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Trends in IP Technology: Their Impact on the Traditional Telephony Carrier

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TRENDS IN IP TECHNOLOGY: THEIR IMPACT ON THE TRADITIONAL TELEPHONY CARRIER WORLD

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FOREWORD

In December 2001 this report was presented to the Working Party on Telecommunications and Information Services Policy (TISP). It was declassified by the Committee for Information, Computer and Communications Policy (ICCP) in March 2002.

The report was prepared by Dr. Farooq Hussain. It is published on the responsibility of the Secretary-General of the OECD.

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EXECUTIVE SUMMARY

The impact of the Internet Protocol (IP) on telephony is anticipated to replace traditional voice services with integrated voice and IP-based applications. The traditional telephony networks, though technically and economically unsuited to supporting the integrated applications including messaging and e-commerce, will nonetheless be leveraged by the ability to be interconnected and interoperate with IP networks.

The potential for leveraging IP-based applications together with the traditional telephony infrastructure will likely create new markets for traditional telephony carriers, opening the opportunity for new alliances and partnerships with content providers, broadcast networks and integrated network service providers to enterprises. These new alliances will generate both opportunities for economic growth of a re-shaped telecommunications industry as well as challenges to the traditional approaches to its governance and regulation.

Specifically, there will be an increased need to harmonize the progression of international technical standards for IP and the traditional telephony spheres as well as assessment of the implications of regulation presently applied to telephony as voice and video services become increasingly integrated within new IP-based applications delivered across a broad based communications infrastructure.

Though negatively impacted by the economy over the recent past, the deployment and growth of broadband infrastructure offers significant potential for telephony carriers to plan a migration from traditional telephony to IP-based services. The new IP-based services integrating voice should not be positioned in direct competition with or replacement of traditional telephony. Rather, the limited opportunity for arbitrage of IP-based voice services against traditional telephony is seen as being supplanted by the opportunity for implementing new services that have integrated voice within IP-based applications which present important new market opportunities.

The demand for broadband services is seen as a driver for economic growth enabling new business and consumer applications. Competition is key in enabling new services and markets to be realized and as a driver for technological change and operational management that will create new alliances and partnerships between the traditional carriers and service providers implementing IP-based applications. Whether viewed as convergence or transition, the traditional telephony world may eventually be replaced by a broad range of communications service providers addressing business and consumer markets with a diverse portfolio of IP-based applications including voice and video.

The impact of IP-based applications will be to significantly increase the volume of global network traffic. The benefit of IP-based voice applications is envisaged as being an enabler of new uses and business and consumer applications. The potential for IP-based voice as a cheaper alternative to traditional telephony is considered to be less important than the opportunity for the integration of voice in new IP-based applications that are considered drivers for broadband services. The potential to successfully exploit these opportunities will be best utilized by those traditional carriers that are most able to embrace the need to form new alliances and partnerships needed to bring these services to businesses and consumers.

Overview

Currently, there is a clearly discernable trend towards the use of Internet Protocol (IP)-based technology for the transmission of all types of telecommunication traffic including voice. These developments could have an important impact on the role and revenue sources of traditional telecommunication carriers. In such an environment it is also important that government policies and regulations adapt as necessary to keep pace with changes and ensure that markets continue to move toward a competitive environment. This paper provides an overview of these technological trends: their possible or potential economic and policy impact, and obstacles that may impede progress to the adoption of new technologies.

The impact of IP technology on the traditional telephony world will in the long run be to replace traditional voice services with integrated voice and IP-based applications. These will extend through messaging and e-commerce, supporting applications with which the traditional telephony network architectures cannot compete technically or economically.

However, Voice over IP-based (VoIP) applications are likely to be best implemented when they are used in opening new sources of revenue for service providers rather than as a means of competing directly against traditional telephony whose vast infrastructure is likely to co-exist and be interconnected to IP-based infrastructure for many years ahead. The greatest impact of IP-based voice services is seen in terms of the ability of content providers to offer integrated voice applications within the suite of services that they can offer their users including Instant Messaging (IM) for example, and for enterprises small and large that can expect to significantly leverage private and public network infrastructure that is able to integrate VoIP applications within e-Commerce applications. These applications would be supporting internal requirements as well as customer services. Thus voice applications can be anticipated to grow aggressively as they become increasingly integrated within IP-based applications. These applications will be increasing by accessed from a broad range of voice-enabled IP devices including desk and wireless phones, Personal Digital Assistants and set top boxes.

The potential for providers of voice-based applications for businesses and domestic consumers extends beyond traditional telephony carriers to include the cable network and satellite and fixed and mobile wireless operators. It is also possible that utility companies may be able to leverage deployment of fiber infrastructure to offer such integrated services either independently or as partners with content providers or other operators. Given the very large transmission capacity that is available to support new services there will be increasing emphasis to derive revenue from services that include voice as an integrated component of enhanced applications and services rather than from generating revenue through the traditional model of call origination/termination alone. This is perhaps especially so since the long term prospects for revenue from voice integrated applications are expected to grow aggressively in both the enterprise and consumer markets whereas the revenues from traditional telephony are anticipated to decline progressively over the same period.

Introduction

IP and Internet infrastructure together with broadband networking are at a key moment in their development. In 2001, the economy specifically impacted the technology sector and telecommunications in particular. While it is increasingly accepted that IP is the technology on which the next generation of telecommunications will be based there are challenges ahead. IP is itself at a crossroads. Although much modified, it has remained fundamentally unchanged as a protocol for two decades. A next generation IP protocol (IPv6) has been in the works since the early 1990s but the jury is still out as to whether it will be the successor to existing implementations of IP (IPv4) that have, at least in the short term, found ways round problems that the new version of the protocol was envisaged to solve such as address space exhaustion, quality of service (QOS) and security. In so doing, the character of the solutions has been drawn to the implementation of overlay networks to support, for example, voice services, Content Distribution, multicast, and VPNs. However, the growth of a large number of overlay networks is recognized for having severe problems of scale and interoperation between networks.

Thus the concerns for the future of IP must be focused on ensuring that the technical development of the protocol continues and that the management and governance of its implementation by the next generation of service providers across the world is rationalized. The general adoption of IP infrastructures by service providers to deliver voice, video, and Internet application services will need to be accompanied by a serious evaluation of the previously held assumptions for the technical development and management of the IP as envisaged by service providers world-wide and in the ability for IP to provide for business models that may offer viable alternatives to those of traditional telephony. The need for this 'reset' on previous assumptions has of course been mainly motivated and accelerated by the impact of the economy on the telecommunications sector in 2001. The outcome in 2002 will be shaped perhaps not by the traditional forces that have shaped IP in the past but by the next generation of service providers who are now seeking to embrace voice services in their product and service portfolios.

The Internet Protocol has offered a technically and economically superior path to the next generation of national and global communications infrastructure

At the time of the early deployment of commercial IP networks voice was king. It was the primary source of revenue for all telecommunications service providers. Though IP and Internet were attracting a lot of attention, in the beginning it was thought that Internet service providers would never be able to support voice services in a way that might challenge traditional telephony. There were, after all, not only technical issues in terms of the latency and reliability of the network but matters of billing, security, privacy and regulation. There was certainly something real about such views but at the same time the operators of traditional telephony infrastructure were very circumspect with respect to any interest in voice applications coming from their Internet groups. They may have suspected perhaps that the envisaged problems facing VoIP presented a double-edged sword - IP brought value but its potential impact on traditional telephony was not well anticipated.

IP was designed to support communication between different computers operating separate and independent operating systems. In the early 1990s the ability to deliver applications such as voice and video over IP were hampered by all sorts of limitations both technical and economic. Even so, it is quite a surprise to see that in five years voice applications over IP and more particularly the position of traditional telephony carriers towards IP-based voice services has spun completely around. The total volume of data traffic carried grew to surpass that of voice by the late 1990s. The story now of course, is that IP is the only way forward for voice and other applications for users; moreover, that it is a matter of time before all communications infrastructure has IP deployed in the core of the network. While it is unlikely that there

will be a convergence of IP and telephony networks there certainly has been progress in advancing the level of interoperability between furthering traditional telephony's decline. As an outcome of the ubiquity of telephony, it is probable that traditional telephony and new IP-based voice applications will coexist in a mixed infrastructure for many years ahead.

As the technical means to manage VoIP became more manageable in the late 1990s it was also apparent that the business of traditional telephony, especially long-distance voice, in the United States was no longer looking indefatigable. By the fall of 2001 the big three long-distance voice companies in the United States, AT&T, WorldCom Inc. and Sprint Corporation had all declared a desire to isolate their long distance voice business from the rest of their companies. These carriers are also amongst the best suited today to move services over to IP since they operate the very largest of the Internet backbone networks. Also AT&T and WorldCom were at the forefront in embracing IP for voice services exploring the specific opportunities that IP presented in delivering efficiencies that implementation of IP in the core network would bring to voice and other services. Qwest and Sprint have awarded contracts to Nortel to build IP-based infrastructure to replace legacy circuit switched technology for voice services over the next few years. Additionally, Cable & Wireless and Teleglobe have both implemented MPLS-based network infrastructure between Europe and North America which is ideally suited to supporting VoIP as have Equant.

In the relatively short period from 1995 – 2000 voice-over IP technology had been able to address issues of cost (both for switching and transport) and for performance (especially for latency in the network). These advances spawned a whole segment of the industry such as providers of VoIP services. At the same time traditional telephony carriers, having carefully calculated the risks and opportunities of IP, began to take advantage of the scale of their network infrastructure and subscriber bases. VoIP companies were launched to take advantage of arbitrage opportunities in competition with the traditional carriers but the cost benefits of VoIP were ones of scale over which the start-up VoIP companies could never gain advantage against the incumbent traditional telephony carriers. The revolutionary value of VoIP was seen in the performance and cost efficiencies of scale that are important mostly to the largest service operators and in the promise of the scope of new voice service features that could be supported. It is these services that challenge those of the traditional PSTN-based AIN.

Support for multiple applications including voice

The ability of IP to support voice and video and more particularly allow for its effective integration into web-based applications spurred the implementation of many new services that facilitated the development of e-commerce and gave rise to the opportunity for VoIP telephony. However, while the VoIP companies focused on leveraging arbitrage opportunities - mostly in international long-distance services, the features and applications development associated with IP-based voice spawned a broad range of companies targeting the sale of these services to ISPs. The approach for these companies was to provide for the means to integrate with the traditional telephony infrastructure [through the use of H.323 and/or SIP protocol gateways] and to provide the means for ISPs to sell IP-enhanced voice services directly and as an outsourced service to operators including CLECs, ILECs and Internet service providers[1].

The focus of this approach was to provide ways by which Internet service providers could enhance their service offerings to gain competitive advantages. However, it was never clear that Internet users were prepared to pay for such enhanced services directly. Developers of enhanced applications were more often positioned to offer platforms for deployment by ISPs though some were launched as managed service offerings. Most often voice enhancements were presented as extensions to existing applications such as e-mail. Service providers seeking to offer managed e-mail services with integrated voice messaging and fax and paging capabilities sought to challenge the base of traditional telephony which of course was managing very large user bases whose voicemail services were not able to be integrated with IP services. Although

the development of enhanced IP-based voice applications gained very significant user awareness, traditional telephony service operators were never able to reconcile the cannibalisation of existing PSTN voice features. Additionally, the IP-based voice features were not charged for on a feature-by-feature basis as was the case for the PSTN-based AIN.

