capability does the new service introduce?
- Maturity of the technology - How mature is the technology on which the new service is based?

A common strategy based upon an infrastructure viewpoint is to implement first phone-to-phone services, then some form of conferencing and value-added services. The resulting path starts from the development of mission critical services that add no new value for the user and are based upon immature or developing platforms (Figure 2.2). A more suitable strategy would be to provide first a service that has value-added for the user, is not yet mission critical and is based on an emerging platform. As the technology matures, providers increasingly run existing services on the new platform (Figure 2.3).

Figure 2.2 Traditional service path for VoIP

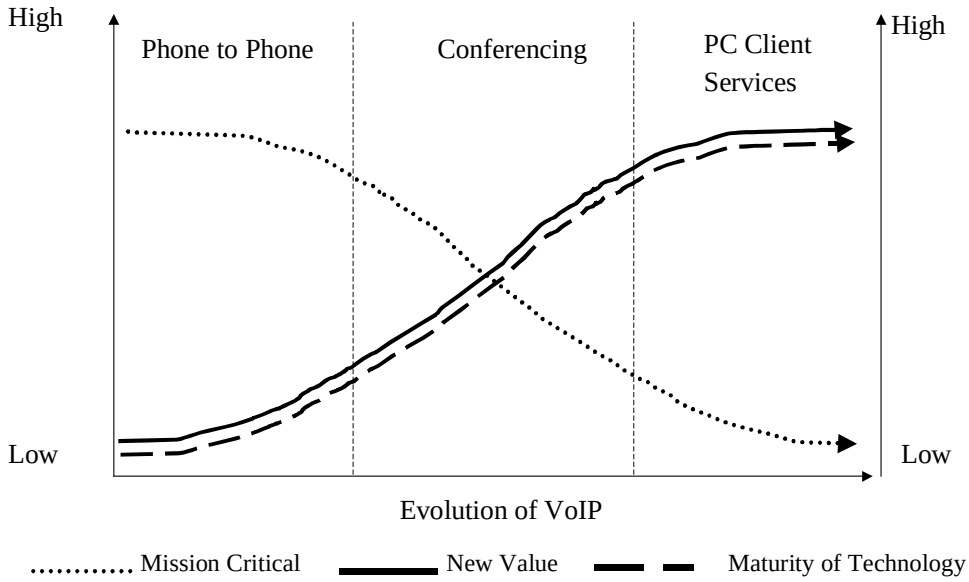
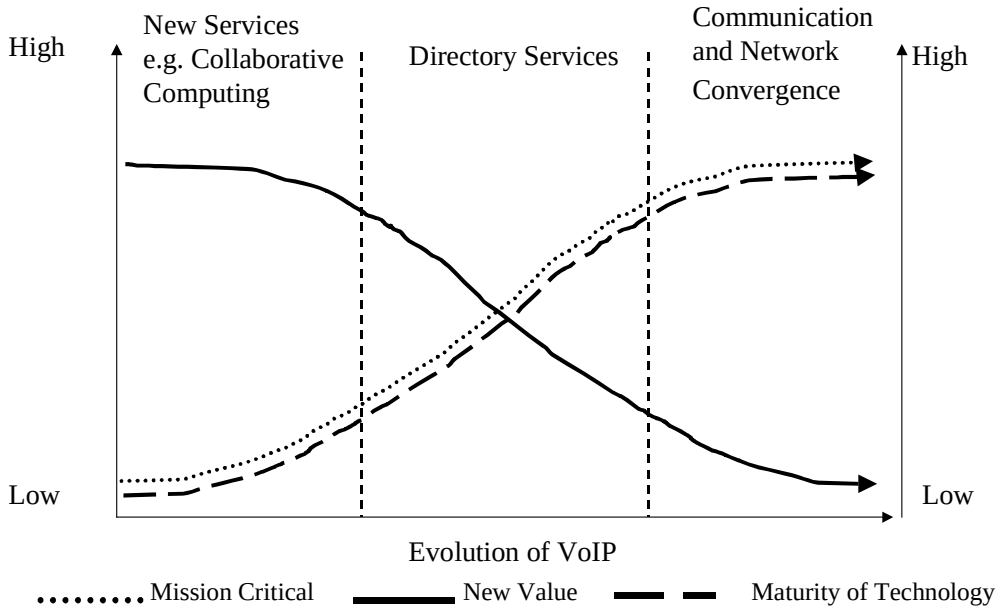


Figure 2.3 Alternative service path for VoIP



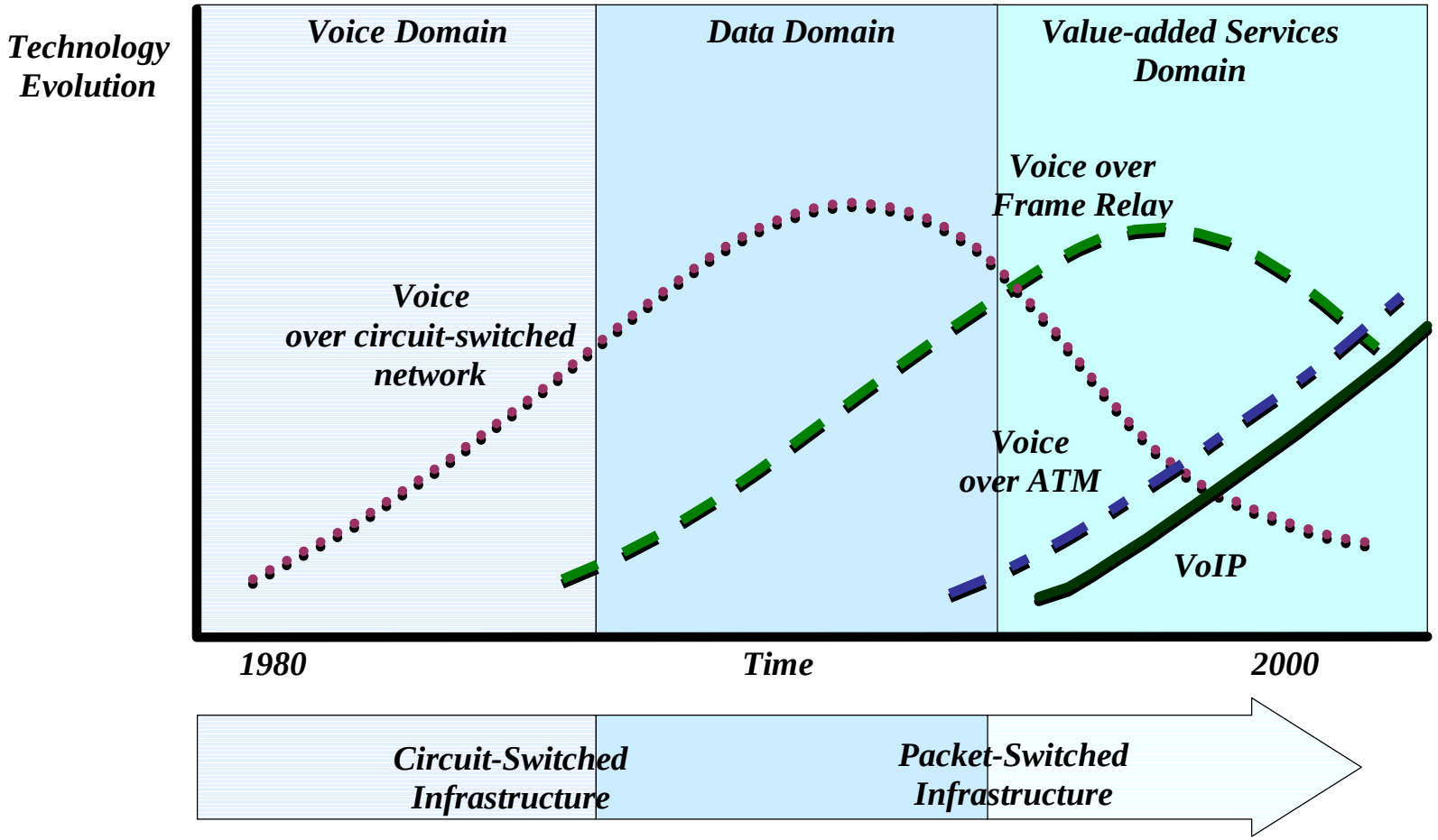
As already underlined, technological and institutional changes have had a significant impact on the telecommunications industry. Service providers are exploiting growing technological opportunities by examining IP as a platform for new applications among which telephony is the first to be introduced, and have begun to deploy commercial services using IP infrastructure.

Two opposite forces are affecting the market structure. On the one hand, there is a vertical division of labour between settlement brokers/global network operators, software providers and ITSPs, where the latter act as intermediary agents and offer VoIP solutions to the end users. On the other hand, due to the complexity of the technology and to the lack of technical skills of users, system integrators are likely to emerge, that offer turn-key solutions (including technical support and maintenance, customer service and training).

IP is well suited to all traffic types and is independent of the underlying facilities. The ultimate objective is to leverage a single network infrastructure using a single networking platform. Circuit-switched networks have not been engineered to provide the required bandwidth or to manage the bursty nature of data traffic. Operators are transporting all the traffic to the data network and are investing to transfer all the capabilities inherent in today's circuit-switched network to a packet-switched one[9]. The current dynamics of technological evolution seems to suggest that voice over packet-switched infrastructures - IP and ATM in particular - are experiencing high growth (Figure 2.4). However, it is still uncertain which technology will prevail and how quality of service will be improved.

[9] This includes the transfer of call processing capabilities so that the users get the same level of expected performance and service for voice calls.

Figure 2.4 Technological evolution and the process of convergence



Source: Author's elaboration from material presented at the Spring 1999 VON (Voice on the Net) Conference

2.3 Conclusions

The expansion of IP telephony from ISPs and specialised ITSPs threatens to create an alternative infrastructure and to cut revenues of TOs. Incumbents can respond to this threat by becoming ISPs and continuing to reduce tariffs, undermining the competitive advantage of new entrants. If the infrastructure (especially the local loop) is upgraded, then it is a straight technical battle between existing and new infrastructure providers, whose outcome will be affected by the competition between the decentralised IP network and the centralised PSTN.

However this is not the only perspective that can be taken into consideration, and evaluating the relative efficiency of different network configurations and technologies goes beyond the scope of this analysis. The outcome of the battle between different operators hinges upon the development of the demand. In this context, demand is not just about the price level of two homogeneous/identical products - Internet telephony provided by the IP network vs. enchanced technologies for voice applications provided by the PSTN. Instead, these two services are quite different and are likely to remain so for a long time, at least long enough for PSTN providers to dramatically restructure their operations. Thus, the nature and the extent of competitive pressure that specialised ITSPs will place on TOs depends directly on the extent of current and future demand for different services. Economics states that substitutes compete in the market, but takes the marginal rate of substitution to be given by consumer preferences, which are pre-ordered. We therefore need a theory that tells us how these preferences work and this represents the subject of chapter 3.

CHAPTER 3 - The demand for Internet telephony: A theoretical framework

How does an innovation diffuse in and adapt to a certain environment? What are the factors affecting users' behaviour and attitudes towards new ideas? This chapter aims at addressing these issues, exploring how technical change and social life interrelate and how mutual shaping between users and artefacts occurs. In developing this analysis both economic and sociological perspectives are taken into account. The theoretical overview concentrates on Information and Communication Technologies (ICTs) as a particular case, in order to provide some useful insights for the empirical analysis of the demand for Internet telephony, which constitutes the final section of this paper.

3.1 The adoption of innovations

The adoption of innovations identifies the process through which new ideas diffuse in and adapt to a social system, an ensemble of interrelated units that share common norms, values and practices and are affiliated to each other by the need to accomplish a common goal (Karshenas and Stoneman, 1995; Rogers, 1995). It involves communication both between innovators and potential adopters, and among potential adopters themselves.

