The Factors Affecting the Growth of VoIP

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Why has Internet telephony attracted so much attention and optimism over the past year? The obvious reason is that it has the potential to significantly reduce the cost of long distance voice communication. Additionally, Internet telephony (or the more generally, Voice over IP) introduces entirely new and enhanced ways of communicating. This report aims to introduce the main ideas involved with the provision of voice services over IP networks, and the factors surrounding the growth of the industry.

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1. Introduction

Why has Internet telephony attracted so much attention and optimism over the past year? The obvious reason is that it has the potential to significantly reduce the cost of long distance voice communication. Additionally, Internet telephony (or the more generally, Voice over IP) introduces entirely new and enhanced ways of communicating.

This report aims to introduce the main ideas involved with the provision of voice services over IP networks, and the factors surrounding the growth of the industry.

This section gives a brief introduction to the idea of Voice over IP (which will be referred to from hereonin as VoIP), and those providing related services. Following sections discuss the technological differences between traditional voice and VoIP provision, methods of VoIP deployment, and the factors influencing the growth of the technology - regulation, advantages, and disadvantages. Finally, economic issues and customer segments are introduced, and suggestions regarding the future of the market are proposed.

The fundamental applications of VoIP are voice, fax, data and multimedia. Although 'Voice over IP' may suggest voice communications alone, VoIP is a general term used to encompass all areas of traditional telephony that are to be offered over the public Internet, and over private IP networks. As a result, fax, multimedia services, and real-time data over the Internet are considered to be sub-segments of Internet telephony.

VoIP has become a key topic in both the growing Internet industry and the established telecommunications sector. The technology has moved from being one shared by a few hobbyists to that being offered by many service providers[*] with many more running trials, both technical and commercial (e.g. BT Syncordia Solutions, NTL, Telstra).

Driven by the promise of a new model for integrated voice and data communications, packetised voice carried over IP offers huge appeal to the market. Advantages include lower charges, more efficient traffic carriage and compelling new services.

For users, the important factors are that tariffs will be significantly lower, Quality of Service (QoS) is unpredictable and often unacceptable, and there are more digits to dial. Service providers, although expecting increased revenues, are faced with many technical problems and regulatory uncertainties.

The benefits of moving traditional voice onto the Internet and other IP networks can be reaped by Internet Service Providers (ISPs), traditional telephone companies (telcos) and next generation telephone companies.

ISPs have become increasingly focused on VoIP because it enables them to offer voice services at significantly lower rates, offer new services beyond Internet access, and improve their network utilisation.
As basic Internet access and services become commoditised, ISPs are looking to introduce a variety of value-added services to increase revenue. Now that VoIP is maturing, and its quality is becoming

[*] see http://www.iptelephony.org/frame/providers.html

acceptable, this is a perfect opportunity for many ISPs.

Traditional carriers have been furtively monitoring the rapid growth of VoIP. As is to be expected, those with the most to lose by the threat of this new technology have caught on the fastest. Telcos have, driven largely by fear, begun to offer VoIP most aggressively. These companies have many opportunities in this area, one being the provision of voice services, under the guise of data services, outside of their regulated boundaries.

Next generation telcos (known as Internet Telephony Service Providers, ITSPs) have emerged recently, with some (e.g. Qwest, Level 3) building entirely new networks. The provision of VoIP and other real-time services over a privately managed IP network can result in greater service quality than Internet telephony. Services can be highly reliable since the network manager controls how resources are allocated.

VoIP technology is in its infancy. However, hardware is constantly improving and falling in price, compression techniques are becoming more sophisticated, and underlying transport mechanisms are advancing the speed of data transfer. In the future, we will see a global communications network that will eclipse today's networks. The gap between VoIP and traditional telephony is lessening, and manufacturers and service providers will continue on towards the goal of unifying voice and data, in a reliable manner, on the Internet and private IP networks.

2. Packet-Switched Vs Circuit-Switched Networks

Packet-switched IP networks set up virtual connections between users. Bandwidth pipes are shared to increase efficiency, resulting in lower costs. It is possible to oversubscribe, queue, and fully utilise every bit of the bandwidth, unlike in a circuit-switched environment employing reserved channels that may or may not get used.
Because packets traverse different routes, they may often require resequencing, and always reassembly. Because many customers may be contending for bandwidth, the transmission speed over a specified path can vary dramatically depending on usage requirements.