Though there remained significant issues of scaling for IP-based enhanced voice services, some service providers were quite successful in providing these services as an out-sourced service to wireless operators and to CLECs targeting the small to medium-sized business market. Surprisingly perhaps, the most significant impact of IP-based voice services was their inclusion in the applications provided by Content Delivery Networks to their users. Thus the inclusion of voice (telephony) applications within the web browser-based applications of content service providers including Instant Messaging (IM) have been aggressively pursued. This integration has also facilitated a simpler user management of voice and other messaging. Additionally, IP-based applications are accessible and manageable by the user across the entire geography of the network regardless of where the application is deployed. This has the effect of affording the user 'local' access to services regardless of whether they are at home, work or in another city or country.

At the same time the large to medium enterprise market has been very attracted to implementing IP-based voice to replace previous PBX systems motivated by significant cost savings as well as improved functionality. The combined impact of the drive by enterprises to replace traditional telephony-based services with IP and that of content providers to integrate voice over IP applications is probably the most significant area of likely impact on traditional telephony in the near term.

Costs compared: Is IP really much cheaper than traditional telephony?

For traditional telephony carriers who have already invested significantly in switched voice the attraction of VoIP is not only that it can be a less expensive alternative. When the overall costs are compared between the two they are essentially similar as measured in fractions of cents per minute. However, these costs can be cheaper for a reseller and can be much cheaper when leveraged for arbitrage circumventing monopolies and regulations. But the opportunities for arbitrage are limited and considered to be diminishing. In fact no competitive threat to traditional telephony carriers has emerged from the flurry of IP telephony companies that emerged to exploit the arbitrage opportunities and the threat to traditional carriers from IP telephony is probably not the place where IP-based voice applications will have their most significant impact. In comparing the cost of transport between the PSTN and VoIP, significant cost elements that can be compared are comprised of: the CPE, access; switching and transmission. For traditional carriers the CPE costs of the PSTN have already been written down and are thus treated as negligible or zero.

While the costs of CPE are significant and may apply exclusively to VoIP, advantages accrue to VoIP in switching, transmission, and access. The implications for the vendors of VoIP CPE are clearly to reduce prices particularly to the enterprise marketplace and these trends are apparent. One of the most commonly cited obstacles to the early adoption of VoIP solutions by large enterprises is the initial capital costs of equipment and the lack of flexibility in terms of leveraging existing analog infrastructure such as lines used for fax and analog phones. For carriers comparable concerns regarding initial equipment costs together with standards issues have impacted the pace at with VoIP might have otherwise been implemented. While the performance and costs of optical transmission and switching is very impressive it remains important for carriers to consider compression for voice applications in addition to super fast transmission. Transmission is the smallest cost component of voice, and the savings from IP in relation to transport alone are very small. These are generally improved only where there are arbitrage opportunities. Small savings, however, can be very important for carriers since they handle very large call volumes running to hundreds of

millions of minutes a day. In these circumstances a fraction of a penny can represent meaningful savings. For all but the largest carriers this type of cost saving has much less value. In conclusion, the promise of IP-based voice is in its potential to better support new features and to be more flexibly integrated within new applications than traditional telephony.

Is IP-based voice the next "killer app?"

There have been too many claims of killer applications and no real appearance of any single application that might fit the description for IP-based voice. It is more likely that the 'killer application' effect will be brought about by the diversity of applications that are being developed and more particularly the ability to make these applications easier and more intuitive to use than has been possible with the feature sets of traditional telephony. The integration of these IP-based voice features into other IP-based applications in web environments may also foster improved means for collaboration and interaction further spurring their use[2].

These applications are likely to be defined in a manner that allows individual users to easily create a personal profile of features specific to their needs. Thus the defined set would be different for each end user. This approach, when integrated with web architectures, allows features and applications to be provided from multiple sources integrated by the user or defined by the user's work environment. The subset features that would best apply to a specific industry, for example, will vary by industry sector, company, department, and by individual. These subsets need to be easily managed and new features and applications must be able to be readily integrated to meet the specific needs of the environment in which they will be used. The flexibility and ease of use offered by this IP-based approach cannot be matched by the traditional PSTN AIM-based features.

IP-based voice applications also take advantage of softswitch technology that allows voice traffic to move over a packet network using IP. Softswitch technology has already introduced a number of new voice applications and services. Because these are IP-based they may be readily extended combined or integrated which will allow for the creation of a large and flexible range of applications to suit a very wide variety of market requirements.

The new IP-based voice applications include:

PC Conferencing:

Web-based user interface for IP-based conference calling managed from the PC desktop/laptop for up to 100 participants. Features can include text file sharing and individual instant messaging (IM) "asides" during group sessions.

Unified Communications:

The integration of e-mail, fax, voicemail, paging enhanced by one or more of the features above such as PVA. The management of these communications by a web-based user interface.

Find-Me-Follow-Me (Personal Virtual Assistant):

A real-time voice service that can forward IP-based voice calls as well as e-mail to the user at any network location. User has a web interface for management in addition to speech recognition based voice management.

The above applications are aimed at improving the ability of a user to manage their communications from voice, e-mail, fax, *etc*. as well as facilitate improved collaboration. Other applications are designed to facilitate more flexible interaction between a company and their customer base using for example:

Voice-Enabled e-Commerce:

> "Push to talk" or "click to call me back" features that voice-enable web sites. These services make real-time voice contact with a call center representative possible while the customer is online via one connection.

Voice-Activated Web Content:

> Voice activated access to select web content through a traditional telephone or wireless handset. By using simple spoken key words, callers are prompted through "verbal menus" to obtain driving directions, travel information, news, sports, stock quotes and business locations, to name a few.

Additionally, there are features that simply improve the functionality of phone services such as the ability to provide a:

Virtual Second Line:

> The ability to make outgoing IP calls from the PC as well as receive voicemail, faxes, call waiting notification and caller ID notification all via one telephone line.

Voice Activated Dialer:

> A device-independent network-based address book activated by the user from anywhere in the world, via any device.

Internet Call Waiting:

> A service that notifies users while online when someone is trying to call – complete with caller ID information and a choice of options on how to respond.

Mobile Internet Applications

Perhaps the area of most significant future impact is that associated with mobility. As wireless operators move forward to deploy networks that are better able to support IP, more applications are likely to emerge that extend the integration of web and voice-based features. Amongst many different applications piloted by mobile operators and services offered to users of PDA's that support wireless internet access are a wide range of portal-based services[3]. The next generation of wireless handsets and handheld devices have been IP-enabled and are much better suited to support portal and other Internet services as well as voice applications. Roaming access, SMS, pager and notification, e-mail, fax and voicemail integrated within handheld devices hold significant promise for both consumer and enterprise markets. Indeed, the newest PDA's launched by Palm, HandSpring and others have integrated both wireless access and voice services.

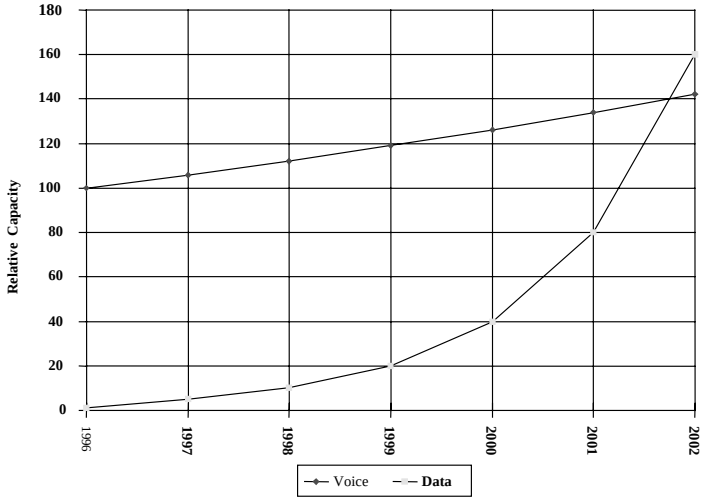
Another important aspect of the integration of IP-based services in such devices is the ability for the user to manage their service and for the provider to extend individual customer care. Portal-based service offerings are well suited to extending services specific to groups of users and to offering localized information which is considered likely to further stimulate the use of the handset or handheld.

Mobile IP-based voice applications integrated with portal services designed to be specifically tailored by the user to their own preferences are combined with an ease of use and manageability. The higher the degree of control the user may have over their communication environment the better. Near term mobile applications including voice portals, text-to-speech, even video conferencing may include voice services that are integrated to the traditional telephony infrastructure. Mobile IP-based devices will in the future be able to support user requests for information such as, Where am I? (GPS); what are my appointments for the afternoon? How do I get there from here? For the future, mobile devices that have the ability to support a broad range of web and voice applications are anticipated to be extensively based on IP infrastructure.

What were the alternatives to IP?

The plan by the US carrier Sprint to integrate IP-based services with a broadband infrastructure based on ATM in its ION project was perhaps the most visible effort to sustain a traditional carrier infrastructure to support traditional voice and IP-based services. Ultimately, costs and technical inadequacies forced Sprint to abandon the plan[4]. WorldCom is decommissioning its X.25 packet network and is in the process of consolidating its IP network infrastructure having previously announced that it would base its future network architecture on IP. Though carriers such as AT&T and Qwest (through its merger with US West) have substantial traditional telephony infrastructure they have similarly based their future direction on IP. Although some carriers continue to place significance on the options to converge their traditional voice and data infrastructures the impact of the economic downturn through 2000 and their resulting desire to slow capital expenditures has impacted the potential value of convergence solutions. However, these conditions have equally delayed plans to move towards an IP-based infrastructure to support voice. Some carriers such as Level 3 Communications have had the opportunity to plan and rollout an IP-based infrastructure from the outset but were similarly faced with the need to support voice services from the traditional infrastructure. While the approaches to leverage Frame Relay and ATM network infrastructure to support traditional voice as well as IP-based services was explored extensively at first the costs and technical complexity of such plans as illustrated by Sprint's ION have generally moved operators towards consideration of transitioning directly to IP.

Figure 1. Voice and IP traffic growth compared for a typical US carrier



Source: WorldCom.

What has happened to VoIP?

Starting from PC-to-PC and PC-to-phone/phone-to-PC implementations VoIP has transitioned from novelty to mainstream. This transition was accomplished aggressively in the mid-1990s as equipment vendors provided VoIP gateways to allow phone-to-phone calls to be made over IP infrastructure. However, the end users of these services were rarely able to take advantage of IP-based voice features. While VoIP operators sought to promote their services with integrated e-mail and voicemail, *etc.* both enterprise and consumer markets responded unevenly. This was assumed to be from a lack of understanding of the value of the features combined with an unwillingness to pay for them in addition to the basic VoIP service. Most VoIP operators saw that the market differentiation VoIP needed was in IP-based features but they were unable to gain early traction with such services in the enterprise market or with content providers. Content providers such as Yahoo! Inc.! Inc., AOL and MSN saw early the value of integrating VoIP within services such as Instant Messaging but these services have been largely integrated as a purchase option for the user. While in the enterprise markets VoIP was viewed primarily as a lower cost telephony option and the lack of an internal VoIP environment within the enterprise, with IP-enabled phones for example, slowed the initial adoption. Large enterprises resisted the large capital outlay associated with deploying internal VoIP infrastructure particularly while open questions remained regarding the protocol standards that would be implemented to permit leveraging existing analog phones and faxes.