For our specific concern - the analysis of the demand for Internet telephony - two theoretical approaches are particularly useful: the innovation-decision process framework and the theory of mutual shaping of users and technology. The first one draws upon different economic, psychological and sociological traditions, which share the empirical generalisation of S-shaped adopter distribution curves (Griliches, 1967; Karshenas and Stoneman, 1995; Rogers, 1995).

These curves are constructed drawing upon the processes learning and diffusion and predict that the rate of adoption slows down after half of the individuals have adopted the innovation[10].

The second theory of mutual shaping of users and technology concerns the joint role of technological and social elements in explaining the emergence of technical artefacts (Bijker et al, 1987; Orlikowski, 1992; Bijker, 1995; Rip, 1995). It emphasises the way in which technology influences social interaction and shapes specific cultures, but it also explains how a new technology is constructed by a combination of enabling and constraining relationships among social groups.

These two perspectives can be applied to the case of ICTs and they will help us understand the development of the demand for Internet telephony.

3.2 Peculiarities of ICTs: design and domestication

The process of adoption of new products or technologies has peculiar connotations for the case of ICTs, because of their material and symbolic nature as objects and facilitators of consumption. Social studies of technology have investigated technology's status as a cultural form, but have not gone so far as to deal properly with its construction in consumption and a few of them have addressed this issue with regard to ICTs (Miles et al., 1994; Silverstone and Haddon, 1996; Boczkowski, 1999). Similarly, research on consumption patterns has barely begun to analyse the social and psychological dynamics of the appropriation and use of artefacts in general, and of ICTs in particular.

Eveland (1986) develops an interesting perspective on the concept of technology that is well suited for ICTs. A technology includes a hardware component, which constitutes the physical object embodying the technology, and a software component, which represents the information

[10]Learning implies decreasing average costs (dynamic economy of scale) which is a function of the cumulated output. Diffusion is a process which is usually thought to be driven by an "information effect" (probability of adoption increases as information about the value of adoption spreads) or by some change in what is being adopted (greater flexibility or lower costs). This last factor links back to learning curves, since cumulative production drives lower costs, which in turn drive accelerated adoption. This process generates S-Shaped adoption curves (Karshenas and Stoneman, 1995).

base and content for the material object. The social embedding of the software aspect is less physically visible than the social embedding of the hardware.

Often the physical artefact affects the adoption of a particular ICT, even if the software is not different from one object to another, since people need to feel comfortable with the tool they use. For example, Internet telephony started diffusing when phone-to-phone configurations were introduced, because consumers were familiar with that particular hardware. Technologies emerge in a specific social system, as the result of a multi-faceted, dynamic process that involves individual and collective choices within organisations and institutions. Their design and engineering incorporate the social, cultural and economic values embedded in the system that produces them.

ICTs are objects in the form of technologies enabling different functionalities and of products/solutions purchased for their aesthetics and applications. However, what characterises them is their status as media. They link individuals with each other through point-to-point, point-to-mass or networking forms of communication, and establish complex relationships between the private sphere and the public one (Silverstone and Hirsh, 1994; Silverstone and Haddon, 1996). As products, technologies and media, ICTs bridge the blurring boundaries between the public sphere where they are produced and distributed and the private sphere where they are appropriated and used. The adoption of ICTs does not end with the action of consumption, but requires a continuous redefinition of the innovation's characteristics with respect to users' requirements.

There is an important issue to emphasise with respect to Internet telephony. Users who are familiar with multimedia applications are likely to adopt these technological solutions more quickly than individuals who do not have any experience in this area. As we will show in chapter 4, most users are quite conservative, and, while incorporating new technologies into their domestic environment, they try to preserve its structure and the control over that structure.

ICTs enter individuals' everyday life through the process of domestication, which is anticipated by design and, at the same time, contributes to the design definition. This process involves not only physical artefacts, but also media content (the selection of TV programmes to watch, computer software to buy and telephone services to subscribe to). The need for domestication is particularly strong if users have experience with the existing technologies and applications,

because they can better define their requirements for customised solutions that upgrade the functionality of and that are compatible with the platform technology they use. The acceptance and mode of usage of a specific technology are affected both by the technical and aesthetic specifications of the design, and by the established practices of the domestic milieu. Through the mediation of the market, design and use confront each other and the resolution of this confrontation contributes to the definition of ICTs (Silverstone et al., 1994; Silverstone and Haddon, 1996).

In the process of accepting new ICTs, users can modify the pre-defined meanings of objects and contents which were representative of a pre-existing culture. Individuals define how objects and technologies are used, what functions they are expected to perform and how these functions change over time (Miles et al., 1994). The functionality of one technology depends upon its incorporation into the routines of daily life and it is more valuable, the more it fits into the user's habits and experience. For example, Internet telephony is no longer just a substitute for traditional telephony, but has become a platform for enhanced communication services that meet the users' requirements.

The initial focus on the impact of technology upon usage modes has been recently challenged by approaches that concentrate on the role of users in transforming the artefacts (Silverstone and Hirsh, 1994; Silverstone and Haddon, 1996). Social studies of computer-mediated communication have emphasised the interplay between technological features and users' action in explaining these phenomena (Boczkowski, 1999).

3.3 A general overview of the innovation-decision process

The rate of adoption is determined by the relative speed at which an innovation is adopted by the members of a social system and is measured by the number of receivers who adopt a new technology in a specified time period. We can imagine a social system both as an exogenous element that exists here and now, and as an entity that develops along with the introduction of an innovation. The endogenous development of a social system occurs to a great extent when firms introduce a technology that breaks into existing communities of users and forms a new market. Internet telephony, for example, allows convergence between previously separated domains - voice, video and data - and cuts into different market segments - users of the telephone and

hobbyists of multimedia applications, consumers and businesses - possibly creating a broader market.

When confronted with an innovation, users engage in a continuous process that starts with the knowledge and ends with the adoption/rejection and subsequent confirmation of the decision made (Rogers and Shoemaker, 1971; Rogers, 1995). At the beginning, the individual becomes aware of the innovation (*knowledge*); then they form a favourable or unfavourable opinion (*persuasion*); the third stage involves some activities that lead to the decision to adopt or reject the new technology/product (*decision*); finally the individual seeks reinforcement for the decision made (*confirmation*). When analysing the innovation-decision process, one has to remember that there is a clear-cut distinction between awareness and adoption. Many potential adopters are often aware of an innovation, but are not motivated to try it and adopt it. The rate of awareness/knowledge of an innovation is more rapid than its rate of adoption.

3.3.1 Characteristics of innovations

The characteristics of an innovation that really matter are not those seen by innovators, but those perceived by the potential adopters. Users usually do not share with firms the same expertise about a new technology and need simple and familiar artefacts. In some cases however individuals have a lot of experience with existing technological configurations and have well-defined expectations about the new ones.

Innovations must possess a *relative advantage*. They need to be perceived as being better than the ideas they supersede. When comparing technologies, products or services, individuals consider both economic profitability and other variables - degree of risk, decrease in discomfort, savings in time and effort, immediacy of rewards. The last factor explains why the so-called preventive innovations, such as a new form of insurance, have generally a low rate of adoption (Rogers, 1995). Evaluating the relative advantage of Internet telephony is quite problematic, since it is difficult to find the appropriate unit of comparison. Some perceive it as a substitute of the telephone; others see it as a platform technology that allows the integration of voice, data and video. Economic profitability considerations therefore vary significantly: for consumers, it is more a matter of savings on international calls; for businesses, Internet telephony allows increasing cost efficiency in network management. As far as risks are concerned, the major problem with Internet telephony is the quality of service. The replacement of the old telephony

system may lower significantly the quality of voice applications, possibly more than users are prepared to accept.

Another important attribute of innovations is *compatibility*, which refers not only to technical features, but also to existing socio-cultural values, past experiences and needs of potential adopters. Old ideas are the main tool with which innovations are evaluated both from a technological and from a social perspective (Miles et al., 1994). In the case of Internet telephony, technical compatibility has been ensured by the development of standards, which enforce inter-operability between hardware and software. However, users are still familiar with device-dependent modes of communication - video on TV, voice conversations on the phone, data on PCs. They are accustomed to reliable voice applications and have high expectations on the quality of service. They require a clear signal and a smooth conversation and Internet telephony is still not good enough for this. The socio-cultural context in which individuals live also affects the efficiency of these applications. The way people talk on the phone varies significantly among different countries and the technical characteristics of Internet telephony are not compatible with every habit, e.g. people talking simultaneously on the phone. For businesses, who are already implementing integrated solutions on their VPNs, compatibility is more a technical issue. However, also corporations sometimes tend to be inertial in putting new technologies into operation.

The extent to which an innovation is perceived as relatively difficult to understand and use - its *complexity* - is also a relevant variable. Different users have different knowledge and skills with respect to a specific technology and perceive different levels of complexity in its use. If some individuals cannot use the technology because it requires a different knowledge base from the one they have, a process of social exclusion may occur (Rogers and Shoemaker, 1971). In the case of Internet telephony, some users do not possess enough skills to configure their PC as a telephone and require easy-to-use solutions, while PC-based configurations have still awkward user interfaces. Social exclusion is unlikely to occur among consumers, since hobbyists of multimedia applications constitute a small elite, but business users may feel competitive pressure and are more likely to adopt Internet telephony in response to it.

Another important characteristic is the *triability* of innovations. Having the opportunity of experimenting a new technology before deciding whether or not to adopt it is an important benefit especially for early adopters, since they can only rely upon available information, while laggards

can learn from other users' experience. Functioning, real world examples are often more important than arguments about advantages and expected functions (Rip, 1995; Rogers, 1995). In our case, triability plays a relevant role. However, in terms of growth rate, the number of people who try Internet telephony is much bigger that the number of actual adopters.

Finally, an innovation is evaluated according to its *observability*, which identifies the degree to which its performance and related benefits are visible to users and not only to companies that produce it. With Internet telephony applications, there is a problem of scarce perception of the possible benefits. Most potential adopters still consider the arbitrage bonus as the only advantage, without seeing long-term benefits, because they are not aware of all the existing applications.

These characteristics have a different significance at different stages of the innovation-decision process. At the knowledge stage, when individuals have contact with the innovation for the first time, complexity and compatibility are particularly relevant. At the persuasion stage, when potential users form an opinion on the innovation, economic profitability, low risk, immediacy of rewards and observability acquire a higher status. Finally, at the decision stage, individuals benefit from the possibility to try the new product/technology (Rogers and Shoemaker, 1971).

3.3.2 Consumers' behaviour and the adoption of a new technology

When analysing how members of a social system adopt an innovation, one needs to consider also the peculiarities of the potential adopters, since the interplay between users and producers and the mutual shaping of users and technologies in the design specification determine the characteristics of the innovation. Adopters' behaviour is affected by a set of economic and socio-cultural values and practices that account for their innovativeness with respect to a specific new technology/product.

Individuals mentally match the new idea to their present or expected future conditions before deciding whether or not to try it. Some state that the opinion on a specific innovation reflects the general attitude towards change (Rogers and Shoemaker, 1971). However, innovativeness is a relative concept and individuals who are progressive towards some innovations, can be conservative towards others. In this respect, the Amish community represents an interesting example (Rogers, 1995). The Amish reject most consumer innovations since they do not fit into their religious beliefs and family values. The members of this social system may be considered as

not innovative, since they refuse any form of technological progress that does not serve their basic needs. However, they are very innovative towards innovations that are consistent with their norms and principles[11].

Different individuals in a social system have different characteristics that play an important role in explaining the pattern of adoption of a certain technology. However, it is very difficult to categorise potential adopters and any attempt at doing this suffers from an inevitable oversimplification. Following different traditions (Rogers, 1995; Karshenas and Stoneman, 1995), we propose a three-category classification: innovators, majority, and laggards[12]. In describing these categories, we apply this classification to the case of Internet telephony.