Traditional telephony is based on circuit-switched technology. Circuit-switched networks provide users with a dedicated end-to-end circuit connection for the duration of a call. The circuit is set up between the originating switch, the terminating switch, and any tandem switches in between. It is characterised by large fixed infrastructure costs and underutilised, but fixed calling bandwidth.
In contrast, VoIP has low infrastructure costs and higher bandwidth utilisation.

The Public Switched Telephone Network (PSTN) has been optimised for voice traffic and is badly equipped to handle increasing amounts of data traffic. Levels of data traffic are set to increase exponentially with new applications such as multimedia and videoconferencing. This would lead to severe degradation of performance, were this traffic to be carried on the PSTN. The popularity of the Internet, coupled with demands for integrated voice and data services at reasonable costs has led to the adoption of IP as the preferred protocol for carrying simultaneous voice and data over public networks.

Due to the technological differences between data and voice networks, it is impossible to transfer the voice telephony pricing model to data networks. Current Internet pricing models are based on a flat-rate fee, or time-usage billing. With the introduction of premium services such as VoIP, providers will move away from these models. It is probable that basic access and services will not be charged for, and

real-time (based on QoS) and other value-added services will be charged for. This will require complex systems, charging for QoS, type of service, reliability, time-of-day, volume of traffic, and other privileges. A discussion of these systems is outside the scope of this report.

3. Regulating VoIP

Regulation of VoIP is largely a question mark. Traditionally, telephone services have been heavily regulated. In most countries, governments retain monopolies for provisioning telephone services, and deregulation has come recently in others (1996 in the US, 1998 in most of the EU).

Most governments' policy towards the Internet has been to encourage growth and competition by using little or no regulation. The rapid development of the Internet has, in large, been due to this lack of regulatory intervention. The introduction of regulation would almost certainly retard innovation in the Internet, and those that stand to gain from regulation are, in general, operators that have enjoyed a monopoly position for many years. Regulatory constraints would put new entrants at a severe disadvantage.

Although there is enormous growth in the short term, with increased choice and competition, the uncertainty over the future of the regulatory structure is still impeding investment and development.

Enhanced data services are those that can be economically provided by independent service providers (i.e. those who do not build their own telecommunications network infrastructure) in competition with network providers as long as they can gain access to network services. Examples of enhanced services are the provision of content for premium rate services and the provision of retail Internet services. Because many regulators are keen to encourage the development of such services, Enhanced Service Providers (ESPs) avoid long-distance access charges. ITSPs and ISPs, as ESPs, are not subject to long-distance access charges. Telecoms operators are urging this regulatory position to change. As ITSPs become increasingly competitive with telcos, it is argued that they should be classed identically. At the same time, it is very difficult to distinguish between different types of Internet traffic, and hence a method of levying access charges on ITSPs seems almost impossible.

The European Commission has defined voice telephony as 'the commercial provision for the public of the direct transport and switching of speech in real time between public switched network termination points, enabling any user to use equipment connected to such a network termination point in order to communicate with another termination point' [1].
This suggests that the following conditions must be met:

- the service offered must be part of a commercial offer
- the service is provided to each member of the public
- the service involves direct transport and speech in real time
- the service is provided between public switched network termination points in the fixed telephony network

Current VoIP clearly lacks some of these criteria, most notably real-time transmission. It also falls short of traditional telephony in that it is not fully reliable, ubiquitous, nor transparent.

VoIP is not a generally available voice transmission service, but an application available to those who have already subscribed to a basic Internet package. Because of this 'closed-user group' offering, the European Commission may not force ITSPs to pay access charges. Also, due to the telephony restrictions in Europe, VoIP is seen as a good way to introduce competition.
It has been suggested [2] that additional regulatory movements may affect the VoIP

industry. These include market entry requirements and entry rules:

Because most Internet services have been classified as non-basic or non-voice services, providers have not been subject to restrictive licensing and market entry requirements that apply to other telecommunications providers. As VoIP begins to compete with traditional telephony, regulators may start to impose registration, licensing, or other requirements on ITSPs. These processes may be time-consuming, and may involve franchise fees or royalty payments, which would significantly disadvantage new entrants.