The development of web embedded voice applications for messaging/instant messaging, e-mail/fax/voicemail combined with the delivery of these applications to mobile phones and handheld devices took place has proceeded at a significant pace. There are millions of subscribers to IM services who are becoming increasingly familiarized with voice features integrated into these applications. Companies such as Openwave and Comverse have focused on the carrier and service provider market for integrated messaging including voice-based IP applications. Equally the push in softswitch technology and the improved performance and price of VoIP equipment for the enterprise market has begun at a time when a clear direction has emerged for a gateway protocol between the IP and traditional telephony world.

What became of the VoIP companies?

Although many start-ups entered the VoIP business, most based their business model on arbitrage of international long-distance telephony minutes. Some sought to build VoIP networks and soon realized that publicly available Internet infrastructure was inadequate to support services. The capital costs of deploying dedicated infrastructure in terms of the equipment and capacity required soon began to undermine early optimism regarding the viability of the business model. Other companies established ‘clearing house’ business models whereby route minutes could be traded between interconnected partners. After a short period both those that had pursued the build-out of VoIP networks and those that had established clearing house models appeared to overlap in their pursuit of essentially the same target market, smaller service providers seeking to generate revenue from VoIP-based international long-distance services. As was anticipated the arbitrage market ran out of space and time in terms of establishing profitability and all suffered severe financial constraints or bankruptcy. The markets, appropriately perhaps, presented dismal evaluations of the sector as it collapsed and consolidated as dramatically as it had burst forth.

Instead of emerging as competitors to the traditional telephony world, the VoIP service providers have adapted to become a facilities-based outsource for them. Rather than building international VoIP infrastructure a number of traditional telephony carriers have reached commercial arrangements with VoIP operators to carry traditional telephony minutes for international long-distance traffic. These arrangements are generally thought to be sought for arbitrage and by pass of international accounting rate settlements.

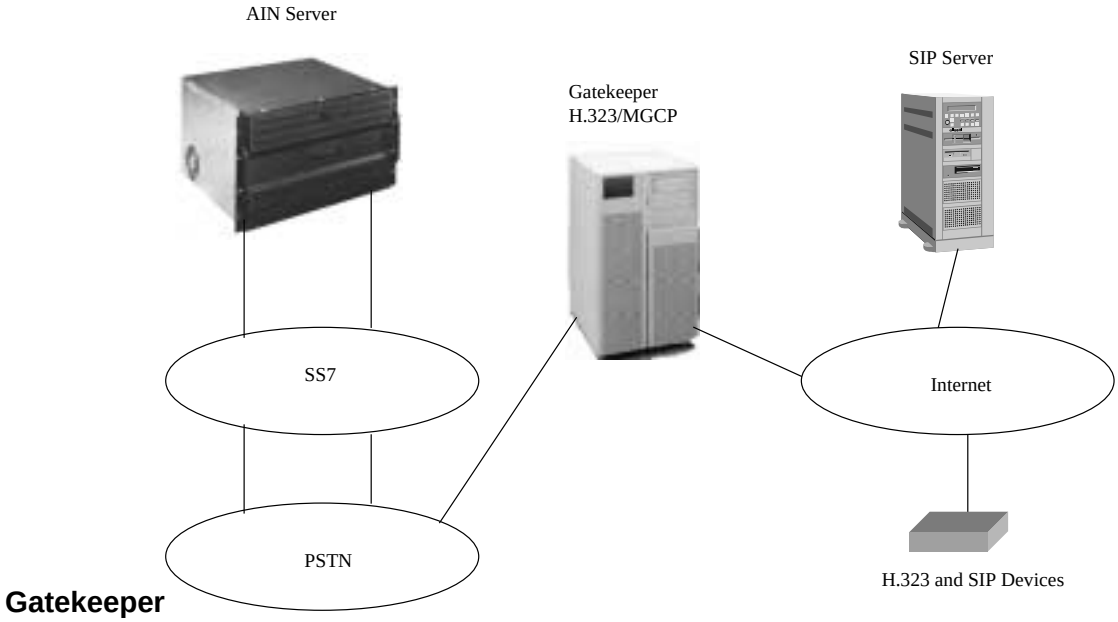
This business model is not very different from that of VoIP clearing houses, a couple of which were established with large international carriers such as AT&T [with GRIC] and Telia. Others such as ITXC have operated as largely independent brokers for traditional telephony carriers and VoIP networks.

Gateway protocols: H.323; MGCP; SIP

To enable IP networks to interoperate with the traditional PSTN infrastructure equipment vendors support the widely used H.323 protocol but also have proprietary implementations such as Cisco's Skinny Client Control Protocol (SCCP). IP-based voices appliances can support H.323, Media Gateway Control Protocol and Session Initiation Protocol (SIP). Of these, SIP has emerged as the favored protocol for both enterprises and service providers. SIP is better suited to supporting IP-based voice applications including conferencing for example, and providing for fully integrated voice, e-mail, and web-based applications. SIP originated out of the IETF and is compliant with other IP protocols such as HTTP allowing for ease of integration with web-based applications. H.323 is an ITU-originated protocol that was developed from ISDN-based videoconferencing standards and was adapted to accommodate voice-over IP. Additionally, SIP is an open standard which adds to its potential value for future voice-over IP applications.

After initial contention between H.322, MGCP, and SIP as to which would be the protocol of choice, most equipment vendors are offering products that would support all three. In the future it is projected that there will be a clear preference and dominance of SIP over the others for both service provider and enterprise markets. Gateway protocols are needed to allow operators and enterprises to leverage existing PSTN infrastructure. The advantages of implementing VoIP for enterprises for example have to be balanced against the capital cost of the equipment (which has been coming down fast) and the need to make use of existing analog lines and fax machines - part of the traditional infrastructure[5]. Softswitch architecture based on either H.323 or SIP also enables integration with existing analog infrastructure rather than requiring a forklift solution to an IP-based voice infrastructure.

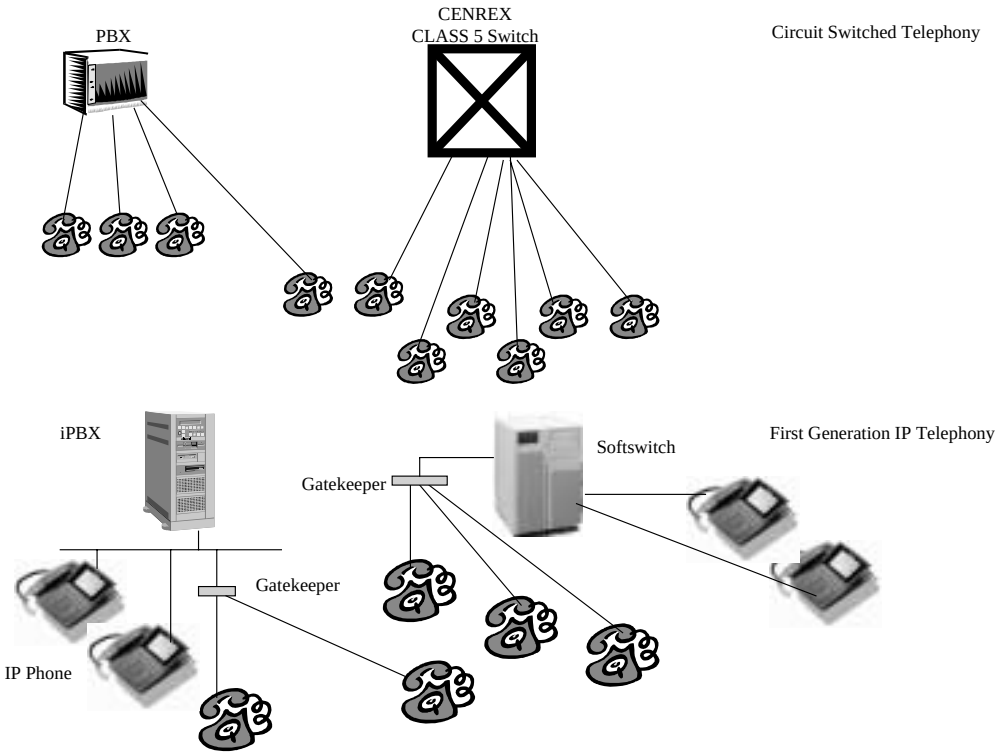
Figure 2. Existing PSTN/AIN and Internet with



Why and when did IP networks become the preferred path to replace existing circuit-switched infrastructure?

In the mid to late 1990s, as the rate of growth of Internet traffic volume grew to surpass that of voice, the attention of traditional carriers focused more attention on network architectures that would be IP-based. As discussed, the impact of IP was not perceived as directly affecting traditional voice. Broadband services were beginning to be rolled out, though. Where they were bundled with voice services, those services were traditional rather than IP-based voice applications. While the development of a broad range of IP-based voice applications was taking place the acceptance of VoIP solutions in enterprises was impeded by the high initial capital cost of the equipment and the lack of implementation of gateway protocols to allow integration of the VoIP with legacy traditional telephony. For carriers, early interest in VoIP focused on the potential to manage the benefits of scale from the small savings that were to be gained by utilizing VoIP. These benefits were maximized in international long distance telephony where opportunities for arbitrage added an additional incentive.

Figure 3. Circuit switched and IP telephony compared



While the implementation of IP-based voice infrastructure was narrowly confined in large carriers, where opportunities were available to build anew, these networks chose IP at the outset. Thus in the United States at least Level 3, Qwest and others have set the precedent for the implementation of IP-based network infrastructure for voice that will be followed as the phasing down of legacy infrastructure permits for the other carriers. The deployment of broadband services with bundled Internet access and telephony services as well as television has spurred interest in IP-based voice. While many existing voice offerings that are bundled in broadband services are traditionally telephony-based, the Internet access service also provides the user the ability to explore IP-based voice offerings that have been integrated with the applications of content providers. Thus carriers having first considered adapting traditional infrastructure to manage telephony and IP over an ATM-based network for example, have in general abandoned these approaches in favor of directly implementing IP-based technology. In part because the traditional approach is frequently

less than satisfactory technically and economically, and that emerging competitors would otherwise gain benefits from being able to deploy IP-based infrastructure from the start. As broadband services gain acceptance in consumer markets, there are likely to be many new challenges for the traditional telephony world since a very broad array of voice applications will be integrated within web-based applications for users. However, there remains a transitional period that is needed to allow IP voice-enabled phones, hand held devices and appliances including gaming/TV set top boxes to extend the accessibility of these applications beyond PCs for the user.

What happens next?

The direct impact of IP on traditional voice telephony as gauged by a comparison of traffic volume is very small. Estimates of the total VoIP traffic for 2000 amount to less than 10% of the traditional telephony total[6] The more meaningful impact of IP has been in the manner by which it is able to support future services. The drive to offer these services is resisted by some traditional operators because they are seen as accelerating the erosion of traditional telephony revenue. Perhaps they perceive the enormous new revenue potential from broadband services as achievable together with traditional telephony. Also, for large enterprises and operators the capital cost of the initial equipment deployments for VoIP have been large, too large to encourage early adoption on a large scale and both operators and large enterprises have been waiting for the establishment of open standards that enable the integration of IP infrastructure with the PSTN. These are standards such as the four implementations of H.323, MGCP and SIP. But equally, IP service providers themselves have been unable to settle out issues of IP QOS that would permit the support of voice, video and data services through, for example, implementation of protocols such as MPLS.