Innovators possess a positive attitude towards innovations and the ability to understand and apply the related knowledge. They usually have a clearly defined personal agenda regarding a new technology (Boczkowski, 1999). The fact that business users are often more "innovative" then consumers suggests that the availability and control of financial resources constitute important explanatory variables for the innovativeness of users. Within this group, some individuals possess a high degree of opinion leadership and stimulate the adoption of a new technology in their community. In the case of Internet telephony, hobbyists of multimedia applications who need to make cheap international calls belong to this category. Corporations with an advanced information technology department and substantial resources to invest in the upgrading of their network can be considered strong opinion leaders and can possibly drive the adoption of this service.

Majority identifies users with a relatively long innovation-decision time period. Adoption occurs either because of economic necessity, or because of social pressure. In the case of Internet telephony, conservative consumers and small businesses, that are not willing to experiment with new modes of communication unless the quality of service meets their expectation and easy-to-use solutions are available, fall into this category.

[11] The conservation of soil and natural resources constitutes an important norm for the Amish and agricultural innovations that reflect this principle are well accepted (Rogers, 1995).

[12] This classification applies to the diffusion of most innovations, but the categorisation of adopters must be interpreted with respect to a specific innovation, not as a general behaviour. The same individual may fall into different groups when different innovations are considered.

Laggards are users who remain locked in old technologies. Often, when they decide to adopt the innovation, it has already been superseded by another, more recent idea, which is already being used by innovators. Among the potential adopters of Internet telephony, consumers who do not have any familiarity with multimedia applications and are not even interested in an Internet connection fall into this category.

3.4 The shape of things to consume

The adoption of Internet telephony can also be examined according to a different theoretical framework, that integrates the literature on design specification (Miles et al., 1994; Utterback, 1994; Silverstone and Haddon, 1996) and the theory of mutual shaping of users and technology (Bijker et al., 1987; Bijker, 1995; Rip, 1995).

3.4.1 The specification of design

When firms introduce a new technology, they have to consider what functions it performs and who may adopt it. The technological trajectory of ICTs allows the continuing emergence of opportunities for new applications. The pace of technical change in the functionalities of core technologies has been driving several innovations that range from incremental improvements to major transformations of the existing applications and to radically new technological solutions. These opportunities refer as much to the functions implemented by devices and to the objects and practices in which those functions are located, as to the features of technologies (Miles et al. 1994).

On the one hand, the technological development is a non-linear process that does not necessarily follow a path along dimensions of increasing functionality. Generic technologies can be introduced, that cut into existing market niches and create a new market[13]. If the technology is completely new, the problem faced by innovators is one of constructing a user (or a market) that originally does not exist. If potential users do not perceive the need for new technological solutions, companies need to build these perceptions, expanding the users' imagination. On the other hand, the branched nature of technical change implies that new technologies develop in

[13] For example, we could envisage IP as a generic platform technology, which unifies traditionally separated domains into a new multifunctional technological environment.

specific directions, each step not being assessed in relation to all possibilities, but determined by the path previously followed (Rip, 1995). Path dependency presupposes that, once a technology has been adopted, it is not easy to substitute it, even with a better one (Arthur, 1988)[14]. If the new technological solution has technical features and functionalities in common with the existing ones, then the issue becomes how to convince users to shift from one product to another.

This is a relevant issue with respect to the market potential for Internet telephony. On the one hand, it is a generic technology possibly generating a new market, which combines users of telephones and users of on-line PCs. On the other hand, it has features in common with the existing applications and performs similar functions. Marketing Internet telephony thus requires both the construction of users that do not exist and the persuasion of users of already existing similar products.

Monitoring users' behaviour is an important step in depicting the market development for a new technology. However, firms also need to look at individual attitudes, practices and values, that may indicate a certain degree of discomfort with existing artefacts, making innovations quite desirable (Miles et al., 1994). For example, Internet telephony allows consumers to use their phone during an Internet session, avoiding the discomfort of quitting one of these two activities (assuming they only have a single telephone line). Firms use the analysis of market developments of new products to select among alternative product configurations. However, it would be reductive to think that the specification of design occurs just in response to users' needs and expectations. Business strategies which aim at creating increasing returns cycles and at building a self-reinforcing community of users and suppliers play an important role (Steinmueller, 1992; Utterback, 1994; Kim and Kogut, 1996; Hill, 1997).

" At an earlier stage, the market is a market of ideas rather than of concrete products, and the currency is not consumer expenditure, but the commitment of business resources" (Miles et al., 1994 p.79).

Basic and applied research leads to discovery and commercialisation of new technological solutions, and core technologies branch into new applications and markets (Rip, 1995). The

[14] This occurs because of cumulative effects. Rational decisions in the context of time may become historically irrational - as the example of the QWERTY keyboard shows (David, 1985).

emergence of a dominant design follows a phase of competition between different alternative designs.

A dominant design embodies the requirements of different categories of users and reflects a set of accepted ideas of what the product looks like (Utterback, 1994; Teece, 1986). However, a commonly accepted idea of what the product will be and of what functions it will perform does not always emerge and its nature is affected and shaped by modes of usage.

3.4.2 The mutual shaping of users and technology

When firms engage in developing new technologies and in specifying the design of a particular artefact they need to proceed through a complex process, which involves creating the artefact, constructing the user and catching the consumer.

Several authors stress that the history of new artefacts cannot be understood if these artefacts are not related to the surrounding technical, economic and social system. Rip (1995) introduces the notion of "socio-technical regime", where organisational, social and societal aspects are linked together with technical ones. Bijker (1995) introduces the concept of "technological frame" to explain the development of socio-technical ensembles. Similarly, the concept of techno-economic paradigm (Freeman, 1991) helps understand these phenomena, as it accounts for the broad societal factors that cross-sectoral boundaries as well as for specific socio-technical regimes[15]. Socio-technical regimes drive the technological progress in certain directions, while limiting other possible developments. The introduction of new technologies takes place against the background of existing regimes, often starting as a substitution and hopefully not becoming locked in this trajectory. This has been the history of Internet telephony, which was first introduced and adopted as an alternative telephony service. Whether this will be its future trajectory or prior use will pave the way for the development of new value-added applications is still an unanswered question.

Some technologies need specific design solutions that match different users' expectations and bridge the conflict between the familiar and the strange, which new technologies embody. In the

process of design specification, innovators have to couple aesthetics and functionality, in order to accomplish this mediation. (Marvin, 1988; Mansell and Silverstone, 1996). In the case of Internet telephony, the problem is not just one of managing technological solutions, but also one of offering a design that facilitates the shift of telephone conversations from one functional artefact to another, mediating the conflict between the old and the new associated with such a conversion. The applications should allow a smooth transition between PSTN and IP, without creating disruption in users' everyday life.

When introducing an innovation, firms need to define the identity of possible users and to build constraints on their future actions. The user is also involved in this process, since in dealing with the object they contribute substantially to specify the design. Firms face a market where consumers do not always have well-defined requirements with regard to new technological applications. While market transactions are useful to articulate prices, they are not appropriate to specify the demand, which is shaped through the interplay between users and producers. The success of an innovation depends on specific socio-technical transformations and the introduction of new technologies requires innovative activity "on the spot", so that technical and social/organisational aspects are aligned (Freeman, 1991; Silverstone and Hirsh, 1994). Socio-technical alignment indicates the internal and external order of technological and socio-organisational parts of the system in which new technologies drive more technologies and organisations with them (Rip, 1995).

The so-called "product-space" does not end with the introduction of a new product, but is a continuous process, which depends on the emergence of different product configurations for intended applications and markets. For example, the first configurations of Internet telephony were PC-based applications suitable for individuals with on-line PCs and a high level of technical skills. Subsequent developments have led to the generation of phone-to-phone applications and of more sophisticated PC-based configurations.

[15] A techno-economic paradigm is a cluster of technological, organisational and social innovations, which develop in a pre-defined institutional and technical system and affect a variety of products and processes and even the economy as a whole.

3.5 Conclusions

In order to proceed with the empirical analysis of the demand for Internet telephony, a summary of the key issues highlighted in this chapter is needed. We have utilised two theoretical approaches to explain the process of innovation adoption: the theory of innovation-decision process and the theory of mutual shaping of users and technologies. We have applied them to the case of ICTs, with specific reference to Internet telephony.

The main peculiarity of ICTs is their nature as media: they enter users' everyday life both as material objects and as tools for communication. The consumption of ICTs thus needs to be understood, not only as an economic activity but also in its historical, social and cultural guises. Users incorporate new ICTs into their domestic sphere and through this process, they contribute to define and modify the aesthetics and the functionality of physical objects, technologies and contents. The design specification of ICTs is accomplished jointly by innovators and potential adopters and the acceptance of new technologies occurs within a pre-defined socio-technical regime, where technological elements and social values and practices interact (Silverstone et al., 1994; Rip, 1995).

The process of adoption of a new technology is affected both by the attributes of the innovation (relative advantage, compatibility, complexity, triability and observability) and by the characterisation of users as innovators, majority or laggards. New technologies can be conceived as opportunities or threats that are evaluated in the light of users' economic and social objectives, and call for a reconfiguration of established habits (Marvin, 1988).

The analysis of the interplay between users and technologies can not be confined to a unilateral causal perspective. Both technological determinism, which focuses on the sociological consequences of technical change and on the autonomy of technological development, and social reductionism, that concentrates on the social shaping of technology, fail to provide an exhaustive explanation of the relationship between artefacts and human beings. Technological and social elements reciprocally influence each other and are at the same time *explanans* and *explanandum* of the pattern of their relationship (Orlikowski, 1992; Bijker, 1995; Boczkowski, 1999).

CHAPTER 4 - The demand for Internet telephony: An empirical investigation

The aim of this chapter is to describe and interpret the results of an empirical analysis of the current and potential demand for Internet telephony applications. The first two sections illustrate the methodology utilised for this purpose and provide a detailed account of the findings. The third part aims at interpreting the empirical evidence according to the theoretical framework proposed in chapter 3. Finally, an analysis of the current state of the market and an elaboration of alternative market scenarios are provided.

4.1 Research methodology

In order to assess the current demand and market potential for Internet telephony among residential and business users, a questionnaire was sent via e-mail to 69 ITSPs. The questionnaire is composed of 18 questions, 14 multiple-choice questions and 4 open-ended response questions - see appendix II for a facsimile of the questionnaire. The unit of analysis was the adoption of Internet telephony and the interest was concentrated on users' behaviour. Considering the scope of the empirical research, other means of investigation could have provided more direct and precise information. A market survey, for example, would have been an appropriate tool to analyse the demand for Internet telephony. A possible alternative could have been a detailed analysis of a specific group of users, even if, in that case, comparisons between different categories of potential adopters would have been missed.

However, time and budget constraints have suggested a less expensive and less time-consuming methodology. For the same reasons and since most companies are located in the US, instead of sending the survey by post, we have relied upon e-mail as a means of transmission. The survey has also imposed some limitations in terms of the depth of analysis. In particular, we have paid greater attention to the differences between residential and business users, than to the pattern of adoption of different applications. Furthermore, a questionnaire generally needs to be short and easy to understand, and this requires a substantial simplification of the issue addressed with each question.

Target companies were selected among an available list of ITSPs, which includes 195 companies. The census of the population was made according to the following rationales. First, we eliminated 45 companies located in geographical areas other than Europe and North America, since we were interested in the demand for Internet telephony in those regions. Among the remaining 150 companies, there was a similar number of TOs and software companies[16]. We chose to contact 100 of these companies, but 31 of them were rejected because of contact information problems. The selected group of companies consisted of 69 ITSPs: 36 software companies (90% from North America and 10% from Europe) and 33 TOs (63% from North America and 37% from Europe).