If ITSPs are classified as carriers of basic voice services, they may be required to comply with routing restrictions and rules. These may restrict services that bypass accounting systems. However, given the complex topology of the Internet, it would be virtually impossible to monitor individual packets and apply routing rules on them.

4. Methods of VoIP

PC-to-PC telephony is the original form of VoIP. Both users are required to be on line before any connection is set up, and must use compatible software and multimedia computers.
It is not practical to separately tariff or regulate this form of VoIP, as it is difficult and counter-productive to try to distinguish audio bits from other bits. It is also difficult to distinguish between real-time, full-duplex communication and time-insensitive store-and-forward information.
Unless the Internet is regulated as a whole, it is not feasible to regulate this form of VoIP.

PC-to-phone telephony arose as IP-to-PSTN (and PSTN-to-IP) gateways became available. A VoIP gateway is the network element that removes the need for a PC in placing a call over the Internet. It packetises and compresses voice traffic from the PSTN and places it on an IP network, and assembles and decompresses traffic in the other direction.
Regulating PC-to-phone VoIP is a difficulty. The originator of the call pays no access charge, as to the service provider this looks the same as a PC-to-PC call. This greatly reduces access charges as the originator usually pays about two-thirds of the overall access charge. At the terminating end, the service provider may provide termination services to both local and long-distance callers, but cannot know where any particular VoIP call originated, spurring problems with regulation and tariffing.
Similarly, with phone-to-PC VoIP, there is no access charge at the termination point, as the originator cannot know where the call will be terminated.

Phone-to-phone VoIP eliminates the need for a PC altogether, using the Internet to carry the voice between two gateways.
Phone-to-phone VoIP calls can now offer greater quality than PC-to-PC or PC-to-phone VoIP calls, as the former may be offered over a dedicated IP network.
There is breakout to the PSTN at both ends, but because the originator cannot know the termination of the call, and vice versa, there will be problems regulating and charging access fees.

Fax over IP is arguably favourable to traditional fax because it does not require real-time transmission. Transmitting a fax, which has traditionally been associated with the PSTN, is no different from sending any other file. Fax messages are able to absorb delay and retransmitted packets without any negative impact on the final received message.

Multimedia conferencing will involve the combination of real-time voice, video and data transmission over the Internet. Although standards are emerging, it will lag behind other VoIP applications somewhat due to the substantially greater bandwidth required for multimedia applications.

5. What are the Factors in Favour of VoIP?

The ISP market today is driven largely by a tariff arbitrage. Although QoS is unsatisfactory compared with traditional telephony, people wishing to make long-distance or international calls over the Internet may do so cheaply, saving 20-100% on a call by bypassing the PSTN [3].

There are three main reasons for the price advantage [4]:

1. Regulators have ruled that VoIP providers are not subject to the long-distance access charges levied on traditional providers.
2. VoIP providers avoid the payment of settlement charges to foreign operators terminating their calls.
3. The networks used are more efficient due to compression and packet-switching. This applies to both intranets and the Internet.

Price will be affected by regulation. As the criteria for classification as voice telephony (see pg. 3) are met by VoIP, there will be some intervention by regulators, however it is not known to what extent this will effect providers.

Without today's tariff arbitrage, neither equipment vendors nor service providers could justify the investments in VoIP in achieving parity with the PSTN.

The US telecommunications regulator, the Federal Communications Commission (FCC), has made a proposal for globalisation of international carrier charges. If this proposal gains strength, then VoIP would lose one of its main price advantages [5].

Price will also be affected by two technological factors:

Compression mechanisms will be developed that will result in highly compressed voice traffic, which can be reconstructed very accurately. These will take advantage of the fact that not every packet needs to be transmitted in order to produce an acceptable received signal.

Internet bandwidth is growing at an enormous rate, with an expected drop in price of about 40% per year, compared with a general 5-10% drop in circuit-switched technology prices [6].