In the United States, rollout of DSL-based broadband services over the past two years was focused on high speed Internet access. Many small to medium Internet service providers were anxious to add DSL-based access services and large numbers became resellers of the national level DSL networks such as NorthPoint and COVAD. Some large Tier 1 ISPs such as PSI also placed considerable emphasis on DSL-based services as a means of serving small to medium-sized business customers. These service rollouts were planning to address the undoubtedly significant demand for broadband services in both consumer and business markets.

In Asia, Korea, Japan and Hong Kong have been amongst the most significant countries to rollout of broadband services and the Gartner Group has estimated a near doubling of the subscriber base from 2.5 in 2000 to 4.8 million at the end of 2001. This base covered China, India, Singapore, Hong Kong, the Philippines, Thailand, South Korea, Indonesia, Australia and Malaysia. European rollout has been hampered by the slowness of incumbents to unbundle local loops and more recently through general economic pressures on service providers[7].

In spite of the technical and regulatory difficulties that have been apparent in the rollout of broadband services internationally, the demand for services is strong. Competition for broadband services will likely take place between the traditional telephony carriers, cable, satellite and Internet service providers. Interestingly, while initial bundled service offerings from cable TV companies were limited to TV and high speed Internet access, they are increasingly able to include local phone service more cheaply than the former local service monopolies of the traditional carriers. Thus in the future the traditional telephony operators face very significant competition from cable operators and content providers. Additionally, the major content providers such as AOL and MSN are equally moving towards broadband access service offerings including cable and DSL and like AOL and Yahoo! Inc. has made alliances with VoIP operators. These service providers unlike the traditional telephony carriers are not burdened with legacy telephony infrastructure. As a result they are perhaps better positioned to respond to broadband market requirements

because they also aggressively pursue alliances and business relationships with entrepreneurial Internet business for both services and technology.

The next area of service development for operators will be to seek to offer better integration between bundled services and to focus on ease of use. At present most bundled services are offered as separate with little or no direct integration between the telephony and Internet messaging, for example. Equally, the availability of business-related applications such as conferencing managed from a PC by the user are offered mostly by independent application service providers rather than from within the suite of services offered by the access operator.

Perhaps of highest importance is the implementation of web-based service creation and management environments for the user to be able to selectively define the range of services specific to their individual requirements. However, traditional telephony-enhanced features are not amenable to integration within web applications and many providers have in their initial bundled offerings sought to offer competitive voice services based on telephony rather than to rollout VoIP-based applications. This approach as also allowed operators to manage these services through existing pricing models bundled for multiple services such as telephony, Internet access, e-mail, web hosting and television.

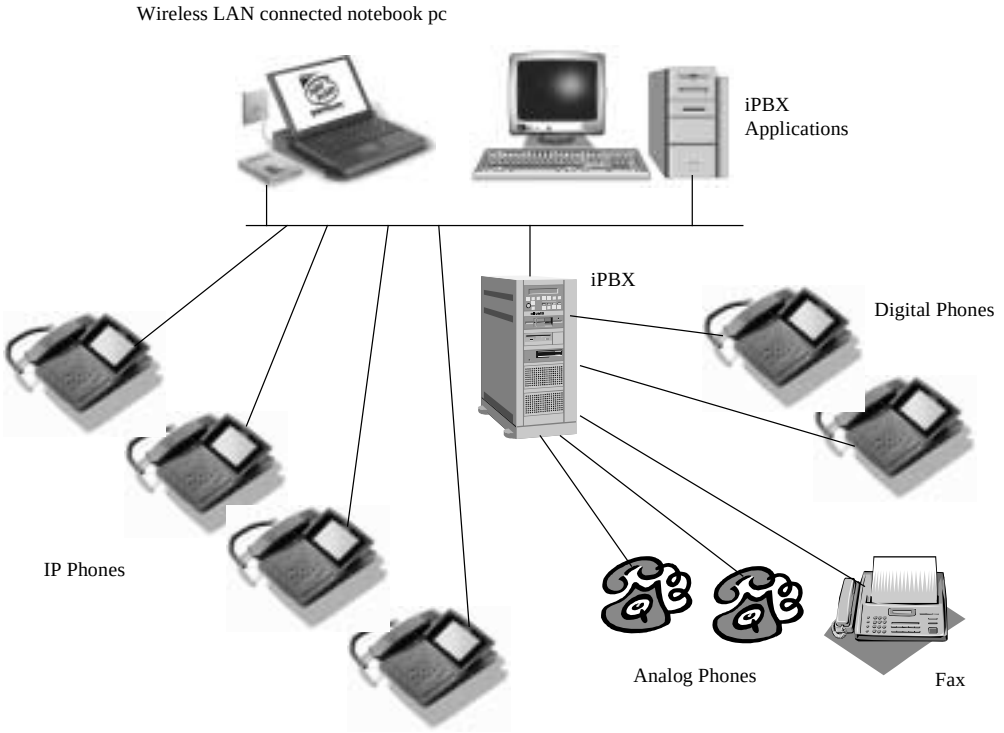
While this approach is perhaps an appropriate initial step for the consumer market it does not address the requirements for businesses and large enterprises who seek to develop a more direct integration of their IP-based services with VoIP and to leverage legacy telephony infrastructure. To deal with this issue service providers will need to provide a means by with users may directly interact with the set up and management of the available feature set. This implicitly requires that the selection of features by a user from those available is natural and intuitive. For a user to be able to easily define, add and remove features requires open API's as these will need to be utilized by third party developers. Service providers themselves will need to be open to collaboration with smaller third party developers for feature and application development through partnering agreements that are common for example in the software industry notably in this instance for PDA's.

By making these features more accessible to the user there is a stronger probability that their use is likely to be increased. It is widely considered that the Soft PBX is best positioned to deliver these requirements to the business and large enterprise markets as Soft PBX technology can be used to provide Centrex services. Thus the impact of IP-based voice can be expected to take place through phases that initially include cheaper transport then through functionality which is independent of transport considerations. Thus the functionality of PSTN AIN will be initially leveraged by iPBX technology that can be used to manage Centrex functionality but eventually replaced by features that are IP-based that are able to be integrated into a broad range of IP-based applications[8].

Increasingly, IP telephony devices are able to take advantage of new features in the device, such as screens, keyboards, higher quality codecs, and speech recognition to take advantage of the performance and price benefits of a native IP network. IPBX-based approaches may offer the best initial path to allow users to initiate calls qualified by purposes such as:

> Find Sam anywhere.
>
> Find Sam anywhere but at home.
>
> Find Sam's voicemail directly, I don't need to speak with him – I just want to leave a message at this time.
>
> Call Sam's administrative assistant.
>
> Find the nearest multimedia station to Sam and send him there so we can conference.

Figure 4. iPBX functionality



Managing multiple identities and IP-based directory and information services and security

Another area of interest will be in the management of multiple identities for users based on their e-mail, office, mobile, pager, fax and physical locations such as home and office. While proposals such as ENUM have been suggested as a possible solution, applications such as IM are already integrating e-mail, voice/voicemail, fax and paging. Additionally, the user base of IM is already very substantial and is continuing to grow aggressively. While, problems remain in establishing standards to allow different proprietary IM systems to interconnect with each other, there are undoubtedly important new areas opening for the establishment of directory and information services based on IP that will be based on web interaction by the user and have global accessibility. There is a significant interest in developing IM applications for business uses which would require security that is presently not adequately managed in currently available consumer applications. Security concerns also impact public e-mail services especially with the broad consumer acceptance of web-based e-mail. Issues impacting the protection of personal privacy and security of communications including voice, e-mail, and the global management of identities with directory services are for the most part areas not yet adequately addressed. The pressure to do so can only increase as these applications become as pervasive in use by domestic and business users.

Access

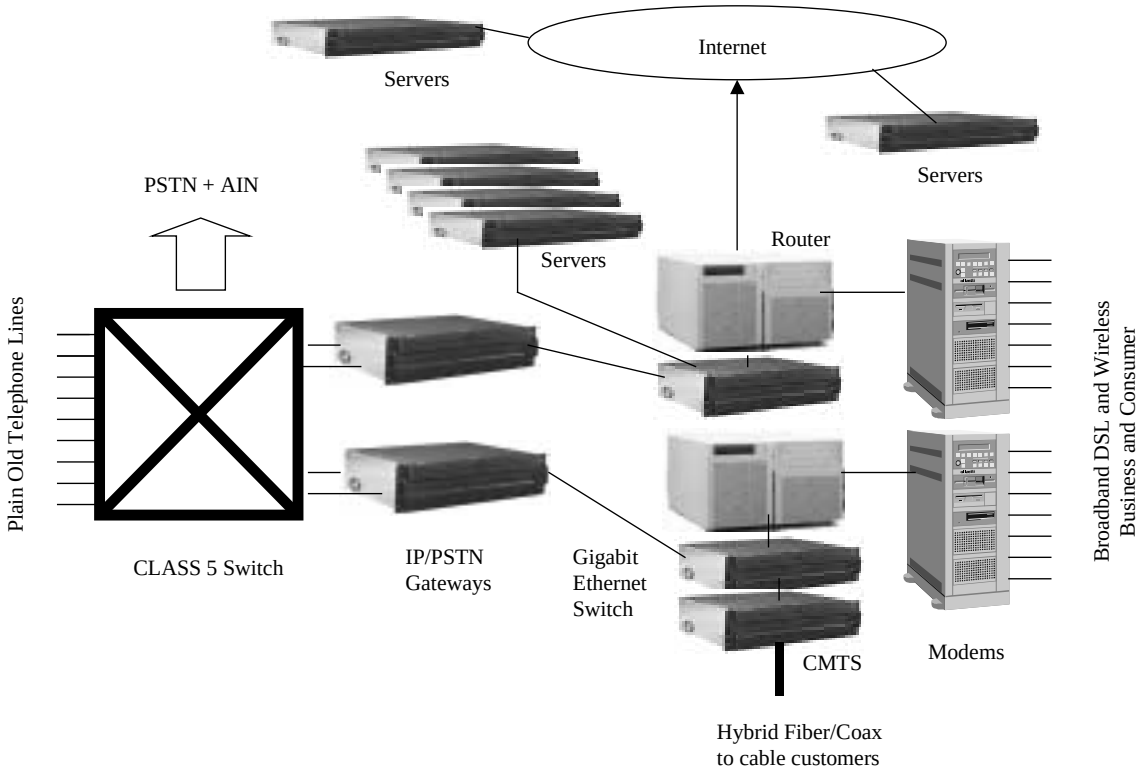
Internet transit

A consequence of the falling price for bandwidth is the tremendous opportunity for ISPs to cut access costs since they will be able to obtain backbone capacity and metropolitan area access far more cheaply. A recent study by McKinsey shows that ten years of price competition in voice has been compressed into

three years for Internet prices. There will be a continued downward trend in Internet access capacity pricing which depending on the route may be extraordinarily aggressive. For example, a contract price for an OC-3 from New York to Los Angeles for 2002 was reported to have been cut 90% in a quarter! With estimates suggesting that available capacity is doubling every ten months, the prices for bandwidth transport are still falling at a projected 80% per year. In the United States there are roughly 14 facilities-based long haul carriers. But it is estimated that only 3% of their fiber is lit and only 5% of the lit capacity is actually being used thus far.