4.2 The results of the survey

The rate of response has been 36% although one response was only qualitative and has been utilised just as a source of general information. 67% of respondents are software companies, while only 37% are pure service providers. The rate of response has been higher in Europe than in the US (respectively 47% and 32%). The composition of the respondents is summarised in Table 4.1.

Table 4.1 Composition of respondents by region and category

	Target Companies		***Respondents (% on the country total)***	
	TOs	***SVs****	***TOs***	***SVs****
USA	35%	65%	18%	40%
EUROPE	80%	20%	33%	100%
OTHERS	80%	20%	---	100%
TOT	47%	53%	37%	67%

*SVs: software vendors

The first three questions investigate the supply and demand for Internet telephony applications and investigate the characteristics of ITSPs. Table 4.2 shows the most common Internet telephony applications offered in the market. Phone-to-phone is the most popular configuration, PC-to-phone is in an intermediate position and PC-to-PC is the least common. In the "others" category,

[16] Software companies produce the software for Internet telephony, while TOs are pure service providers and do not produce the software.

fax-to-fax, fax-to-phone and web-enabled call centres are mentioned. It is very interesting to note that 52% of respondents provide three configurations, 15% two configurations and 17% just one configuration.

Table 4.2 What kind of Internet telephony application does your company provide?

Phone-to-phone	67%
PC-to-phone	54%
PC-to-PC	46%
Others	50%

Table 4.3 confirms that firms' strategy of Table 4.2 matches perceived demand requirements. According to 63% of respondents, the most common configuration of Internet telephony purchased is phone-to-phone. Just 21% of respondents consider two applications - phone-to-phone and PC-to-phone - equally popular among users, but these are also the companies that provide more than one application.

Table 4.3 What is the most common configuration of Internet telephony purchased (or downloaded) by your customers?

Phone-to-phone	63%
PC-to-phone	30%
PC-to-PC	13%
Others	17%

Table 4.4 summarises the findings of questions 4, 5 and 6, concerning the degree of interest of different users towards Internet telephony applications. The proposed scale ranges from "very interested" to "not interested".

Table 4.4 How interested do you think residential users, SMEs and large businesses are in these applications?

Users/Level of interest	*Very interested*	*Moderately interested*	*Not interested*
Residential users	38%	46%	13%
SMEs	46%	50%	4%
Large businesses	63%	33%	4%

According to 63% of respondents, large business users are very interested in Internet telephony applications, a percentage that goes down to 46% for SMEs and 38% for residential users. Most ITSPs state that residential users are moderately interested, but a significant percentage (13%) claims that they are not interested. Two issues need to be considered with respect to these questions. On the one hand, ITSPs have more accurate information on business users than on residential users. This is because they communicate with corporations more regularly, due to the corporations' needs for customer services, maintenance and support of VPNs, but not as much with consumers[17]. On the other hand, it is likely that the interest of users in these technological solutions is overestimated. Although the three questions are separated, it is possible for the respondents to see a relationship between them and to rank the interest by category of users. In addition, the questions do not ask the respondent to consider all potential users in the group and thus "users" may be interpreted as "those who might have an interest", e.g. those with networked PCs.

Question 7 aims at gathering information on the type of users who are currently purchasing Internet telephony applications (see Table 4.5).

Table 4.5 What category of users is currently demanding your Internet telephony applications?

Residential users	50%
SMEs	58%
Large Businesses	46%
Others	54%

The results are affected by the fact that most respondents produce Internet telephony solutions and sell them to service providers, which in turn contact end users. This explains why 54% claim that "others" - mostly ISPs and TOs - are demanding Internet telephony applications. The demand for Internet telephony seems to be quite similar among different categories of users, with a small prevalence of SMEs and residential users.

This is quite relevant if compared to the findings depicted in Table 4.4 concerning the level of interest of different classes of users. There is a mismatch between those who are currently

[17] It is important to note that Internet telephony is used by individuals with technical skills and familiarity with multimedia applications.

purchasing Internet telephony applications and those who are most interested in them. This suggests that in the near future the pattern of usage might change. The results also highlight another issue related to the business strategy of ITSPs. 42% of respondents sell Internet telephony just to one category of users, while 17% supply two and 33% all three.

Having examined the current patterns of usage of Internet telephony the questionnaire aims then at understanding what factors support or hinder its adoption. Questions 8 and 9 investigate the drivers for the diffusion of Internet telephony, while questions 10, 11 and 12 explore the obstacles to its adoption. Target companies are asked to evaluate a series of factors facilitating or obstructing the adoption of Internet telephony according to a three level scale - not important, moderately important and very important.

It is important to stress that empirical findings for SMEs and large business users are quite similar. This is a little bit surprising, since other sources of information (Krupinski, 1997; OECD, 1998) suggest that the two markets have different patterns of diffusion of multimedia applications, and that the SOHO market is in an intermediate position between large business users and consumers as far as the diffusion of Internet telephony is concerned. However, one has to remember that the development of Intranets is helping all business users become familiar with this technology. Figures 4.1 to 4.5 summarise the results of these questions.

Figure 4.1 What are the main factors supporting the adoption of Internet telephony among residential users?

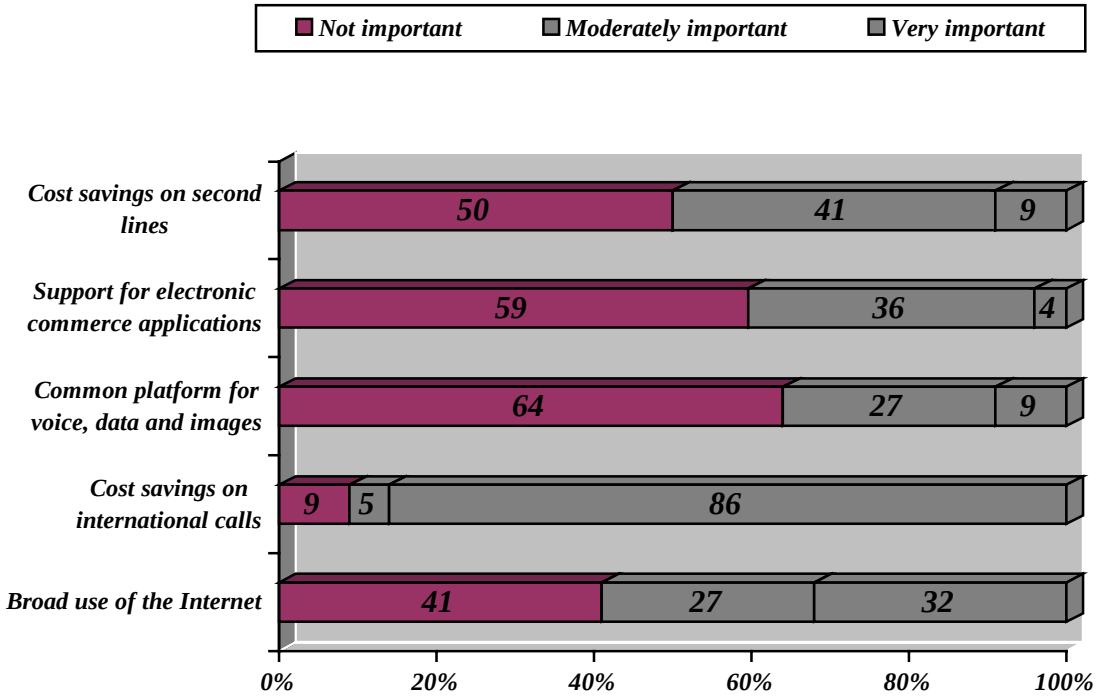


Figure 4.2 What are the main factors supporting the adoption of Internet telephony among business users?

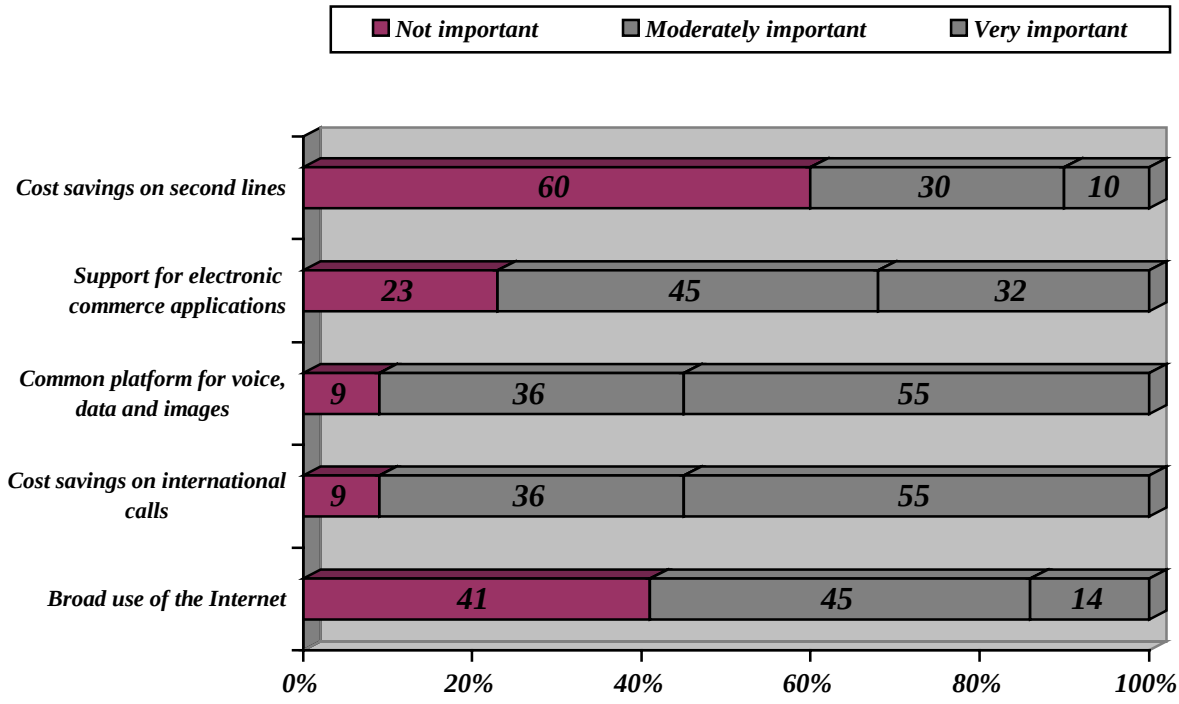


Figure 4.3 What are the obstacles to the adoption of Internet telephony among residential users?

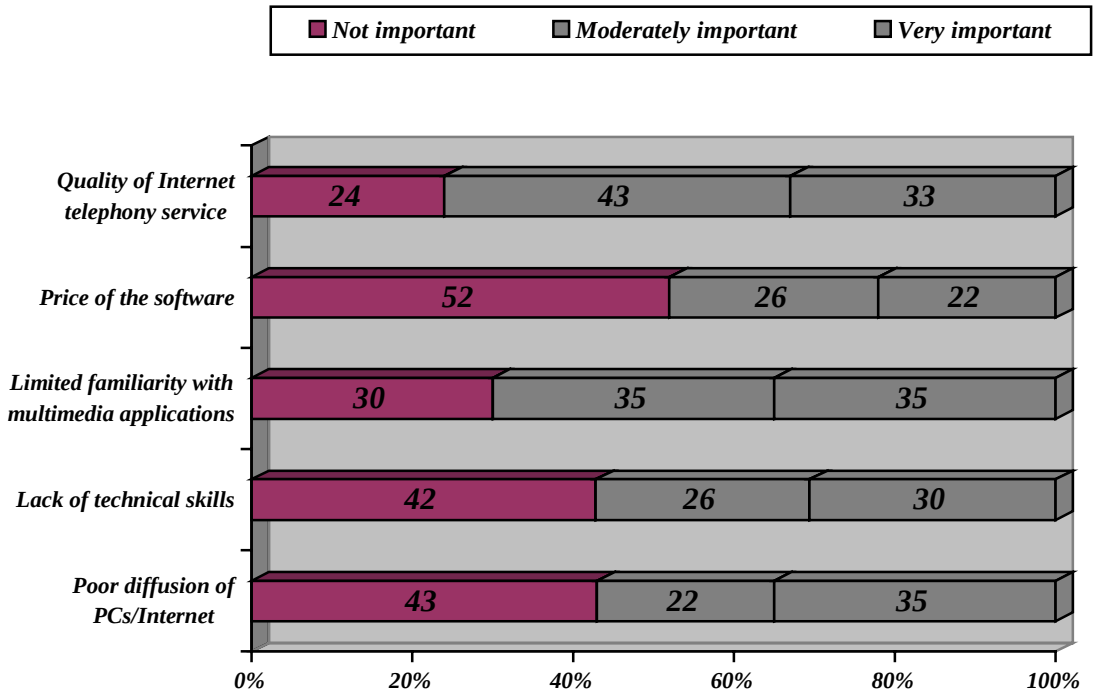


Figure 4.4 What are the obstacles to the adoption of Internet telephony among SMEs?