Bandwidth will also increase remarkably due to new last mile (from the exchange to the home) technologies such as cable, xDSL, fibre to the curb, radio local loop, and satellite. The twisted-pair copper loops of the PSTN were not designed to carry high-speed data traffic, and will therefore be succeeded by faster, more appropriate methods.

New pricing models for Internet provision will also help to free up some 'wasted' bandwidth and resources. The current flat-rate pricing model provokes users to stay on-line for long periods of time, consuming resources that are being contended for. A tiered pricing system will encourage more efficient use of resources, hence creating available bandwidth for those willing to pay for it.

The original users of VoIP were hobbyists. The group of users now includes general technology users, and the tariff arbitrage has become the primary focus of the market. However, the focus is expected to move away from tariffs alone. The offering of new features and applications are likely to fuel the market.

Convenience will be important in the future - to use Internet telephony today is cumbersome, requiring a user either to use a computer (which was not designed for this purpose) or to dial several digits before the destination number can be dialled. The next generation of users attracted to lower prices will only show real interest in the technology when it becomes as convenient to use as PSTN telephony. This convenience will come with a new generation of VoIP gateways and equipment. Gateways are constantly

improving, but are still deficient in many ways.

As gateways evolve into robust embedded systems, they will be able to handle hundreds, or even thousands, of simultaneous calls. In an effort to reduce sunk costs, high numbers of calls will be made over these systems.

Today's equipment is extremely expensive compared with traditional PSTN equipment (about four times the price), and the networks do not interoperate well with each other or with the PSTN. Because of these factors there is much energy being channelled into the development of superior, and cheaper, equipment.

ITSPs are beginning to offer features that make VoIP more convenient, and move it more closely to what is familiar on the PSTN.
Dialling has been awkward, requiring the user to first dial an access number provided by the ITSP. Only after this call is routed to the access IP telephony switch can the destination number be dialled. Providers are beginning (early 1999) to introduce VoIP services that will no longer require the user to dial any differently than he would when making a regular call [5]. Korea Telecom has been one of the first providers to integrate the PSTN and IP networks in this way [7].
Lucent Technologies [8] and Nortel Networks [9] have developed packages that will support the delivery of enhanced VoIP services, including the above, single stage dialling.

Once feature parity exists, future uptake of VoIP will depend largely on the introduction of enhanced applications.
Applications already available include call waiting, caller ID, multicast, and multimedia conferencing. Simple traditional features could be much richer over a packet-switched network. Caller ID, for instance, traditionally only shows the number of the calling party. In an IP environment, the caller could announce who he is, where he is, request a multimedia connection, or give any sort of information he wishes to the called party.

VoIP call waiting can also be richly enhanced. When a call arrives, the following choices are available to the subscriber [10]:

- receive the call on his PC
- send the call to voice mail
- drop the Internet connection and receive the call on his telephone
- ignore the call

The benefits of such enhancements are obvious. The need for separate lines for voice and data disappears, and flexibility is increased.

To a certain degree, the availability of many of these features are due to the low prices available with VoIP. Many rich features could be deployed over the PSTN, but it would be extremely expensive to do so.

New technologies will be able to support many applications concurrently through a PC or whatever device is used. Voice, data and fax may be managed by a single device. This will create new markets and also increase competition, as previously distinct industries converge.

VoIP is driving the public network towards an open, client-server topology. Proprietary switching systems and legacy networks have retarded integration of voice and data for many years, but competition in the area of telephony has initiated the move towards an open network. This could be the trigger that brings about true convergence of voice and data networks, but this will not happen until cost parity exists between packet-switched voice and circuit-switched voice technologies [6].
Whether or not parity will exist is in debate. While vendors are bringing down the cost of packet-switching equipment, circuit switching equipment and transport costs are also decreasing.

Theoretically, it would appear that the operation of an integrated voice/data IP network should be easier and more economical than managing two networks, but there is no real practical evidence to support this theory.

The saving of bandwidth with the deployment of VoIP will be of great importance to providers. A PSTN call consumes 64k of dedicated bandwidth, whereas the compression mechanisms used with VoIP can reduce that to approximately 8kbps plus overheads (12kbps for fax), with no bandwidth used when the users are not speaking. Although voice has been compressed to below 8kbps, this is not recommended because quality degrades rapidly below that [11].

