Convergence: the Business Case for IP Telephony

A white paper from an independent observer

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Terminology

IP is the lingua franca of data communications: the language that computer systems speak. Its derivation is that of the Internet (IP = Internet Protocol).

LANs and WANs are the acronyms for local and wide area networks, both of which employ IP. A LAN is a communications network that functions within a confined geographical area, e.g. an office. Users employ PCs or workstations (aka as client devices) that connect to the LAN via network adapters. The actual communications link is a cable. Servers (large computer systems) are also attached to the LAN and as the name implies, they provide communications and other services to the client devices. This way of working is known as the client-server model. A WAN is a communications network that functions over a wide geographic area, e.g. a campus, city, country or even, in the case of multi-national enterprises, the world. A WAN comprises individual LANs that interconnect over the network of a carrier.

Convergence refers to the coming together of data, voice and video, i.e. the ability to carry all media types on one network. This is what IP enables. A converged network does not see any difference between voice and other media types; once digitised, voice is just another data stream.

Voice over IP (VoIP) indicates that an analog voice signal has been digitised and converted into the packet format used by IP. This is done in order to allow telephony and other audio signals to be transported over the same network as regular data traffic. A separate network normally carries telephony: either the public infrastructure or the internal network of regular phones connected to the company's PABX. Thus, VoIP refers to a conversion and transportation process. The key benefit is the use of one network instead of two. VoIP does not add any value to the user experience.

IP PABX. A PABX is an in-house switching system that connects, disconnects and transfers calls. In a VoIP environment these basic functions are still required and an IP PABX supplies them. However the term is somewhat confusing since no switching is involved. VoIP calls are routed, not switched. You can think of routing as soft switching. Software in a server performs this operation. The software also extends enterprise telephony features and functions to network devices, e.g. IP phones.

VPN (Virtual Private Network). The first private networks comprised leased lines that connected the various PABXs of an enterprise. Inter-office calls were not metered and a private numbering scheme could be employed. This eliminated the need to dial long-distance and international codes. Carriers and alliances of carriers provided the first VPNs. Lines were no longer leased but call capacity and the numbering scheme were retained. This solution was cheaper but still very inflexible. Today, carrier-class IP networks are used to interconnect IP PABXs and routers in order to deliver VPN functionality, not only at a much lower price, but also with consummate flexibility.

Internet Telephony refers to VoIP over the public Internet. Although technically feasible, the call quality is considered to be too variable for serious use by business professionals. This comes from the fact that voice traffic has to be given priority over data. However, VoIP is employed over managed IP infrastructures, e.g. corporate intranets and the backbone networks of carriers. Unfortunately, the terms VoIP, Internet Telephony and IP Telephony are often used interchangeably.

IP Telephony is given a very specific meaning in this white paper: it refers to the telephony applications that are enabled in a homogeneous IP environment as well as the integration of these applications with mainstream business processes. IP Telephony therefore focuses on: the business case; the end user experience; the increase in productivity that comes via the ease with which telephony applications such as call conferencing can be employed; and finally and all importantly its impact on the all-important bottom line.

Executive summary

In the last forty years the world of data has progressed from mainframes through to mini computers and on to PCs and PDAs. Data communications has also advanced in leaps and bounds, together with wireless telephony, but progress on the wireline side of voice has been minimal.

The baseline technology has hardly changed in the last one hundred years and the cost of communicating over the public network has only come down as a result of deregulation, the competition that followed, and the deployment of new technologies. Tariffs, however, are still based on time and distance, even though this model no longer makes sense in today's global marketplace.

The impact of Internet technology and the Internet Protocol (IP) in recent years has been seismic and now the tremors are starting to be felt in the office voice environment. IP has been implemented on LANs and global backbone networks, but most offices still employ PABXs and wireline phones for voice communications. The phones are no longer black and push buttons have replaced rotary dials, but calls are still set up and processed in the same old way.

IP telephony is a relatively new development, one that the telecommunications industry started to take seriously around 1998. Since that time it has become a robust technology for which there is an overwhelming business case. There is only one significant issue and that is integration with legacy communications hardware, i.e. existing PABXs. Rip and replace does not always make sense, but evaluating the benefits at the departmental level or in new office facilities, for example, is something that should definitely be considered. Experience gained at an early stage will be extremely valuable when defining your unified communications requirements.

This white paper makes the business case for IP Telephony, a case that is founded on:

1) The ease with which communications applications are employed

2) The resulting stress-free increase in personal productivity

3) The convenience and cost benefits that come from the management of one network instead of two

4) The ability to interface telephony with mainstream business processes

5) The intrinsic flexibility of an IP based network

6) The use of standards-based technologies, i.e. IP and the Ethernet

7) The overall impact on the bottom line.