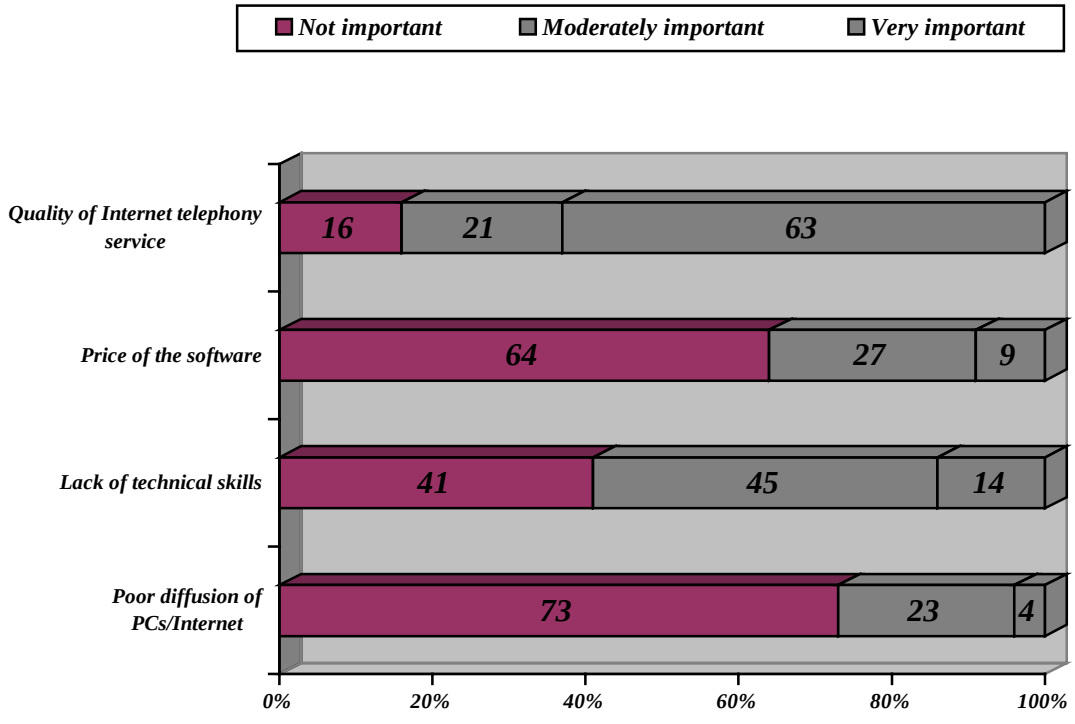
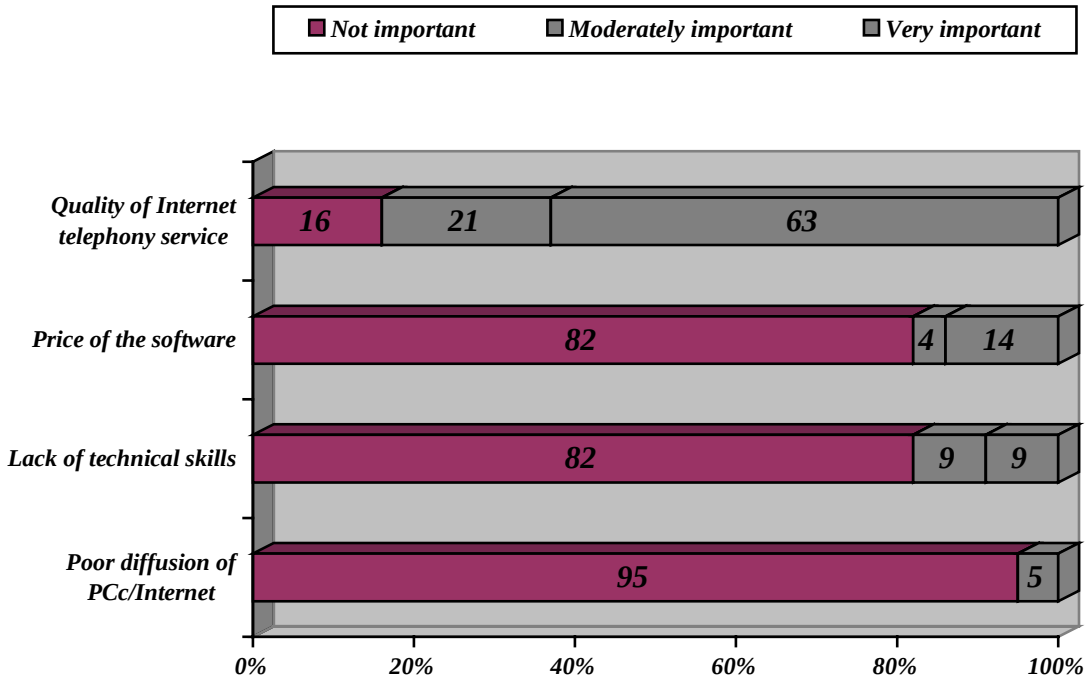


Figure 4.5 What are the obstacles to the adoption of Internet telephony among large business users?



Cost savings on international calls constitute a very important driver for the adoption of Internet telephony among residential users, according to 83% of respondents. The broad use of the Internet is also a relevant variable, although just 30% rate it as very important. A few respondents (4%) consider the possibility of supporting electronic commerce applications as a relevant driver. This is due both to the fact that residential users are not familiar with on-line shopping and to the scarce perception of Internet telephony as a facilitating technology for electronic commerce.

Cost savings on international calls represent a very important factor also for business users, according to 50% of respondents. Equally relevant is the opportunity for companies to have a common platform for voice, data and images, which facilitates network management. A small percentage of respondents think that cost savings on second lines are supporting the adoption of Internet telephony. Most companies are connected to the Internet through a VPN and employees can already use the telephone during an Internet session. The possibility of supporting electronic commerce applications represents a relevant factor more for business than for residential users.

Also the findings concerning the obstacles to adoption of Internet telephony applications highlight significant differences between residential and business users. We need to say that a

mistake was made in the design of the questionnaire, by adding another category for residential users (limited familiarity with multimedia applications). This might affect the comparisons between residential and business users, but it does not affect the differences between SMEs and large business users.

In the market for residential users, quality of service is considered an important problem by 76% of respondents and a very important problem by 33%. However, the poor diffusion of PCs and of the Internet and the limited familiarity with multimedia applications constitute also relevant obstacles according to 33% of respondents. The situation is quite different for business users. Both for large corporations and for SMEs the issue of quality of service is the most important one. 84% of respondents rate it as an important or very important inhibitor, but 63% regard it as very important, a much larger share than for residential users. It is significant that the second most relevant obstacle to the adoption of Internet telephony - lack of technical skills - is considered very important just by 9% (large firms) and 14% (SMEs) of respondents. In this respect, however, it is worth emphasising that respondents consider the lack of technical skills as being much more relevant for SMEs than for large business users, and this may be due to the existence of developed information technology departments in large corporations. Another relevant point is that a very low percentage of respondents see the poor diffusion of PCs/Internet as an important obstacle to business users (nobody rates it very important for large companies). Other inhibitors to the adoption of these technological solutions are mentioned, such as the risk of moving telephony to a new infrastructure and the cost of maintenance for business users, and the little awareness of existing solutions for residential users.

Questions 13 and 14 aim at assessing the current use of Internet telephony among on-line users in the US and in Europe (Tables 4.6 and 4.7).

Table 4.6 What percentage of on-line residential users in Europe do you think is currently using Internet telephony applications?

Users/Adoption rate	***0-10%***	***11-20%***	***21-30%***
Residential users	77%	23%	0%
SMEs	77%	23%	0%
Large Businesses	88%	6%	6%

Table 4.7 What percentage of on-line residential users in the US do you think is currently using Internet telephony applications?

Users/Adoption rate	***0-10%***	***11-20%***	***21-30%***
Residential users	82%	18%	0%
SMEs	88%	12%	0%
Large Businesses	88%	6%	6%

According to most respondents, the rate of usage of Internet telephony among on-line users in Europe and in the US is less than 10%[18]. The rate of adoption is higher among business users than among residential users and, in general, it seems that these technological solutions are more diffused in the US than in Europe. However, the differences are not very significant as far as residential and large business users are concerned, as opposed to SMEs. This may signal the fact that the typical European SME is seen as more innovative than the typical American one[19].

On-line users have been chosen as a sample because of the stage of development of these applications and the very poor quality of service of phone-to-phone configurations. The total available market is constituted by individuals connected with an on-line PC - this being also a signal of familiarity with multimedia applications - who want to make cheap international calls or to have enhanced services which, for example, facilitate electronic commerce or simplify network management. It is important to stress that even considering the total available market for Internet

[18] In retrospect, there is a problem with these two questions regarding the choice of ranges of values. Since most estimates fall in the range 0-10%, it would have been better to split this range into two smaller categories, in order to capture more precise information on the rate of adoption.

[19] Again, this result may also reflect different views of the relevant market.

telephony, which is a small portion of the market of telephones and PCs, the rate of diffusion is quite small[20].

The last four open-ended questions explore the market potential for Internet telephony from a general perspective.

Question 15 investigates the future pattern of usage of Internet telephony in terms of categories of users and scope. There is general agreement on the fact that demand will increase in the next few years - according to some respondents in the next few months. The rationale of usage will no longer be to reduce the costs of calls but to build converged networks. Emphasis will be on value-added applications that integrate voice and data. The following statement was made in the responses: "*...We are quickly moving over the initial "toll arbitrage" hump. Large enterprises now seem to have developed a lot of confidence in Quality of Service provided by internet telephony and so they are rapidly deploying it using private infrastructures of IP networks. The second wave will be integrating applications such as voicemail, IVR, fax services, follow me services, etc. into IP...*". There will be a tendency to move voice applications from the public Internet to private networks, so that the level of service can be maintained and users who are accustomed to the PSTN quality can continue to be satisfied.

However, there are divergent opinions as to which category of users will drive this process. Most respondents claim that large enterprises have developed high confidence in Internet telephony and are rapidly deploying it on VPN. They will also benefit from enhanced applications such as voicemail and web-enabled call centres over the next twelve months. Residential users will be slower in adopting these solutions, both because they have to use the public Internet (which embeds problems of congestion) and because of the poor diffusion of the Internet and PCs/Access devices at home. Quoting directly from available responses: "*...Business users will start deployment and use of IP as a means of communication much faster than the residential users because residential users have to use regular internet which is thin in international space...*". Others state that as soon as voice quality problems will be solved, residential users will quickly adopt Internet telephony applications and become an attractive market for operators.

[20] In 1997, there were an estimated 741 million traditional telephone users, 191 million PCs users and 60 million Internet users worldwide. In 1998, 26% of households were on-line in the US, while this percentage did not exceed 10% on average in Europe (Internet Magazine, 1999; Morgan Stanley, 1997).