The ubiquity of IP networks in enterprises is ensuring a large addressable market for VoIP equipment as well as facilitating the integration of VoIP equipment into existing networks.
Enterprises have also begun to put voice on their WANS and LANs, cutting costs as the voice is treated as data. On a private network such as an enterprise's LAN, control of data is much easier than on the public Internet, and so QoS can far exceed that of VoIP on the Internet.

The value of any telecommunications network increases exponentially according to the number of users/computers attached to it (Metcalfe's law). As more and more IP equipment is attached to the Internet, the benefits derived from being part of a VoIP network will increase, fostering further demand.

Even in its most basic form, voice carried digitally over the Internet is considerably harder to bug than speech carried in analogue form over a twisted-pair copper wire. Internet security issues tend to be more related to authorisation and authentication than to lines being tapped.

To sum up, there is huge opportunity in the provision of VoIP. Presently, the main attraction is the low prices that can be achieved by bypassing various access charges that traditional providers must pay. VoIP is no longer a technology employed merely by hobbyists. A new generation of users has emerged, and as convenience of use and richness of applications become satisfactory and attractive, VoIP will become increasingly popular among general telephony users.

6. What are the Factors Retarding VoIP?

The unreliability of the Internet is the main market restraint of VoIP. There are many QoS issues experienced by packet-switched networks that do not affect circuit-switched networks. Acceptable sound quality has become expected on the PSTN, whereas VoIP is an immature technology, experiencing many problems in this area.
The Internet is a best-effort network, where variable latencies and dropped packets occur. Because a voice service requires real-time transmission, VoIP often results in a heavily degraded QoS.

Delay: there are four types of delay in IP networks: propagation delay, network delay, accumulation delay and processing delay.
Propagation delay is that which is caused by the signal having to travel a distance. It is governed by the laws of physics and cannot be overcome.
Network delay is a function of the capacity of the pipes in the network and the processing of the packets as they transit the network. The delay associated with jitter buffers (see below) is considered part of the network delay.
Accumulation delay depends on the type of voice coder used. It is caused because a finite amount of time (varying from a single sample time to several msecs) is needed to collect a frame before the processing begins.
Processing delay is caused by the actual encoding and collection of encoded samples into a packet for transmission. It is a

function of the coding algorithm used and the processing time.

Jitter: jitter is a variable inter-packet timing caused by the network a packet traverses. This is removed by buffering fast packets in order that the slowest packets arrive in time to be sequenced correctly. This causes additional delay. The conflict of minimising delay and removing jitter has resulted in various methods of dynamically adapting the buffer size to match the time variations. This minimises the delay associated with jitter while preventing buffer underflow [12].

Dropped Packets: present IP networks are best-effort networks and do not guarantee service. Fortunately, uncompressed voice communications tend to be highly tolerant of dropped packets. However, many voice compression mechanisms result in the transmission of the changes (actual or predicted) between adjacent signals, rather than the whole signals themselves. Hence the loss or corruption of a packet can result in propagated errors, hugely degrading the quality of voice or video, often beyond recognition.

Echo: echo is caused by signal reflections in a hybrid circuit that is converting between a four-wire circuit and a two-wire circuit. It is present in all telephone networks, but is acceptable in a circuit-switched network because round-trip delays are usually short enough to go unnoticed. In packet networks, the round-trip delay is almost always noticeable, and an annoying reflection of the speaker's voice can be heard in his ear. Although echo-cancellation can be used to filter out the echo, this is often insufficient, usually with only a prediction of the actual echo removed.

Talker Overlap: if the one-way delay exceeds about 200msecs, the two speakers will adopt a mode whereby one speaks, the other listens and pauses to make sure the speaker is finished. Usually, the pauses are ill timed, thus, they will end up stepping on each other's speech.

Quality problems are the most important barrier to the development of VoIP. Until a QoS management mechanism is available, this unreliability will remain a major restraint.

Unreliability will also be cause for concerns in areas such as public safety. PSTNs are usually well engineered and very reliable. General services are rarely unavailable, and emergency services are extremely reliable. Although there may be much movement of voice onto the Internet, VoIP will have to mature greatly before it can be considered an overall threat to the PSTN.