Carriers and network service companies have in the past not been particularly successful in aggregating service value around content. By contrast content providers have been very successful channels for the re-sale of voice and access services. The challenge for the carriers is to manage the very high volume but low margin Internet transit business in a manner that permits them to leverage the ability of other service providers to bundle services including voice in broadband service packages. While it is widely accepted that bandwidth is a commodity and that higher quality of service is required to support the demand for future services, these services will require capital expenditure to transition and upgrade them to be able to manage voice and Internet services. This expenditure is constrained by the current economic climate.

Figure 5. The broadband-based central office



Local/metropolitan access

Thus the major incentive to enter into the broadband services market is conditioned by the ability of service providers to manage local access issues. In this context another major trend – the availability of wide area high speed Ethernet - is likely to be of growing importance. With the Ethernet standard, the Local Area Network (LAN) normally confined to the premise of a user is becoming transparent to the Wide Area Network (WAN). The extension of LAN with Ethernet frames at high speeds over wide areas enables high quality, reasonable cost voice, videoconferencing, streaming media, and other useful business

applications such as remote storage and mirroring. Wide Area high speed Ethernet also enables peer-to-peer computing and data sharing that is projected to be of importance in future e-commerce and business applications. While the Tier 1 ISPs and carriers, the so-called "heavy haul" operators, have challenges in managing the future of the transit business because of falling capacity prices, they are also well positioned to leverage new wide area Ethernet technology to offer IP-based voice, video and other services to business and large enterprise customers that represent both the early adopters and the potentially most lucrative revenue stream for broadband services.

What is driving the demand for DSL service?

DSL access, though initially touted to significantly improve the end user experience for web applications, has gathered broader appeal for the residential consumer market especially when bundled with voice and cable services. The costs of local and long distance voice are generally much lower in such bundled service offerings sometimes dropping the local telephony costs by a third for residential users in the United States. Additionally, the convenience of having always-on Internet access without tying up a phone line and eliminating repetitive logons improves the use of all services. Additionally, many operators offer their users a web site from which they can review and manage the services including billing. Thus it is widely perceived that the demand for DSL access is controlled primarily by the ability of service operators to implement local loops to the user. Where this is difficult or delayed, the opportunity for alternatives such as cable or satellite is significantly improved. Additionally, both cable and satellite services are actively sold through retail channels and these gain penetration irrespective of voice services which are not supported by satellite service offerings. It is conceivable that in the future service offerings including Wireless Local Loop will extend the introduction of the LAN to homes and Small Office Home Office (SOHO) as well as small business branch offices. This introduction would in turn spur the demand for IP-based voice, video, and business applications further driving use of the network. Large enterprise users need their subsidiary business and customer relationships to have access to the range of IP-based services that they intend to implement for sales management, customer relations, *etc.* Thus there is a related incentive for large enterprises to encourage suppliers, distributors and customers to adopt broadband services.

Is Voice over IP a broadband driver?

Broadband access permits the introduction of business orientated-IP applications that support voice that may also leverage existing telephony equipment through the use of iPBXes. This approach significantly increases the scope and flexibility and ease of use of the features and services that can be managed. Centrex-based voice is complex and associated with a feature by feature charge that is not readily managed by the user. By being Internet-based there is an opportunity to provide the user with access to a secure web page to permit the user to define and change the feature set they wish to use. By permitting the user to make changes on their schedule and without fees, the utility of the feature set is likely to be considerably more user friendly, more manageable from a cost perspective and therefore more likely to be used. Additionally, Centrex offers uniform services only for a specific location across whereas an enhanced iPBX being IP-based can offer uniform services world-wide. For SOHO and small business markets the key advantages of broadband are likely to be perceived in the ability to install and operate low cost iPBXes to leverage and extend existing voice services in addition to providing improved IP-based services. The key features that are associated with iPBXes include:

User interface

Centrex generally offers tone input with voice answerback which has its limitations. Deep IVRs (Interactive Voice Response) are universally hated. While speech recognition offers a solution to this problem and is implemented in Centres and iPBX there remain some technical constraints such as background noise filtering and the ability to scale that will need to be overcome before widespread adoption. The ability to introduce IP phones with displays offers a significantly improved user interface over current desktop handsets. Web-based user interfaces on PCs also permit better management of stored phone and fax numbers, paging and voicemail.

Easier to use

There is a widely seen need to improve the usability of the PBX that is more readily addressed by iPBXes than Centres-based systems. This would make it possible, for example, for any user to intuitively use the phones to transfer a call, conference, etc. With Centrex these features are enabled by a sequence of key strokes that are not usually intuitive or consistent from one system to the next. Centrex also has no help screen.

Provide help

The proprietary approach of Centrex-based PBXes locks users into specific vendor systems. Thus it is difficult to generate approaches to intuitive use of features across systems that may be supported by broad-based help systems that might otherwise be developed by third parties. IP-based systems are more usually developed with help functionality which has a common search pattern that users generally find easy to use.

The driver for DSL in the residential market is perhaps the attraction of lower cost voice with always-on Internet access or a service bundle that may also include cable TV. For SOHO and small businesses that have local and/or regional branch offices, voice and the ability to implement iPBX to better leverage existing telephony infrastructure are very important.

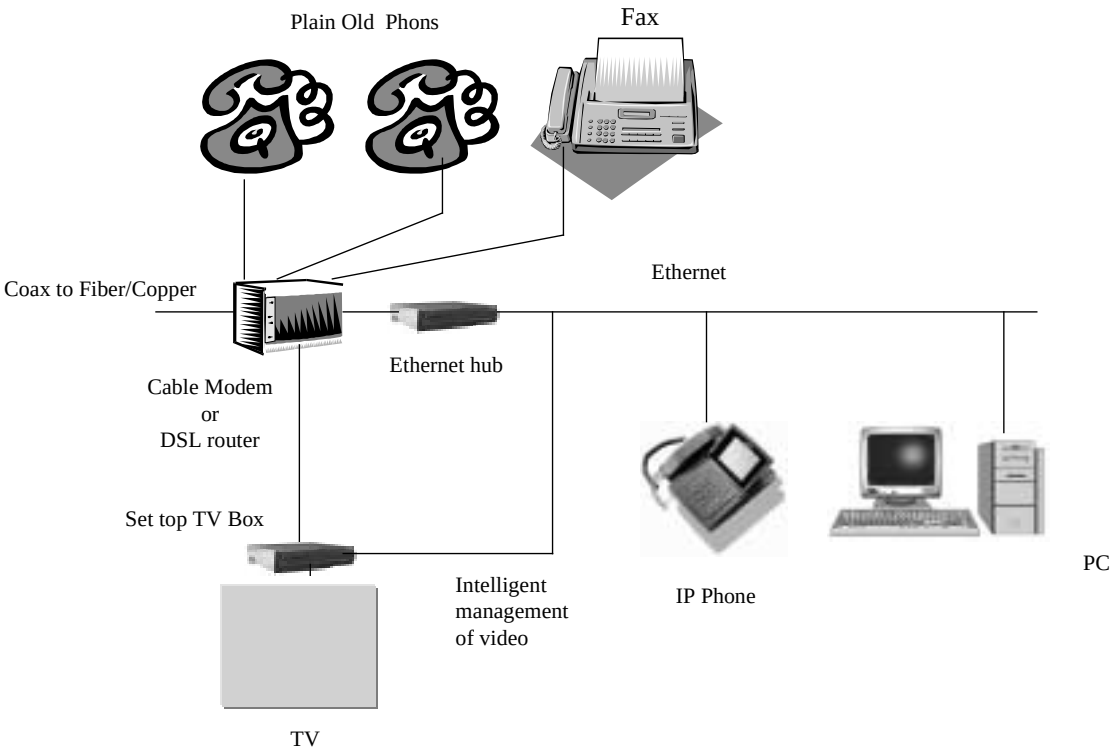
Web applications supporting audio and video

The HTTP protocol, the foundation of web-based applications, represents perhaps the most successful applications environment in software history. The Web is a distributed architecture permitting many intelligent services to be located anywhere on the Net and to be accessible from anywhere. Access is managed through a browser-based client device (IP-enabled phone, PDA, desktop PC or other Internet appliance.) The client device, not the server, both initiates and manages all communications with the server. When a user accesses an application, a client device pulls content in the form of HTML and applications such as Java, Flash and Active X from the server and runs them on the client device.

The distributed service model of the Web is exactly the opposite of the centralized approach of telephony. Not only do the services come from different servers, they may be provided by different and multiple service providers. Typical examples are content provider news, information and entertainment services, IM services, as well as e-commerce providers that integrate independent subsidiary suppliers. Equally, enterprise applications can be offered by Applications Service Providers (ASPs) delivering individual solutions such as Customer Relations Management (CRM), Sales Force Automation, (SFA), Enterprise Resource Planning (ERP) etc. This permits service providers or large enterprises to outsource as many or as few specific services as best fits their business model.

Traditional telephony infrastructure cannot support the integration of voice and video applications as flexibly as they can be handled when developed within IP. For example, IP-based videoconferencing is the basis for collaborative applications to include shared whiteboard, shared applications etc. Ease of use and management of these applications by the user stimulates demand and improves overall productivity of the individual. They provide for better preparation for meetings and perhaps a more efficient use of travel time.

Figure 6. The broadband-based customer premise



The increasing availability of these applications is likely to bring about an overall growth in the usage of communications but it does sideline traditional telephony from the key sources of future revenue that are represented by these services. Traditional telephony simply cannot compete with these IP-based voice and video services which are near term opportunities for service providers. The core components of telephony – the handset, PBX, the Central Office Switch and the switching network are legacy infrastructures to be managed through the transition to IP-based services. The architecture of the telephony network with PBX, Custom Local Area Signalling Services (CLASS) switches providing Centrex and enhanced service features such as call waiting, call forwarding, caller ID, call blocking, etc. are unable to meet the requirements of contemporary business or residential needs. Importantly, the architecture of dumb handsets/terminals, PBXs and CLASS switches imposes solutions are complex for users and administrators alike. However, the ubiquity of traditional telephony necessitates that future voice and video services must allow the user to make and receive calls with traditional phones though integrating this facility via an IP-based appliance for seamlessly managing traditional telephony with new IP-based applications including VoIP.

DSL for the support of traditional voice applications and Internet

Most bundled voice and Internet services offered are integrating traditional telephony with Internet access. Some residential offerings include cable television. There is a substantial interest to stimulate small and medium-sized business implementation of DSL-based services including bundled service offerings for traditional voice. Thus the incentive for traditional telephony carriers to aggressively roll out DSL services is rising as price competition against cable operators for bundled services gathers momentum. However, in the United States the incumbent local exchange carriers appear to be seeking to manage the demand for DSL services directly to residential and small business users against the need to manage onward revenues from traditional voice. While this may restrain the ability for independent service providers to offer or re-sell DSL services from the LECs, it is likely that the competition pressure from cable operators will force them to open more aggressive rollouts than would otherwise have been the case. The increasing implementation of integrated voice and video in web-based e-commerce applications further fuels the need for DSL service offerings which, though initially based on traditional telephony, will transition to VoIP as the costs associated with the deployment of VoIP equipment are reduced. Equally, important is the need to recognise the market pull for these services that has been negatively impacted by the slowed business economy.