Responses to question 16 show that there exists uncertainty also with regards to the relationship between electronic commerce and Internet telephony. Respondents have different views on this issue. Some claim that there is no link between VoIP and electronic commerce. Consumers are still attracted by calling cost savings of Internet telephony. They will start using more sophisticated Internet telephony applications only when those become available and if they can save on a second phone line without impacting on the quality of service they are accustomed to (after all, second lines are not very expensive). As mentioned in the responses: "*...If the users get used to using applications like PC (web) to phone (for say customer support calls), and they get used to the quality of the new application of voice, then that would be a way for e-commerce to push internet telephony into the home...*". People who engage in electronic commerce may do so because the idea of electronic commerce is *not having to* talk to producers. As stated in the responses: "*...I do not see these (Internet telephony and electronic commerce) as being closely tied. I believe the type of person today who uses e-commerce is doing so because it does NOT involve a person and is direct access to information/product etc....*".

Others suggest that the development of electronic commerce will stimulate the use of new types of free or reversed charging for voice services. The existence of such applications can also increase the diffusion of on-line shopping. Providing that the mechanics of using PCs for voice becomes simpler and users accept the quality of this new service, there is a way for electronic commerce to push the use of Internet telephony in home applications.

Question 17 aims at estimating the market potential for Internet telephony. Some discrepancies emerge, due to different definitions of the market: some consider just the equipment, while others include the whole range of technological solutions. Respondents estimate the potential for these technological solutions between $500 million and $2,000 million in annual revenues within the next three years. The European market is perceived as being more profitable than the American one, because of the higher-quality telephony infrastructure and the less competitive telephone market, which will provide fertile ground for next generation networks to be built.

Finally, question 18 investigates the possible future drivers for the adoption of Internet telephony in the residential market. There is a general agreement that familiarity and simplicity of Internet telephony applications constitute important variables in fostering their diffusion in the residential market. Quoting directly from the responses: "*...People will not accept the complexity of having to configure PC's as a main telephony device - these are years off being sufficiently reliable and*

stable for doing acceptable telephony (do you really want to have speech break up when you move the mouse on your PC or open an Excel spreadsheet?)...".

The usage will be stimulated also by the development of "killer applications" such as Internet call-waiting and voice-enabled web sites with collaborative browse features. Respondents agree that issues of quality of service need to be addressed: "...*Voice over the public Internet requires a small but continuous amount of bandwidth to offer good quality reproduction. Because this can not be guaranteed, it will be a while before it is used for business to business applications...*". There is a consensus on the fact that residential users are not interested in Internet telephony technology per se, but in cheap phone calls and enhanced applications. This reflects the absence of a clearly differentiated service available on the Internet that is not available through more direct telephony applications such as "free-phone" numbers. It is the deployment of technological solutions and services together with other market developments, such as electronic commerce, that will move Internet telephony adoption forward.

4.3 The adoption of Internet telephony: an interpretation of the empirical evidence

This section aims at interpreting the findings of the survey according to the theoretical framework developed in chapter 3, in order to highlight barriers and incentives determining future market scenarios. The drivers and obstacles to the adoption of Internet telephony identify both the characteristics of the innovation as perceived by users and the attitudes of potential adopters (Rogers and Shoemaker, 1971; Rogers, 1995; Miles et al., 1994; Silverstone and Haddon, 1996).

4.3.1 Attributes of Internet telephony applications

Do users perceive the *economic profitability* of Internet telephony applications? Recent studies show that savings on international calls are quite substantial, ranging from 73% for calls between Europe and the US to 87% for calls between, for example, Singapore and the US. However, traditional calls over the PSTN are becoming cheaper both because of regulation and because of technological advancements, and the perception of consumers towards Internet telephony will probably change[21].

For residential users, cost savings on international calls still represent the main driver for the adoption of these applications. As far as business users are concerned, the economic profitability of VoIP is more related to the cost efficiency of network management. According to the empirical evidence, the adoption of Internet telephony by business users is also fostered by the possibility of supporting electronic commerce applications. Companies may see Internet telephony as a technology facilitating the diffusion of on-line commercial transactions and thus as an indirect source of revenues.

Together with economic profitability, one has to consider the *risk* encountered by the potential adopters in switching to new applications, or in adding functionalities to their old applications. Why should consumers shift from the traditional telephone, which is reliable and based on a mature technology, to a new communication medium? ITSPs agree that quality of service is a major obstacle to the adoption of Internet telephony. However, congestion is likely to affect more the public Internet than VPNs, and in turn to impact on consumers more than businesses. Although the current level of Internet telephony service is considered an important inhibitor for all categories of users, we have seen that it represents almost the only one for corporate users, while it is just one among other obstacles for residential users. The risk embedded in using VoIP is still perceived by consumers as being too high, considering their expectations on real-time services such as voice applications.

[21] In OECD countries, between 1991 and 1998 collection charges for peak-rate international calls per minute have decreased from US$ 1.34 to US$ 0.78 (OECD, 1999).

The second issue to be addressed is the *compatibility* of new applications with existing ones, in terms of technical features - development of standards and inter-operability between different hardware and software - and in terms of users' characteristics, habits, and socio-cultural environment (Miles et al., 1994; Silverstone et al., 1994). The adoption of Internet telephony implies a quite radical change in the modes of communication. Users must have the possibility to deploy new applications, which requires a broad diffusion of (on-line) PCs and of the Internet itself together with the adoption of the IP as a platform technology. We have seen that technologies are more easily adopted, the more familiar users are with the hardware. There is therefore the need for increasing familiarity with multimedia applications – as opposed to device-dependent solutions.

According to 33% of respondents, the poor diffusion of PCs/Internet represents an important obstacle to the diffusion of Internet telephony among residential users (especially in Europe). PC-to-PC and PC-to-phone configurations will become more and more valuable in the future if this diffusion improves. Subscription-free services, which provide consumers with an Internet connection for the cost of a local phone call, have brought a considerable number of European households on-line but have not eliminated all the barriers. Providers must find a way to motivate consumers to spend time on-line despite Europe's metered charges for local telephone usage.

There is a misperception that the European Internet market is simply one or two years behind the US; however, structural differences exist between the two markets. The metered telephone usage alone will continue to hinder the growth of on-line advertising, content and commerce ventures in Europe by inhibiting Internet usage. In 1997, on-line households in the US were 23%, while in Western Europe as a whole they were 4%: in Germany and in the UK, the countries with the highest penetration of on-line PCs, the percentage is around 9-10%, while in France it is around 6% (Ernst &Young, 1999). Even considering individuals who access the Internet at work, the percentages are still low – 31% in the UK, 24% in Germany and 13% in France. Estimates suggest that the number of total on-line households in Western Europe will triple over the next five years, increasing from 14 million households (9% penetration) at the end of 1998 to 47 million households (31% penetration) by 2003 (Internet Magazine, 1999). This increase will narrow but not close the gap between Western Europe and the US in terms of total households on-line. A recent survey shows not only that the penetration of on-line PCs and multimedia applications is very low, but also that many people are not interested in these technologies. At the

end of 1997, PC-owning households who were not interested in subscribing to on-line services represented 17% in UK, 15% in France and 10% in Germany (Internet Magazine, 1999).

The third factor affecting the decision to adopt a new technology is its *complexity*. Empirical evidence shows that most potential adopters lack the technical skills to configure hardware and software and find Internet telephony too complex for the competencies they possess. Individuals do not accept the problem of having to configure their PC as a main telephony device: Internet telephony should be like a normal telephone for ease of use and should have the same functionality. People require turnkey solutions and this includes support, maintenance, and management of technologies. Even for businesses, going beyond today's user integration is hampered by the complexity of combining the technology. For example, intelligent routing of voice calls on the PSTN is expensive and complex to implement, because the network is device-centric and requires a dedicated circuit between devices, and the intelligence is connection-oriented[22].

Fourth, *triability* plays a relevant role in explaining the diffusion of Internet telephony. There is evidence that the use of these applications is fostered by the possibility of experimenting with them, and a substantial number of people are currently trying Internet telephony, although only a few of them are adopting it.

Fifth, it is important that users can observe the benefits of the new technology - *observability* of an innovation. One of the main problems with Internet telephony is that consumers perceive this technology as a substitute for international calls. However, the initial impetus given to Internet telephony by price arbitrage will decrease and consumers, as businesses, will have the opportunity to evaluate and consider the enhanced functionalities embedded in these applications. Individuals are often not aware of the availability of technological solutions as such, and this lack of knowledge is due not only to users' inertia in collecting information, but also to ill-targeted firms' marketing strategies. As soon as users get to know other applications (e.g. for customer support) Internet telephony will be pushed into the home. This requires an additional effort by firms in refining the design specification of technological solutions, in order to meet users' needs and expectations (Utterback, 1984; Teece, 1986).

[22] Conversely, the IP is person-centric and the intelligence is integrated in the information.

4.3.2 The interplay between users and technologies

Beyond the specific attributes of the innovation itself, determined jointly by the process of design and by the modes of usage, the characteristics of different groups of users also play a fundamental role in affecting the pattern of adoption of new technological solutions (Rogers, 1995). In the case of Internet telephony, we have distinguished two categories of users - consumers and businesses - and we have divided corporate users into large businesses and SMEs, although the latter distinction has proven to be not particularly useful for examining the market potential for Internet telephony.

In the estimation of companies, consumers and businesses have different attitudes towards the adoption of innovations that modify the existing modes of communication. Residential users have been the pioneers of Internet telephony applications, but at the beginning the market was made up of technicians who used the technology to make cheap international calls. Then corporate users started entering the market with more resources to invest and a longer-term view. What is currently happening is that the market for residential users is stalling, although its potential is still high (the market for on-line PCs is far from being saturated) while Internet telephony is increasingly being deployed on corporate VPNs.

The complex relationship between cultural and technological factors that affect the adoption of a specific technology determine also its relative stability over time, which in turn reflects users' satisfaction with the artefact both from a symbolic and from a physical point of view (Miles et al., 1994; Silverstone and Haddon, 1996). We can say that Internet telephony constitutes not only a technical tool but also a means of communication, and one that potentially could have a great impact on existing human interactive systems. For a long time consumers have utilised the telephone as the main mode of distance conversation. The demand for traditional telephones is still very high at home and the business of providers is largely focused around voice communication[23].

The demand and the acceptance of new ICTs takes place within a specific socio-technical regime (Rip, 1995), characterised by pre-existing technological trajectories and well-established social

[23] It is worth underlining that, although the growth of data traffic is much greater than the growth of voice traffic, voice still accounts for 80% of revenues of global TOs, while VoIP accounts for just 0.6%.

values and practices, e.g. how people communicate and how different cultures affect modes of communication. The technical features of Internet telephony are not compatible with every geographical or cultural environment. For example, with the current quality of service, there are problems if individuals talk simultaneously during a phone call[24].

Expectations of users towards voice applications also matter a lot. New technologies need design solutions that match different users' expectations and mediate the conflict between the old and the new that new artefacts embed (Marvin, 1988). When individuals dial a number, they are used to hear immediately a signal - they expect a very short call set-up period. This has to do with the perception they have of the services that technology can offer. Traditional telephony is expected to be quite reliable, since the technology is mature, and to provide a high quality service. In the case of mobile phones, on the contrary, individuals can stand a longer call set-up period, because they consider the device less efficient than a fixed telephone, but accept the lower quality conversation in exchange for the opportunity of moving around with the phone.