The existence of legacy networks is a restraint on the growth of IP networks, particularly within enterprises. Compelling business cases are needed to replace voice networks that work perfectly and offer better quality than IP networks.

The present lack of interoperability is a major impediment for VoIP. H.323 is the standard for the transmission of real-time audio, video and data communications over packet-based networks.
Currently interoperability exists only at the client software level. This enables H.323 clients to communicate with other telephones through a H.323 gateway. However, no standard exists that allows gateways from different vendors to interoperate. This is slowing the adoption of IP by telcos [13].

The VoIP community has not yet agreed upon a common Call Detail Record (CDR). This would make it possible for one network provider to access and settle with another network provider or owner. Without a common CDR, the areas in which next generation telcos and ITSPs operate will be limited to those in which they have their own IP gateway. This is very undesirable for all users, particularly for businesses.

Standard applications for billing and OAM&P (Operations, Administration, Maintenance and Provisioning) do not exist, forcing users to rely on one vendor for a complete solution. This is a great restraint, especially when proprietary applications cannot be integrated with existing operations support systems.

The problem of integrating VoIP gateways with existing PBXs (Public Branch eXchanges), switches and routers often results in a complex configuration. This is due to a lack of experienced technicians, and the closed architectures of most PSTN network elements.

Scalability is also a problem because there are many needs in this area. The port density of each gateway can be easily increased, as can the overall number of users due to the distributed nature of the Internet, however sufficient business, service, network and element management tools and processes are not available, making scalability of general operations difficult [13].

When technical problems are overcome, an acceptable voice quality will be available, probably exceeding that of the PSTN. There will be widespread availability of VoIP without having to subscribe to a basic Internet package, and truly scaleable, interconnected services will be available [14]. Much development and maturing will need to occur before this becomes reality

.

7. Economic Issues

Presently, VoIP is lower priced than circuit-switched voice. The debate over whether VoIP is intrinsically lower cost is centred around two primary issues.
The first questions whether or not the lower price is merely due to the present regulatory framework, and the second asks whether the equipment and network required to handle a VoIP call is inherently cheaper than that of traditional telephony.

The lower tariff opportunity is presently available, but may be short-lived, not only because of the cost structure of VoIP, but because of the competitiveness of long distance providers and the abundance of high capacity fibre.

As soon as ITSPs lose their ESP exemption, their ability to offer VoIP at a lower price than PSTN operators will become entirely dependent on the true costs of building and operating a VoIP network. This is an important issue, which is fundamental when approaching the question of which type of network is more efficient.

Traffic on the Internet is doubling about every five to ten months. Packet-switched technologies, which approximately double in performance per cost every year, are in a much better position to keep up with growing demand. Circuit-switched technologies, take about four times as long to double their performance per cost, forcing ISPs to buy that much more equipment to keep up with the demand growth. This is economically out of the question in the long term.

IP networks have many advantages over traditional circuit-switched networks.
VoIP ports are substantially simpler than traditional telephony ports. Although the current cost per port (or per line) for VoIP equipment generally far exceeds that for traditional telephony (roughly $200 per line vs. $2,000 per VoIP port), it is expected to drop to approximately half that of traditional telephony within the next few years [15].

The economics of packet switching on a per-packet basis will tend lower than for circuit switching due to the superior efficiency of the former. With the development of new encoding algorithms, packet network utilisation can be expected to improve further.

In the ideal telecommunications marketplace, the prices of services would

be closely related to the cost of providing those services.
Traditional telephony has not worked this way. Most countries have substantial inter-service cross-subsidies built into their pricing schemes, so that universal service may be provided. Also, telcos have traditionally developed their prices based on return on investment, which has enabled them to depreciate assets over a number of decades.

ITSP charges are likely to be based on marginal costs, which are minimal compared to fixed costs. As real competition is created, traditional providers will have to move away from the traditional pricing model and towards marginal-cost pricing.

Telcos generally tend to employ large numbers of personnel to ensure good customer service and quality of service, leading to increased tariffs. The potential cost of bringing the reliability and service quality of IP networks up to PSTN grade may turn out to be significant and hence lessen the price advantage.