The adoption of DSL by traditional telephony carriers

There has been a widely recognized demand from large enterprises for IP-based voice and video services. However, the demand has sometimes been impacted by the initial capital costs of the equipment required or the inability for the Internet service providers to offer the required services. Also, throughout 2001, restraints on capital expenditure in businesses have deferred plans to move forward. ISPs have expressed a strong interest in offering different levels of service that would permit large enterprise customers in particular to implement VoIP and videoconferencing applications within the broader range of their IP service portfolios. However, there has been an uneven implementation of the technology necessary to support the necessary differentiated levels of service.

The MPLS (Multi-Protocol Label Switching) standard is widely proposed as the means offering differentiated levels of service with the Quality of Service (QOS) characteristics to support delay sensitive applications such as voice and video. While many large enterprises have expressed interest in adopting MPLS services, their implementation by carriers in the United States and Europe has been uneven. In 2001 many carriers felt capital expenditure restrictions sufficient to delay or defer implementation, the kickback effect of which has been to dim large enterprise interest in adoption of these services at least until they have established commercial service. AT&T, WorldCom, Level 3, and Cable & Wireless are among the carriers to have committed to implementing MPLS within their networks whereas others such as Qwest and XO Communications are reportedly still evaluating the appropriateness of the protocol. The general ubiquitous adoption of MPLS is still a matter of some uncertainty however and amongst the established Tier 1 Internet Service Providers, Sprint and Genuity have thus far not announced plans to implement it. However, as ISPs move to implement the ability to deliver differentiated levels of service, enterprises will be able to adopt VoIP and realtime video applications more readily at present. This is considered to still be two to three years out for all but the larger enterprises whose size of user base and private network infrastructure helps justify the initial costs of deployment.[9]

While the large enterprise market provides considerable incentives to Internet Service Providers to support VoIP and video applications, there other areas of market pull that might suggest an earlier adoption of VoIP by businesses where enterprises are required to replace legacy infrastructure and do not have investment in PBX infrastructure. Many enterprises have already piloted VoIP and may have already transitioned up to half their voice requirements over to IP-based systems. But the decision to move

completely to an IP-based infrastructure can be weakened by the continued fall in traditional telephony costs. While the present costs associated with maintaining a PBX infrastructure may in fact be less than the capital costs of deploying an IP infrastructure, these costs are expected to fall and the IP infrastructure is able to support services that the traditional telephony infrastructure does not address.

While a direct implementation of IP is currently best suited to 'green field' builds, the implementation of softswitches and iPBXes may be attractive in circumstances where it is important to leverage legacy telephony infrastructure. Both Qwest and Sprint have announced plans with Nortel to replace their local service infrastructure with IP-based networks though this replacement is planned to take place as a transition over several years beginning with a 'converged' network architecture based on softswitches. By contrast, China Unicom, with no legacy infrastructure, is reported to be implementing a VoIP network from the outset to serve 300 cities in 30 provinces.

Traditional carriers have accepted the need to build IP-based networks to support voice video and Internet applications either through approaches that embrace a transition from legacy infrastructure or by building from scratch. The initial capital cost of either approach has perhaps been restrained for many operators by the current economic climate that has encouraged them to conserve cash and drive short term profitability. This restraint perhaps also encourages those service providers that are able to deploy and deliver DSL services where there is a discernible market demand that in the United States is hampered only by ability to deploy in local markets. WorldCom recently acquired Rhythms Netcommunications, and Sprint and Qwest amongst others are offering DSL services. While there has been significant consolidation in the US market, the competition for the DSL market is now positioned with fewer but much stronger players. Additionally, traditional telephony may be further challenged by the consolidation as traditional carriers compete to offer new services to users but face new competitors including content providers and cable operators for the consumer market, and Tier 1 ISPs for the large enterprise who are also better positioned to offer IP-based services including voice [10].

The alternatives to DSL from competitors to the traditional carriers and their use for VoIP

Estimates of the US market for broadband services including DSL, Cable and Satellite suggest that it will have grown to around 11 million residential and small business users by the end of 2001. It is forecast to continue to grow to 36 million users by the end of 2005. In Japan there were estimated to be 1.2 million ADSL subscribers with a projected growth to 5.4 million by 2004.[11] However, the competition for broadband services from alternatives to DSL may be significantly influenced by the anticipated continued fall in capacity pricing based on available fiber capacity. Cable systems, though already maintaining a substantial installed base, must absorb the costs of upgrading existing infrastructure to support broadband services and all alternatives must manage access costs against the price of fiber capacity.

Cable

AT&T Broadband, AOL Time Warner, Comcast, and Cox Communications are in negotiations to acquire the AT&T infrastructure which includes significant Internet service capability based on the earlier AT&T acquisition of @Home and Excite. The outcome of AT&T's planned sale of its broadband operating unit may impact traditional carriers approach to bundling DSL services including television. It is certainly clear that they will face significant competition for residential high speed Internet access. Some regional operators such as RCN Starpower in United States have begun to offer DSL-based services that include local and long distance voice, Internet access and cable TV. Similar approaches have been made in Asia by Korea ThruNet, for example, which specifically target residential and SOHO markets.

Fixed wireless

While fixed wireless access technology remains an important technology to pursue broadband local access it is slowed by the lack of successful implementation to date. Additionally, fixed wireless access for broadband services is likely to fit specific instances of requirements in some geographies but may not have effective penetration in the major metropolitan areas as was once thought. Given the heavy emphasis that is likely to be placed on delivering broadband services to businesses from all carriers the requirement to leverage fixed wireless technology seems small when compared with the alternatives available.

Satellite

Hughes plans to dispose of Direct TV, though the outcome of current negotiations with EchoStar is uncertain since this consolidates the satellite TV operators in the United States into a single player. Satellite has special value for broadband services such as videoconferencing, especially as applied to distance learning for example, where integration with web-based applications would further enhance the appeal of the service for institutions seeking to offer education to a global market. While this is a vertical market it is ideal for satellite-based services to address. Satellite-based services for voice, and video can be very attractive supplements to large enterprises that seek coverage that cannot be completely met through terrestrial/trans-oceanic fiber. Other satellite-based companies such as Intelsat are placing a high degree of prioritization on Internet-based services and may be anticipated to consider offering comparable voice and videoconferencing services to those envisaged by Hughes. In general, satellite operators have been most successful with Internet services where there is inadequate or expensive terrestrial infrastructure. This has limited their ability to penetrate the most lucrative markets for Internet services. They have tended to focus on low-cost long haul transit services and are thus not as well positioned to offer bundled broadband services without partnerships with service providers for whom value added services are their core business. However, satellites may offer TV broadcast networks, for example, opportunities to offer services globally in the manner of content providers as satellite is well suited to offer multicast service. Equally, satellite operators envisage enabling global businesses such as banking the ability to offer network services globally by being managers of 'virtual networks' built on the infrastructure of the satellite operators[12].

DSL Deployment

Competitive issues for VoIP vs circuit switched POTS

The year 2001 has seen a very significant shakeout in DSL providers in the United States and Europe. At the beginning of the year there were an estimated 2.4 million DSL-based broadband subscribers and that number was forecast to grow to around 18.6 million by 2004. At an average of USD 50 per month as a typical charge for residential users, this translates to over USD 11 billion in revenue for the consumer market alone. But during the course of the year all three of the national broadband service providers, NorthPoint Communications, Covad Communications, and Rhythms Netconnections were either forced to shut down or filed for Chapter 11 bankruptcy protection. While other large service providers such as PSI and Winstar and Teligent have also followed this pattern, as have many smaller ISPs who have either abandoned deploying DSL services or gone out of business. The result is that over 80% of the United States' DSL service lines are supplied by the former RBOC's and their affiliates.

The competition for high speed access, however, has been significantly stimulated by the bundling of voice and Internet access services for consumers in particular from cable service operators whose installed base at the beginning of the year was estimated at 4.7 million subscribers roughly double the DSL base. Thus despite the collapse of the competitive DSL providers, in 2001 the demand for DSL services and the

competitive pressures from high-speed cable modem services remained very aggressive. The market demand for bundled voice and Internet service continues to grow in the consumer base as well as in the small business markets. The enterprise market meanwhile has seen a significant rise in the products being made available for large enterprises and multinationals to support VoIP including iPBx and IP:PSTN gateways supporting H.323 or SIP. The major equipment vendors such as Cisco, Nortel, Avaya, and 3Com are all increasingly focused on the enterprise market with VoIP products.

The pattern for the residential, small business and the enterprise overall reinforces the general perception that integrated voice and Internet will continue to develop very aggressively and are sources of significantly growing revenues. As such integrated voice and Internet services, together with enhanced applications supporting them, will significantly erode the base of traditional telephony that has no means by which to respond to either costs or the value of the applications available through IP-based services.

Service bundling: will voice be treated separately by service providers?

For most DSL service offerings, especially those rolled out by incumbent LECs, voice is treated as a separate service that is generally offered in bundled service packages as switched service rather than as VoIP. However, independent service operators and cable companies have launched broadband services based on VoIP. In Korea, one of the country's largest cable modem providers, Korea Thrunet, has recently launched a VoIP service for the residential SOHO market. The service offers local, long-distance and international telephone services through their IP network (coaxial fiber) rather than from the PSTN. The most significant competitive advantage over switched services is the substantially lower telephone charges for users. In Hong Kong, the Cable operator i-Cable is trialing a voice over IP phone service across its cable network.[13] In Japan, in December 2001, 'Yahoo BB' commenced a trial broadband telephone service "BB Phone". BB Phone utilises VoIP technology and Yahoo BB's broadband infrastructure to offer inexpensive rates for telephony. Domestic calls in Japan and international calls to the United States are priced by Yahoo BB at around USD 0.02 per minute.[14] Commercial service is expected to be launched in the second quarter of 2002. In Canada, Bell Canada is trialing Nortel Networks' voice over IP (VoIP) product, with its business customers.[15] At the same time Bell Canada is conducting consumer trials with Net2Phone.[16] In the United States a number of CLECs have also targeted the residential and SOHO market with comparable bundled service packages. While most offer switched voice along with Internet access and sometimes with cable TV, all are positioned to offer the local voice services at levels that can represent savings of 30% or more when compared with local service from the incumbent LECs. These services are often competing directly with DSL services for voice and Internet access that are being rolled out by LECs and it is unclear as to how successful the independent operators may be over time. But a clear consequence of the competition for broadband services has been to maintain pressure on the LECs to deploy broadband services bundled with switched voice.

Of special interest in the Korean service offering cited is the ability to leverage local, long distance and international calling over a VoIP infrastructure at substantially lower rates than for switched voice. For international calls the savings are claimed to be up to 90% depending on the country being called. Also in such models local calls within the network of the service provider can be offered on a flat monthly fee for the service rather than on a per call basis.