Business users find Internet telephony applications more compatible with their existing practices. Current enterprise communication solutions are still resourced and provisioned as two different and, in most cases, disconnected technologies. PSTN provides services like fax, voicemail and the telephone; IP offers services like data networking, messaging, personal productivity, and databases. However, in every day life, users pick up the telephone to talk about an e-mail, combining separated technologies to improve the efficiency and comprehension of communication. The limited familiarity with multimedia applications constitutes a major inhibitor to Internet telephony adoption among residential users. In the process of design specification, firms need to couple aesthetics and functionality, so that users feel comfortable with the new hardware and, at the same time, can exploit the enhanced software capabilities (Eveland, 1986). In order to stimulate the diffusion of these applications, there is the need for solutions that allow a smooth transition from PSTN to IP, without disruption or radical changes in users' habits.
As seen in chapter 3, the "product-space" does not end with the action of consumption, but is constantly modified through the emergence of different configurations which are well suited to specific markets (Shapiro and Varian, 1999). The process of incorporation of Internet telephony in users' everyday life has changed the functions it is expected to perform. In particular, applications purchased for cost savings on international calls have become tools that facilitate

[24] Voice is very redundant and a lot of information can be thrown away. The same possibility for

electronic commerce. Enhanced applications for electronic commerce are particularly appealing for business users. A technology is more valuable the more it fits into users' practices (Mansell and Silverstone, 1996), and business-to-business electronic commerce is currently more developed than business-to-consumer electronic commerce[25]. However, Internet telephony is not the only application that allows web-based audio to agents calling. According to a recent survey, on-line merchants have not yet implemented any type of IP telephony solution, due to the immaturity of this communication medium (Jupiter Communications, 1999). User interface is still awkward and the web sites of many companies need to be simplified. With web-enabled call centres, providers should use the visual media as much as possible (e.g. giving information through real-time e-mails), to reduce the time people stay on-line, which is more important than reducing the cost of the call.

4.4 Market scenarios for Internet telephony

Will Internet telephony become a major component of a new integrated telecommunication environment or will it remain a niche service? The prospects for these technological applications depend upon the interaction between demand and supply in the process of evaluating innovative solutions. On the one hand, technological developments in the overall Internet will play a crucial role in determining the opportunities for Internet telephony. On the other hand, users' requirements and expectations will contribute to establish its future trajectory. Efficiency advantages and the availability of integrated services can foster business users to move rapidly to Internet communication based on intelligent terminals. However, if ITSPs want to implement these applications also in the residential market, they must overcome the existing barriers to the adoption of Internet telephony.

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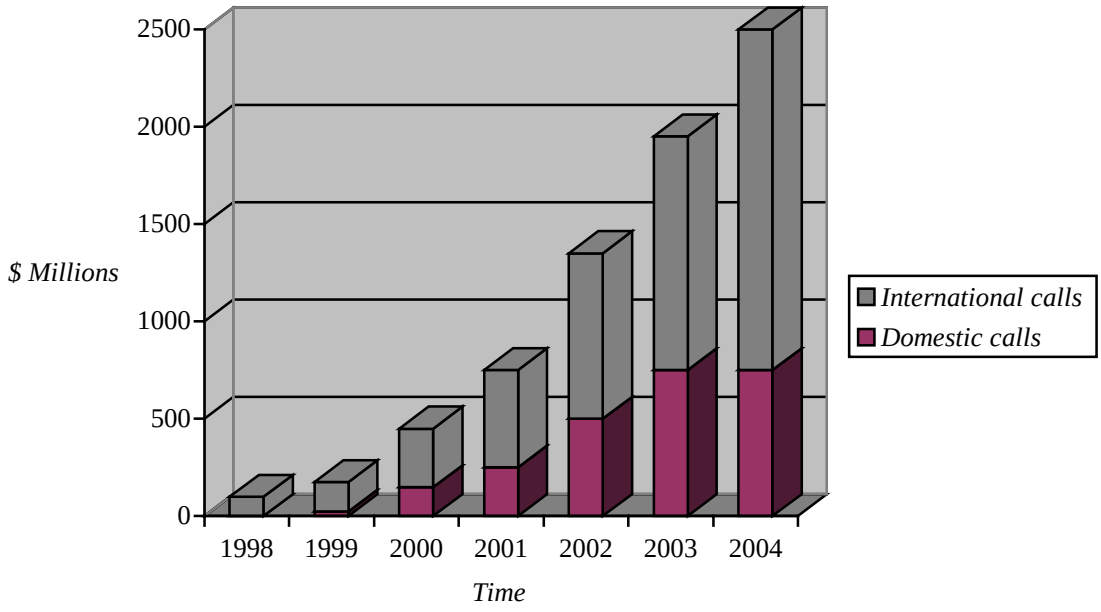
compression does not exist for data and consequently more bandwidth is needed.

[25] Recent estimates predict that business-to-business electronic commerce annual revenues are increasing from $17 billion in 1998 to $327 billion by 2002 (Ernst & Young, 1999).

4.4.1 The current market for Internet telephony

Studies show that in the next few years Internet telephony services will experience an impressive annual growth, with consumer spending reaching $1 billion in 2002. Calls travelling upon the IP network will not be only international calls, but increasingly local calls (Figure 4.6). By 2004, 1/3 of US consumer spending on Internet telephony will be for domestic calls. Global voice over the Internet services revenues will reach $63 billion by 2002, supplanting telephone service revenues.

Figure 4.6 US Consumer Spending on Internet telephony



Source: Forrester Research

Other forecasts show that by the year 2000, 15% of all international phone calls will be on the Internet and some claim that this Figure will be as high as 36% by 2003 (Lakelin, 1999). The market for Internet telephony is estimated to be worth $600 million by the end of 1999 and $1.89 billion by the end of 2001, experiencing a five year compound annual growth rate of 149%. Higher revenues will come from Europe - 31% by the year 2001 – with the North American market falling behind (Table 4.8).

Table 4.8 Revenues for the Internet telephony market by geographic region (estimates for 2001 in $ million)

Region	***Revenues***
North America	500
Pacific Rim	523
Europe	592
Rest of the World	274

Source: Delta Three (1999)

When looking at the estimates on the usage of Internet telephony, one has to consider that it is very difficult to track users. There is a lot of "black phone" Internet telephony whereby people use their existing phones, but the call is converted to the IP network, usually for cost savings. Both large corporations and service providers are building proprietary networks for this purpose. In either case the end user is probably not aware that the call is going over the IP network, just as they are unaware that their calls are often digitalised at present.

Although significant improvements have been made and especially business users have started exploiting the more advanced functionalities than the simple price saving, it is important to notice that 80% of Internet telephony sales still derive from toll by-pass solutions. The demand is expanding, but providers need to implement marketing strategies targeted at emphasising Internet telephony's multifunctionality. People are accustomed to good quality voice service and will not abandon it unless they can benefit from new configurations. Consumers want a cheap and convenient way to communicate with each other over the phone, but are deterred by complex and advanced technological solutions. However, cheaper and more convenient may mean more efficient, in terms of cost and time savings. Business users could foster the adoption of the technology and this is where most revenues for providers are. For corporations it is a matter of improving communication efficiency, and sometimes of responding to competitive pressure ("If my rivals use this, I have to use it as well"). PC-based applications, which have so far accounted for a small fraction of revenues in the market of Internet telephony, can become successful if deployed on IP. For VPNs, the important issue is not transport but management, because the value of service is defined by the ease of management more than by the underlying infrastructure.

4.4.2 The future demand for Internet telephony

How long will it take for VoIP applications to be successful in the market? There is a general agreement that the demand for Internet telephony will follow the stages of its technological development, from toll by-pass to enhanced services (Hopkins, 1999).

There are significant differences between consumers' and businesses' pattern of adoption of VoIP solutions, which will translate in different modes of usage in the future. Corporate users are implementing enhanced services over VPNs and, if investments in bandwidth will help solve the problems of congestion, companies will eventually also run voice over Intranets. The integration of different modes of communication is already happening and the increasing reliability of the network, which is improved independently by the fact that voice is installed, will foster the rate of adoption of Internet telephony. As far as residential users are concerned, Internet telephony is in a more critical stage and it may either remain just a tool for multimedia hobbyists or diffuse in the home place as a new mode of communication.

VoIP is poised between two possible market scenarios:

- ***Scenario 1*** *- Internet telephony remains a niche service*

- Poor quality of service
- Poor diffusion of PCs/Internet
- Scarce perception of functionalities beyond toll by-pass
- Poor development of business-to-consumer electronic commerce
- Scarce familiarity with multimedia applications
- Cost-based prices of international calls
- Substantial investments in ATM technology

- ***Scenario 2*** *- Internet telephony diffuses extensively in the market*

- Implementation of technical and pricing mechanisms to solve congestion
  - Investments in bandwidth - business market
  - Rationing of access - residential market
- Widespread diffusion of the Internet
- Increasing familiarity with multimedia applications among residential users
- Development of business-to-business and business-to-consumer electronic commerce
- Long-term view of network management, according to the revised path of convergence

In ***Scenario 1***, the quality of service continues to be extremely inconsistent, the diffusion of PCs/Internet remains low, potential adopters do not perceive the possible benefits of Internet telephony and other market developments, like electronic commerce, do not take off. Consequently, consumers remain unsatisfied with the second-rate quality offered by Internet telephony and they do not acquire familiarity with value-added services and multimedia applications, because of technological and social lock-in phenomena. Existing modes of communication prevail over new ones and individuals keep on using separate networks for different services.

If the penetration of on-line PCs does not increase as predicted, PC-based Internet telephony applications, which constitute the most advanced solutions from a technological point of view, remain a tool just for business-to-business electronic commerce. Furthermore, the development of business-to-consumer electronic commerce, which represents an important driver for the adoption of Internet telephony, continues to be hampered by factors such as the lack of security of financial operations and the scarce familiarity with on-line shopping. The initial impetus given to Internet telephony by price arbitrage disappears too quickly for ITSPs to move towards the provision of new high-value integrated services. The lack of price advantage, of support for real-time services and of high-speed Internet access technologies relegates Internet telephony to a niche market.

In this scenario, one niche offers cheap, poor-quality services at the margin, typically for hobbyists of multimedia applications who make a substantial number of international calls. Another niche supports new integrated services on corporate VPNs. Established TOs adjust their prices and their strategy to follow the technological trajectory of VoIP. We have seen in chapter 2 how centripetal forces could enforce the emergence of a centralised network controlled by TOs.

The PSTN operators restructure their activity to adapt to new technological opportunities and take advantage of their dominant position (especially in the local loop).

For ***Scenario 2*** to be realised, there must be enthusiastic adoption of intelligent voice terminals and of new enhanced services first among corporations and then among residential users. This could be evidenced by rapid growth in the market for Web phones and on-line PCs. In this scenario, new service providers gain market shares from the established TOs. New entrants exploit the growing technological opportunities by developing value-added services. Following the introduction of cheap transmission technologies, a decentralised network architecture emerges and the IP becomes the dominant platform for existing and new applications. In this context, ISPs and alternative service providers (e.g. call-back companies) carry out most activity, and the emergence of the new infrastructure threatens the revenues of TOs.

Internet telephony originating from intelligent terminals becomes an established means of communication for all voice calls, not just for the ones on profitable international routes. Consumers have more choice about the type of services they receive, who they buy them from and the quality of service they expect. Corporations have a single network infrastructure, which is easy and more efficient to manage and users can dial-up to connect to the corporate voice and data networks. Once they log in, the network recognises the user extension and routes all calls (voice and data) to the IP address of the users at their location. The market for voice applications becomes highly segmented, with high-price, high-quality, flexible services for corporate users, enhanced applications with differential price/quality mix for residential users and low-price discount calls for users who are willing to exchange quality for price.

The relative likelihood of these two scenarios for the demand for Internet telephony can not be evaluated just according to a technical perspective. The prospects for the diffusion of Internet telephony depend crucially on users' behaviour towards new telecommunications value-added services. The theoretical framework presented in chapter 3 tells us that users' needs and expectations are going to play a relevant role in determining the future of Internet telephony.