While the economics are currently debatable, the barriers to entry for ITSPs are extremely low, and as infrastructure and hardware costs decline, the unit economics may well switch in favour of VoIP.

8. Customer Segments

VoIP and its enhanced services are especially suited to particular customer segments, and for a variety of reasons [16]:

Businesses in full control of their IP LAN can obtain near-toll quality VoIP on that LAN. Technical problems are much less daunting due to the closed nature of the network, which results in greater reliability than on the Internet. This means that delay in processing and reception can be minimised, and calls are closer to PSTN quality. VoIP via the Internet may also be adopted for inter-office communications, where quality is less of an issue than when dealing with customers or partners.
Businesses can also set up web-enabled call centres, so that customers wishing to contact them by phone can initiate a call without having a second line or disconnecting their Internet session.
Businesses such as banks can eliminate their toll-free number access charges by letting customers call a local number, from which they are transported to an internal, centralised network. This essentially looks like a local call to the customer, and costs that for the business [17].
Businesses that have high telephony usage, such as travel agents and financial services, will be the target of many new entrant VoIP providers.

SOHO (Small Office/Home Office) premises have higher penetration rates than consumers for multiple telephone lines, PCs, and on-line services. Their high connectivity and multiple needs are an opportunity for VoIP service providers, who can provide a 'virtual' second line and significantly enhanced services. Small businesses are also likely to be more willing to trade off convenience and quality for lower prices.

International callers are willing to accept lower-quality international calls at a lower price, possibly the price of a local call or less than that, depending on which type of VoIP is used. Consumers tend to be cost-conscious and more flexible than business customers regarding quality and convenience.
Many large cities have high densities of people with strong foreign links. Offering VoIP between, say, San Francisco and China, would allow service providers to build up large amounts of traffic between these locations. This backbone cost reduction seems to be one of the main objectives of the next generation telcos. Gateways can be appropriately positioned, and a dedicated line could be set up between these destinations. This may allow for VoIP without use of the Internet,

and hence overcome significant QoS problems.

9. Conclusion/Implications

The current appeal of VoIP is more or less based on the ability to bypass high long-distance tariffs. Whether or not ITSPs are required to pay these charges, it is likely that the tariffs will come down in response to competition [18].

VoIP technology needs to improve in many ways, the most obvious being in the areas of quality of service and reliability. Long delays, jitter, packet loss and echo are the primary issues for concern.
Standardisation will also be of great significance in allowing equipment to integrate, interoperate (with each other and with the PSTN), and scale well, in terms of both technology and business processes.

Ideally, VoIP should comprise high-volume call processing within and between public and private networks, real-time translation between IP and circuit-switched networks, scalability (both economic and technological), and broad acceptance and implementation of standards.

IP will act as a unifying agent, pulling all types of data together, regardless of the underlying architecture of the networks.
The deployed system will need to provide ease of connectivity in terms of dialling a party directly, whether or not that party is on the Internet; the addition of features that provide a competitive differentiation, other than price, from traditional long-distance services; a set of open standards that operates independently of the product being used.

The growth of this market will have implications for all telecommunications operators.
For incumbent telcos, deregulation has increased competition. Many of their most profitable services will now be offered at lower prices over the Internet. This is not only resulting in lost market share, but is depreciating legacy networks, which have been very valuable assets.
Benefits include the opportunity to offer these services, and to move into foreign markets through deregulation and the deployment of VoIP.

VoIP has given ISPs a great opportunity to break into business network services. This will allow them to compete with traditional Value-Added Network (VAN) providers.
They may also provide a complete communications package including voice, Internet access, fax, videoconferencing, messaging and content. Those offering such a solution will look to gain a competitive advantage, and may be able to lock customers in, reducing extremely high churn rates.

The main implication for businesses and consumers is that they will be offered more choice, and at a lower cost.
VoIP will increase competition within specific industries, and across boundaries that are becoming blurred by convergence. This will give the customers increasing power.

The worldwide revenue for VoIP looks to follow an exponential growth curve. The total revenue is predicted to reach almost $2 billion by the end of 2001 [18], growing to $3 billion by 2002 [4].
Nearly half (48%) of ISPs are planning to offer some form of VoIP by the end of this year (1999) [14].

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