The entry of this type of broadband service calls the closing curtain for earlier VoIP models based exclusively on PC-to-Phone services, many of which continue to leverage arbitrage opportunities in long distance and international calling. While POTs handsets can be enabled for use for VoIP calls through a gateway device attached to the cable modem, such services can also use PC-based applications that might be integrated in browsers. In the short term the service rollout of broadband is likely to continue to leverage switched voice permitting a gradual introduction of IP-based voice applications and VoIP as

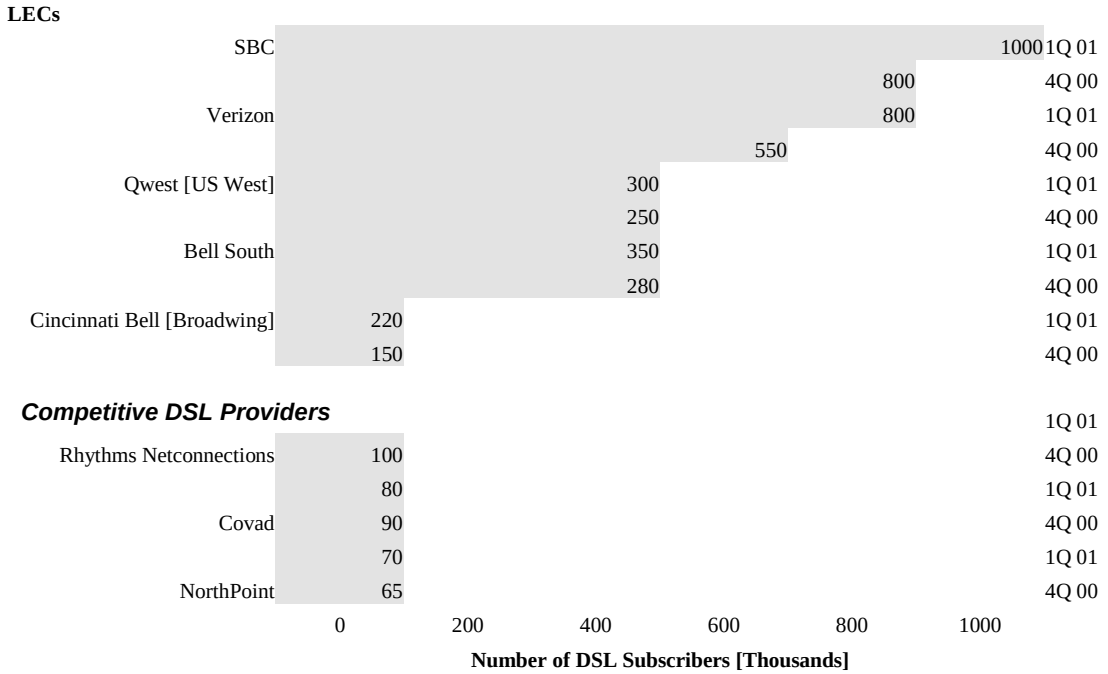
independent providers strive to launch services that are both price competitive and richer in features. Many independent service providers are seeking to launch these services targeting the small and medium-sized business markets seeking initial differentiation based on price for switched services but with the opportunity to leverage future features and functionality that are possible with IP-based services.

Pricing of VoIP over broadband

The pricing for DSL services in OECD countries is addressed in a separate paper "The Development of Broadband Access in OECD Countries".[17] As service providers roll out DSL services, it is likely that many will initially leverage traditional telephony for the voice component. Where service providers are able to bring to bear a native IP infrastructure, VoIP may be enabled via customer premise gateway devices. These devices would enable the use of traditional phone together with IP enabled handsets, appliances and PCs. The price competition that might be anticipated between such services and traditional telephony would be significant, especially if the VoIP services were broadly more attractive by having more features that can be managed more easily by the user than Centrex features.

Following the collapse of CLECs in the Untied States, through 2001 very few service providers remained that could address this opportunity early. Thus this type of VoIP service rollout is slowed until service providers are willing to again address both the regulatory challenges and the capital costs associated with the deployment of VoIP equipment. Broadband access is priced at the access speed the user selects ranging from USD 55 for 768/128 Mbps to USD 100 for 1.5/384 Mpbs for Verizon's service in the United States. These prices include the use of a single phone number and Internet access. Typically, competitive providers have demonstrated pricing ranging 10-15% lower for the access but also lower phone rates, especially when more than a single phone number and better Internet service packages are desired. The DSL routers or cable modems are sometimes additional costs at the time of installation. In Canada, Roger's Cable and Bell Canada are reported to be planning to introduce 'bit capping' presenting users with a two tier pricing structure for light and heavy users. Bell Canada's Sympatico service is also offering VoIP service with IP-enabled phone handsets. Bit caps may serve only to further slow the demand for broadband services. While some providers have considered other restrictions such as supporting FTP servers from DSL connections, most are looking to drive subscriber growth by offering pricing plans based on access speed requirements appropriate to the user's needs. In some cases these offerings extend up to 8 Mbps.

Figure 7. DSL subscriber distribution



Note: Totals include both business and residential consumer subscribers. NorthPoint, Rhythms and Covad all filed for Chapter 11 bankruptcy. NorthPoint was acquired by AT&T and Rhythms by WorldCom.
Source: DSL Prime, Telecommunications Reports International.

The future

Accommodating for change

Since 2000 the US and international market has seen a substantial consolidation of the telecommunications sector. In the United States in particular this consolidation has seen the collapse of the Tier1 independent ISPs, the disappearance through merger and acquisitions of much of the mid-level ISPs, the CLECs and independent broadband (DSL) services providers. The US telecommunications landscape is now comprised of what are sometimes known as "the big seven" Tier 1 Internet Service Providers comprising AT&T, Sprint, Genuity, Cable & Wireless, Qwest, Level 3 and WorldCom. The former Regional Bell Operating Companies have grown through acquisition and are now represented by SBC, Bell South, Qwest and Verizon. Lastly, the five major wireless operators are comprised of Verizon, AT&T, Sprint, Nextel and Voicestream. Importantly, AOL Time Warner and Microsoft MSNNBC as very large providers of Content appear to both be reaching for positions which would include voice in the services offered to customers.

Looking back on the past two years, with hindsight it is easy to see that much of what passed for business planning was really no more than wishful thinking. In 2000, five leading service providers – Frontier Global Crossing; Level 3; Metromedia Fiber, Williams and 360 Networks - invested around USD 60 billion in fiber optic assets. With the collapse of the market capitalisation of these companies in 2001 from USD 70 billion to USD 10 billion, this investment has been essentially lost. Linked to this was the collapse in growth forecast for vendors of optical and switching technology which has decimated Nortel and Lucent amongst many others, leaving Cisco and Juniper to consider the prospects of the very large service provider and enterprise markets. While not completely lost, the opportunity once considered for softswitch vendors is a glimmer of its former self. Although this is considered to recover somewhat, it is anticipated that the recovery will be slow, taking three or more years.

The traditional carriers (both long distance and regional) have become transformed as a result of the last two years. They have emerged as the carriers of by far the largest volume of global Internet traffic. While it is clear that their strategic direction involves dependency on IP as core network infrastructure, it is also apparent that the pace of innovation in the network may have slowed significantly. Amongst the causes may be the widely accepted perception that there has been an overbuild in fiber capacity which has impacted both the vendors of optical fiber and switching equipment and the capacity pricing that service providers may plan for. Perhaps directly related to this has been a significant fall in the price of capacity as well. There is now routine speculation of much delayed need for WDM in the metropolitan networks and for high capacity switching. The focus is perhaps to discern which of the service providers will best be able to manage the issues of underutilized fiber capacity, the need to implement new technologies, and ability to identify the best mix of services to drive revenue growth.

The emergence of SBC, Verizon, Qwest (US West), and Bell South as amongst the largest of the service providers in the United States is also a possible reason for some to anticipate a much slower pace for the adoption of new technology. The model by which these companies have procured new equipment has tended to use standards sourcing from a single source (Telcordia, formerly Bellcore) that in the view of many is very restrictive in terms of cost and time for innovative technology start-ups to adopt. Thus for the future, these service providers will depend on traditional sources for the supply of new technology and equipment. The CLECs that remain to compete against these very large carriers are few in number though perhaps better positioned in their ability to launch new services and to leverage partnerships with Internet Applications Service Providers who are able to offer managed IP-based voice and other applications that the CLECs might not otherwise be willing to risk the capital expenditure to deploy. Thus independent providers perhaps still have speed and flexibility with which to address the market while the very large consolidated LECs face competition from both the CLECs and the long haul networks who remain the primary carriers of Internet traffic.

The Tier 1 Internet Service Providers are, however, impacted by the continued fall of Internet transit pricing and their service models are heavily based on retaining transit as a central source of revenue. They are likely to maintain this position although it is anticipated to continue its path towards lower margins of profitability. These providers do not anticipate maintaining traditional long distance telephony and are therefore challenged to enter local markets primarily for new broadband customers and to continue to implement technology that will enable their infrastructure to support IP-based voice and video services that large enterprises are seeking. As they do so they will meet content providers who have progressed their service models to include deployment of network infrastructure, a significant component of which will be cable TV capable of offering integrated cable TV, Internet, and voice and video. The anticipated re-positioning of the industry takes place as wireless operators embrace IP-based applications and services that will be readily competitive with traditional lines.

AOL Time Warner is positioned both as a cable operator, a local access provider and as a VoIP provider through its investment interests in companies such as Net2Phone whose service it also resells. MSN has similarly struck up relationships to resell VoIP services with VoIP companies such as Deltathree and Telus, Canada. MSN and AOL alike are striving to drive the use of their IM services by offering VoIP functionality integrated within the application. In time it can be anticipated that the application may itself transition to a pay-for-feature service that includes voice services. These might be offered from multiple sources allowing the user to select the service based on price and quality best suited to their needs. MSN and AOL's planned VoIP services for IM and other applications are to be based on the SIP protocol permitting users to make calls from their computers to any phone number in the world. Similarly Microsoft and AOL/Sony TV set top boxes primarily intended for gaming and Internet access can be anticipated to be enhanced as gateways to allow users to use traditional telephony handsets to make VoIP calls based on cable modem gateway devices that are already being used for services currently offered by independent broadband service providers in many countries.

At present it is difficult to guess the future of broadband access revenues to potentially offset traditional telephony revenues for carriers. Undoubtedly, broadband-enabled voice and video will erode traditional voice revenues. This erosion clearly begins earliest in the most lucrative market segments – those of small business and enterprises. Clearly, switched voice over broadband as a bundled service is not a means towards replacement revenue. It might be a means to better manage the decline of switched voice services against new services that include voice, and are IP-based but that do not have a direct counterpart in the telephony world. Similarly, mobile services are presently predominantly voice but as mobile phone and handheld devices extend support for browsers, video and other applications the present charging models for wireless calls will surely come under pressure. While it is reasonable to anticipate continued growth in volume of services, the consideration of voice as a stand alone service is being challenged – perhaps not all at once, but rather it will inevitably be eroded and replaced by a multimedia service environment defined by the user. Ultimately, the most important impact that IP may have on traditional telephony is to have enabled the user to select voice as one option amongst many as the means to effect communication from a range of devices whether handheld, desktop or integrated into an appliance or vehicle.

The next generation of services

The provision of enhanced IP-based voice applications such as conference calling using virtual iPBXs targeted at small and home businesses are likely to emerge in service provider portfolios as they address bundled service opportunities based on broadband and high speed Ethernet access for these markets. Services targeted at the residential market are likely to be based initially on a combination of switched voice and Internet access sometimes bundled with cable TV access. These services can be expected to be the mainstay of the initial rollout of broadband services. The large enterprise market, particularly the segment associated with corporate multinationals, may be expected to drive the adoption of large user implementations of VoIP (larger than 10 000 users). These large enterprise implementations will be dependent upon the Tier 1 ISPs ability to offer MPLS-based services with Service Level Agreements (SLAs), QOS and differentiated service levels needed to support voice, video and other business critical applications.