In ***Scenario 1***, technical and social obstacles hamper the process of incorporation of Internet telephony in users' everyday life. Potential adopters do not feel comfortable enough to switch to a new mode of communication, which is perceived complex and unfamiliar to their habits and practices. Furthermore, telephone users have too high expectations compared to what Internet

telephony can offer. In ***Scenario 2***, the incorporation of Internet telephony in the socio-technical regime of technologies, individual values and practices of the potential adopters takes place. Firms succeed in constructing the users of new applications and in matching technical features and customers' needs. The adoption of Internet telephony follows the innovation-decision process of knowledge-persuasion-decision-confirmation, in which users become aware of the possible advanced functionalities of these applications and gradually move towards new forms of communication.

The interaction between users and new technologies follows complex dynamics and the relevance and significance of a specific technology may be challenged at any point during its lifetime. According to the perception of different users, Internet telephony may represent a way to make phone conversations or a platform for enhanced applications. In this respect, the two scenarios can be seen not only as substitutes for each other, but also as sequential market developments.

CONCLUSIONS

The aim of this study was to analyse the current demand and market potential for Internet telephony. We have examined the pattern of adoption of this service among residential and business users and have evaluated possible market scenarios for the future. Technical, economic and social factors supporting and hindering the adoption of Internet telephony applications have been highlighted. Some conclusive remarks and a research agenda for the future follow.

In order to investigate what factors are affecting the diffusion of Internet telephony among residential and business users, a survey among European and North American ITSPs was conducted. The unit of analysis was the adoption of Internet telephony and the main concern was the users' attitudes towards this new service. Considering the purpose of this empirical investigation, other methodologies could have provided more direct and precise information, such as a market survey or the analysis of a single group of users. However, time and budget constraints have suggested a less expensive and less time-consuming methodology and, for the same reasons, instead of sending the survey by post, we have relied upon e-mail as a means of transmission. Furthermore, we have paid greater attention to the differences between residential and business users, than to the differences in the pattern of adoption of different applications.

The pattern of adoption of Internet telephony applications is currently determined by two sets of factors. On the one hand, it is affected by the specific attributes of these technological applications - economic profitability and risks, compatibility with existing applications, complexity, triability and observability - as perceived by the potential adopters. On the other hand, it is influenced by the perception of different groups of users towards new modes of communication.

Empirical findings suggest that Internet telephony is generally perceived more as a substitute for traditional telephony than as an enhanced service. The demand for these voice applications is still at an early stage especially among residential users, who often are not even aware of the available value-added applications. Consumers' habits together with limited technical skills are hindering VoIP's adoption. Business users represent a more profitable market, since they have more familiarity with multimedia applications and are already implementing enhanced services on VPNs. However, the rate of adoption of Internet telephony is still low also among corporations.

Quality of service constitutes the main obstacle to the diffusion of Internet telephony, and cost savings on international calls still represent a very important driver. This reinforces the idea that the perception of the potential functionalities of Internet telephony is still limited.

The results of the survey suggest also that the economic profitability of VoIP and the risks embedded in switching to new communication services are perceived quite differently by consumers and businesses. For residential users, it is more a matter of cost savings on international calls, while for corporations economic benefits stem from the cost efficiency of network management and the possibility of supporting on-line commercial transactions. The compatibility of Internet telephony with existing modes of communication affects significantly the behaviour of potential adopters and is evaluated both in terms of technical features - standard and inter-operability between different devices - and in terms of users' established practices. The diffusion of these applications is also linked to the development of electronic commerce and business users are more likely to adopt these applications than consumers. The scarce penetration of (on-line) PCs and the poor diffusion of on-line shopping among residential users partially explain this pattern.

We have underlined that the technological evolution of VoIP is generating value-added applications, which combine voice, data and video on a single network platform. However, the future of Internet telephony is poised between two possible alternatives. It may remain a low quality, cheap niche service for hobbyists of multimedia applications, or it may diffuse as a next-generation platform technology, which enables the convergence of computing and telecommunications. Consumers are accustomed to device-dependent, easy-to-use communications media and the prospects for Internet telephony depend upon the interplay of technological developments and users' behaviour.

The uncertainties surrounding the future technological trajectory in the telecommunications make it difficult to predict the possible market scenarios for enhanced voice applications. There is the need for a better understanding of users' attitudes towards telecommunications value-added services. So far, most of the research in this area has addressed the supply side of the market, assuming the existence of a well-developed demand. But this study has shown that a high penetration of enhanced telecommunications applications still has to be reached and that potential users have very heterogeneous perceptions towards them. Even considering the rapid process of convergence, it is not clear if and when VoIP will extensively diffuse. Communication is not

revolutionary - it is always people talking on the phone with other people – but the underlying technology is new and people need some time to become familiar with it. Future investigation should take this into consideration and address the issue of diffusion of new communications media not only in the light of technical and economic considerations, but also according to a more sociological thinking.

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APPENDIX I

List of Acronyms

ATM: Asynchronous Transfer Method

ICTs: Information and Communication Technologies

IP: Internet Protocol

ISPs: Internet Service Providers

ITSPs: Internet Telephony Service Providers

LAN: Local Area Network

PC: Personal Computer

PSTN: Public Switched Telephone Network

SMEs: Small and Medium Enterprises

SOHO: Small Office - Home Office

TCP: Transport Protocol

TOs: Telecommunication Operators

VoIP: Voice over IP

VPN: Virtual Private Network

WWW: World Wide Web

APPENDIX II

QUESTIONNAIRE ON INTERNET TELEPHONY

1. What kind of Internet telephony application does your company provide?
(Tick as many answers as it is appropriate)
* [] phone-to-phone
* [] PC-to-phone
* [] PC-to-PC
* [] Others (please specify)

2. Does your company produce its own software for Internet telephony?
* [] YES
* [] NO

3. What is the most common configuration of Internet telephony purchased (or downloaded) by your customers?
* [] phone-to-phone
* [] PC-to-phone
* [] PC-to-PC
* [] Others (please specify)

4. How interested do you think are residential users in this application?
* [] Very interested
* [] Moderately interested
* [] Not interested

5. How interested do you think are small/medium business users in this application?
* [] Very interested
* [] Moderately interested
* [] Not interested

6. How interested do you think are large business users in this application?
* [] Very interested
* [] Moderately interested
* [] Not interested

7. What category of users is currently demanding your Internet telephony applications?
(Tick as many answers as is appropriate)
* [] residential users
* [] small/medium business users
* [] large business users
* [] Others (please specify)

8. What do you think are the main factors supporting the adoption of Internet telephony among residential users?
(1=not important; 3=very important - put a 'x' close to the relevant number)
* broad use of the Internet [1] [2] [3]

* cost savings on international calls [1] [2] [3]
* cost savings on rent of second lines [1] [2] [3]
* common platform for voice, data and images [1] [2] [3]
* potential for supporting electronic commerce applications [1] [2] [3]
* Other(s) (please specify)

9. What do you think are the main factors supporting the adoption of Internet telephony among business users?
(1=not important; 3=very important - put a 'x' close to the relevant number)
* diffusion of the Internet [1] [2] [3]
* cost savings on international calls [1] [2] [3]
* possibility to integrate voice, data and images [1] [2] [3]
* potential for supporting electronic commerce applications [1] [2] [3]
* cost savings on rent of second lines [1] [2] [3]
* Others (please specify)

10. What do you think are the main obstacles to the diffusion of Internet telephony among residential users?
(1=not important; 3=very important - put a 'x' close to the relevant number)
* poor diffusion of PCs/Internet [1] [2] [3]
* lack of technical skills [1] [2] [3]
* limited familiarity with multimedia applications [1] [2] [3]
* price of the software [1] [2] [3]
* quality of Internet telephony service [1] [2] [3]
* Other(s) (please specify)

11. What do you think are the main obstacles to the diffusion of Internet telephony among small/medium business users?
(1=not important; 3=very important - put a 'x' close to the relevant number)
* poor diffusion of PCs/Internet [1] [2] [3]
* lack of technical skills [1] [2] [3]
* price of the software [1] [2] [3]
* quality of Internet telephony service [1] [2] [3]
* Other(s) (please specify)

12. What do you think are the main obstacles to the diffusion of Internet telephony among large business users?
(1=not important; 3=very important - put a 'x' close to the relevant number)
* poor diffusion of PCs/Internet [1] [2] [3]
* lack of technical skills [1] [2] [3]
* price of the software [1] [2] [3]
* quality of service [1] [2] [3]
* Others (please specify)

13. What percentage of on-line residential users in Europe do you think is currently using Internet telephony applications?
(tick the appropriate cells - put a 'x' close to the relevant number)

Residential users(%)	[0-10]	[11-20][21-30][>30]
Small/medium business users(%)	[0-10]	[11-20][21-30][>30]
Large business users(%)	[0-10]	[11-20][21-30][>30]

14. What percentage of on-line residential users in the US do you think is currently using Internet telephony applications?
(tick the appropriate cells - put a 'x' close to the relevant number)

Residential users(%)	[0-10]	[11-20][21-30][>30]
Small/medium business users(%)	[0-10]	[11-20][21-30][>30]
Large business users(%)	[0-10]	[11-20][21-30][>30]

Please comment briefly on the following questions:

15. Do you think that this pattern of usage will change in the near future? Which category of users is going to exploit these applications?

16. Could electronic commerce foster the adoption of Internet telephony among residential users?

17. What is the market potential for Internet telephony applications in Europe and in the US over the next three years in terms of US dollars?

18. What factors could stimulate usage of Internet telephony applications by residential users?

Other comments
E-mail sent to ITSPs on 10 June 1999

Dear Mr...,

Questionnaire - Internet telephony market

My name is Nicoletta Corrocher and I am a Master student at SPRU - Science and Technology Policy Research at the University of Sussex, Brighton (UK). I am currently writing my master dissertation on the market potential for Internet telephony, with a focus on residential users.

In particular, for the empirical research of my project dissertation it would be helpful to identify the pattern of diffusion of this application within the market for residential users. I am interested in gathering information on how many residential and business users are currently using Internet telephony or other similar applications that allow the integration of voice and data. I am analysing mostly the European attitude of users, but insights into the US market would also be useful.

Hopefully it will be easy to answer these questions. Please feel free to add extra comments you think are relevant, and fax or email me with your reply by 30 June. Responses will be used for statistical purposes only - details about individual organisations will remain confidential.

Thank you for your help.

Best regards,

Nicoletta Corrocher

E-mail sent to ITSPs on 18 June 1999

Dear Mr...,

Questionnaire - Internet telephony market

My name is Nicoletta Corrocher and I am a Master student at SPRU - Science and Technology Policy Research at the University of Sussex, Brighton (UK). I am currently writing my master dissertation on the market potential for Internet telephony, with a focus on residential users.

In particular, for the empirical research of my project dissertation it would be helpful to identify the pattern of diffusion of this application within the market for residential users. I am interested in gathering information on how many residential and business users are currently using Internet telephony or other similar applications that allow the integration of voice and data. I am analysing mostly the European attitude of users, but insights into the US market would also be useful.

Hopefully it will be easy to answer these questions. Please feel free to add extra comments you think are relevant, and fax or email me with your reply by 15 July. Responses will be used for statistical purposes only - details about individual organisations will remain confidential. I can provide you with a summary of the results of my research when it is completed.

Thank you for your help.

Best regards,

Nicoletta Corrocher

E-mail sent to ITSPs on 5 July 1999

Dear Mr...,

I haven't received any reply from you with regard to my questionnaire on Internet telephony. The survey is closing in a few days and I have to start analysing the results and writing my dissertation as soon as possible. I would be grateful if I could receive a reply from you and I will be happy to provide you with a summary of my results, as soon as the research is completed. I enclose a copy of the questionnaire and I hope to hear from you soon.

Thank you for your cooperation.

Best regards,

Nicoletta Corrocher