Mobile Internet services including IP-based voice applications will continue to be implemented by vendors of equipment although their deployment in services may be constrained by the inability of service providers to deploy them in cost-effective offerings from the perspective of the user. IP can be expected to impact wireless services as handheld devices are able to support IP-based voice applications and video, challenging the traditional pricing structure of wireless voice services. This may be some years off, as wireless devices although demonstrating the scope and breadth of their future potential - still appear to be at proving stage in terms of readiness for full-fledged commercial service.

More immediate perhaps is the widespread use of IP-based messaging as integrated within IM services such as those offered by AOL, Yahoo! Inc.! and MSN. These applications are already being offered to Internet-enabled mobile phones. Though less attention has been paid to enterprise implementation of IM, these applications, in addition to new business-orientated peer-to-peer services are likely to advance the integration of IP-based voice applications and the convergence with switched voice. AOL and Yahoo! Inc. have already begun to offer enhanced voice services including unified communications and speech recognition technologies that integrate VoIP within IM. The forecasts for the enhanced IP voice markets are expected to grow from scratch in 2001 to USD 12.3 billion by 2005 in the United States. Currently enhanced IP-based voice applications are estimated to account for only 3% of VoIP revenue but could grow to 25% over the next two years.

Recently, Microsoft has launched a TV set top box primarily for games and entertainment use. However, this Internet-enabled appliance, like the one planned by AOL and Sony, is readily enabled as a device to

allow phones to be used with it and for IP-based voice applications. These appliances introduce yet another opportunity to combine and manage the delivery of multiple services to the home that are made possible by IP. Increasingly, service providers will be required to address remote storage applications that are of growing importance in supporting e-commerce maintaining transaction records and bring with them new challenges for maintaining security and privacy. Other e-commerce driven requirements would include the integration of speech recognition and synthesis for voice-enabled applications that have, to a significant degree, already been established for telephony applications such as directory services and customer care (Customer Relations Management - CRM). However, the degree to which these features within traditional telephony can be leveraged through integration within new IP-based applications is uncertain as the costs of developing them from scratch might often outweigh the benefits of trying to leverage existing telephony infrastructure. Streaming media is gaining in importance as applications that integrate news clips, speeches, and sporting events gain popularity - for example, where mobile devices can be enabled to support a video stream based on a voice request. Services that will in the future based on applications integrating voice, video, e-mail and other messaging will demand a more robust approach to service level agreements both between providers and between providers and end users.

Some future governance and regulatory issues

The governance of IP standards is managed outside the framework established for traditional telephony and telecommunications under the ITU. In the future the roles of the IETF and more recently ICANN in the forward development and management of IP will undoubtedly require better co-ordination and harmonisation with those standards directly impacting the traditional telephony world. The process by which IP has developed thus far, although fantastically successful, should not necessarily be viewed as solely derived from the institutional framework under which it was brought about. It may well be that the institutional framework that has fostered IP has been overtaken by the success of the protocol and that a significant reform will be needed in the foreseeable future. The key success of IP has been in the establishment of open standards through global collaboration and ultimately this approach will need to be adopted by the institutional framework required for its governance at a national and international level. The impact of IP is that it will likely replace telephony over time in doing so. The manner in which this transition is managed will require co-operation and collaboration between the IP and telephony worlds.

The regulatory models for voice are unsuitable for the treatment of IP-based voice applications because these applications have their highest value outside traditional telephony although they can certainly be implemented alongside it. For instance, broadband services are generally being rolled out offering traditional telephony with Internet access, also providing the user access to alternative voice applications. Additionally, IP-based applications open up much broader issues of regulation than the management of telephony revenues - issues that have not needed to be addressed by traditional telephony. IP enables a user to maintain a global presence that extends well beyond a telephone number and an ability to interact across borders, challenging many of the existing approaches to the responsibilities of carriers. As VoIP specifically impacts less than 10% of overall voice traffic, its long term impact will not be directly against the traditional telephony consideration of regulation because VoIP are of much lower priority than these other aspects of IP-based services.

While IP is based on open standards, the circumstances surrounding the implementation of proprietary IM applications, for example, is an issue that must be addressed. At present, users of these applications may only message within the members of the application that they use. As IM is incorporated into Internet-enabled mobile phones and handheld devices, its potential utility for users will be severely restricted by the absence of interoperability between the different Instant Messaging platforms. As IM is adopted by business, both the interoperability and security issues of this very successful integration of voice, Internet chat, paging and e-mail will need to be resolved. AOL, MSN, Yahoo! Inc. and others have recently begun

to take the steps necessary to resolve the exchange of messages between different IM applications although there will be challenges. IM applications also are used to send e-mail, attachments, enable voice calls, and they can support video. The interoperability and standards setting to successfully allow these applications to be integrated poses significant challenges ahead.

Some future areas for policy consideration may include how best to approach the integration of voice into non-traditional telephony applications. For example, whether it would be appropriate to look towards future IP-based voice applications as a driver of new sources of revenue rather than a direct competitor to traditional telephony. Another area of possible interest may be in how services can be supported globally based on the present cost structure for providers to obtain international Internet connectivity. This may be of special importance as all future applications are bandwidth-intensive. Integrated IP-based applications supporting voice will likely set different demands for quality and service levels required by commercial and domestic users. The required levels of service must be agreed to between all operators offering or delivering these services and it is likely that these services will entail the use of the Internet, private service providers or enterprise IP networks and the PSTN. Undoubtedly, as the new IP-based services are rolled out, the need to standardise quality, level of service and policies for these applications will need to progress past the Internets present 'best effort' model.

Conclusion

The impact of IP technologies on the traditional carrier world will be to significantly increase the volume of global network traffic and to broaden the range of applications and types of usage that can be supported. However, traditional telephony will continue to be used alongside and where appropriate from a technical and business perspective integrated with the IP infrastructure. Over time traditional telephony will give way to IP-based voice applications. New IP technologies will enable applications that incorporate voice and video in ways that are not possible for the PSTN to support. Certainly, underlying switched transport protocols such as ATM will provide a means by which to leverage the investment in the PSTN to support voice-based services and features, and these may endure and be used effectively in the progress of IP technology for many years. A new version of the IP protocol, IPv6, has been nearly a decade in preparation and is still very far from being generally adopted. Thus there is little reason to suppose that mature and successful switched transport protocols will not continue to be used to leverage legacy infrastructure to some degree.

It is reasonable to anticipate a gradual shift of usage patterns away from traditional telephony as the types of application to be supported and their usage grows over time - both traditional telephony and the PSTN network giving way to an IP-centric global communications infrastructure. However, given the sheer size of the traditional telephony infrastructure it is reasonable to anticipate that integrated IP-based voice applications and traditional telephony may coexist for many years ahead.

The future of IP-based voice is not an issue of whether it is cheaper than traditional telephony. Voice over IP will be sold on feature functionality and value of the applications within which it has been integrated rather than purely on the traditional view of 'cost per minute' to the end user. IP-based voice and video applications are enabling collaborative computing as a component part of the workplace in which IP enabled devices are becoming pervasive – computers, laptops, wireless PDAs, desk and mobile phones and with more to come. Thus IP-based applications will foster new rather than replacement communication and create new business opportunities for those who able to exploit its potential.

There will be differences in approach to this opportunity. Inevitably some will try to preserve existing models of business for as long as possible while at the other extreme some may take too bold a risk with new technology. It would be reasonable for traditional carriers to leverage existing infrastructure and to

some extent mitigate the risks of transition to new services and applications. But in addition it will be necessary to accept that the business models of traditional telephony will be replaced. New business partnerships and alliances may help to best advance new IP-based services including voice and video and help to better position traditional carriers for the future. Equally, the public Internet itself must be anticipated to evolve to better support the service levels required by the new applications as well as in its fundamental business model.

NOTES

1 CLEC voice line revenue will flatten out by 2003-2004 at about the same time that competitive providers should begin to see revenue gains from enhanced IP voice applications. Greg Mycio, New Paradigm Resource Group, Chicago, 2001.

2 Enhanced IP voice market is forecast to reach USD 12.5 billion by 2005 in the US alone. Mark Plakias, The Kelsey Group, Princeton, N.J. in Voice Rises Up, Kate Gerwig, Tele.Com, November 27, 2000.

3 "Palm Planning to Integrate Wireless into Handhelds", Bob Brewin, Computerworld, December 17, 2001. Palm plans to integrate new wide-area networking DSP chips from Texas Instruments Inc. that will support GSM-based mobile services in its next generation of handheld computers.

4 "Whatever Happened to Sprint's ION?" Sinead Carew, LightReading, December 27, 2001.

5 "Sound Alternative to Telephone Networks", Scott Morrison, Financial Times, November 13, 2001.

6 Packet Geography, Telegeography, 2001.

7 "Where Now for DSL?" European Communications, Lesley Hanson, October, 2001; The DSL Debacle, Luc Hatlestad, Red Herring, July 15, 2001.

8 Enhanced IP voice services account for 3% of current VoIP revenue but could grow to 25% over the next two years. Probe Research, Cedar Knolls, NJ.

Between 2002 - 2005 enhanced IP voice service demand will be largely driven by softswitch technology providers. How this growth will be facilitated is still one of the open questions of this nascent and presently fragmented market segment. It contains a wide variety of services offered by many types of service providers and pure software developers all targeting different sets of customers. As enhanced IP voice applications gain market acceptance they will encroach progressively on the enhanced services of traditional telephony which in the US is estimated at USD 5 billion per year today for voicemail and CENTREX features such as call waiting and caller ID etc.

9 "MPLS Gets Lukewarm Reviews", Mary Jander, Light Reading, December 4, 2001.

10 Broadband service provider XO Communications announced in December 2001 that it had signed a three-year contract to provide integrated voice services to MedQuist, a large enterprise. The broadband-based services included local and long-distance voice and Internet access.

11 Survey Nihon Keizai Shimbun, December 10, 2001.

12 "Broadband from Outer Space", Andy Dornan, Network Magazine, January 2002, "A Higher Power", Paul Korzeniowski, Tele.Com, January, 8, 2001, "WorldCom Launching Satellite ISP", George A. Chidi Jr, Computerworld November 27, 2001.

13 Totaltele, “Hong Kong's i-Cable Trials VoIP Service”, January 21 2002. http://www.totaltele.com/view.asp?articleID=47917&Pub=TT&categoryid=628&kw=voip

14 Softbank, “Broadband Telephone Service: BB Phone Commences Trial Service”, December 18 2001.

15 Totaltele, “Bell Canada trials Nortel VoIP with Major Corporates”, January 8 2002, http://www.totaltele.com/view.asp?articleID=47471&Pub=TT&categoryid=823&kw=voip

16 Totaltele, “Bell Canada and Net2Phone Link for Consumer VoIP”, October 6 2001. http://www.totaltele.com/view.asp?articleID=44464&Pub=TT&categoryid=628&kw=voip

17 OECD, "The Development of Broadband Access in OECD Countries", October 2001. http://www.oecd.org/pdf/M00020000/M00020255.pdf