It is an impressive, bullet-proof case, but missiles continue to be launched by the vendors of legacy PABX hardware. Competition is healthy, but the dissemination of messages containing inaccuracies and near lies is not. This issue is covered in the section titled Fear, Uncertainty and Doubt.

The primary focus of this white paper is on IP Telephony at the desktop, i.e. the convergence of voice and data on wireline local and wide area networks and the resulting benefits. However, wireless telephony in the office is also covered since LANs are themselves going wireless and as a result these two environments are converging. This development is covered towards the end in the section on Wireless IP.

Plain vanilla telephony

We take the phone and the public infrastructure for granted; we don't need to know how telephony works. However, in order to understand why IP Telephony is so important and the fundamental change that it enables, it is necessary to outline the infrastructure that underpins plain vanilla telephony.

The public network — the PSTN (public switched telephony network) — uses a 'circuit-switched' technology that has not changed in over a hundred years. As illustrated in figure 1, when one party phones another the call is set up by a series of switches (aka exchanges). A PABX in one office might switch the call to a local (branch) exchange, which then switches it to a national exchange, from there it might go to an international exchange, and then proceed back down the link until it reaches another PABX and the called party. This explains why tariffs are based on distance. The PABX switches calls from phones to and from the public infrastructure; it also handles internal calls. The functionality is therefore similar to that of an exchange; a PABX is a Private Automatic Branch eXchange.

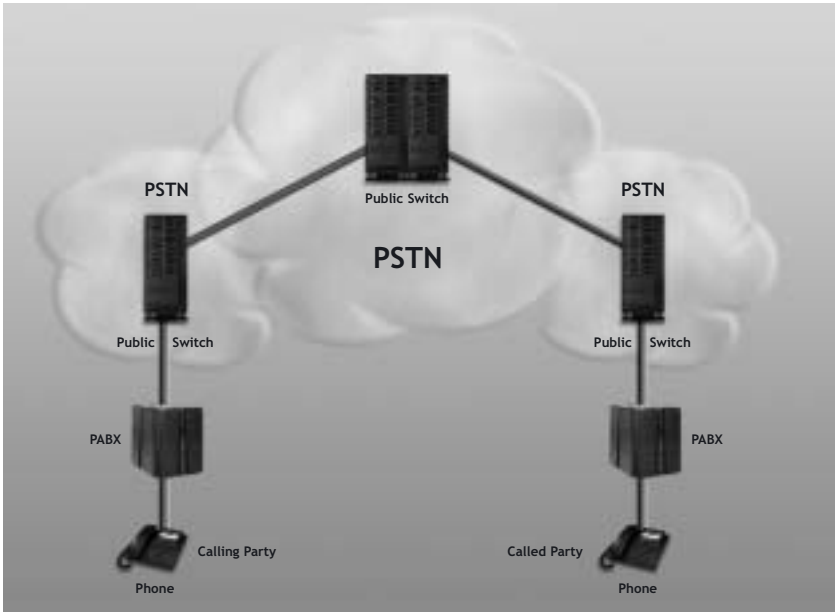


Figure 1. Calls between two parties are set up by a series of private and public switches. The resulting communications link is retained for the duration of the call.

Once this end-to-end link is established it is used for the duration of the call; this valuable communications resource cannot be employed by any other party until the call is terminated. That is why tariffs are also based on duration. This is something we used to take for granted and until IP and the Internet came along there did not seem to be any alternative, but this technology is very inefficient. For historic reasons, the bandwidth of a circuit-switched connection is over-engineered and therefore over-priced. Each call gets a dedicated 64 kbps link, which is considerably more than is needed with today's technology. Circuit switching also ties up resources since the central exchanges and PABXs stay in the loop after the call has been set up and are only released when the call is terminated.

In a circuit-switched VPN every location has a PABX, or in the case of small offices, a key system and the carrier interconnects these switches. This process takes time and the resulting infrastructure is not flexible. Adding a new location may take months and retaining the same number when employees change to new locations is something of a logistical nightmare.

Packet-switched telephony

Digitising an analog voice signal and chopping it up in thousands of small packets of data might sound like an improbable technology and in some ways it is, but once voice becomes just another data type then virtually anything and everything can be done to the signal, as this paper will show. There are a number of technical issues, but they have been addressed and the technology is robust, particularly when running on corporate LANs and WANs. VoIP is therefore a technique that enables internal calls to bypass the public infrastructure and thereby minimise communications costs. This explains the term 'toll bypass.'

In an IP environment the signals are not switched, they are 'routed' by a computer system. See figure 2. Once a stream of packets has been sent on the way that part of the computing resource is free to handle another call. The links between routers can also handle more than one call; in fact, they can handle many calls simultaneously since each packet of data has a unique identity. Thus, the need to base tariffs on call duration is eliminated since no resources are tied up unnecessarily.

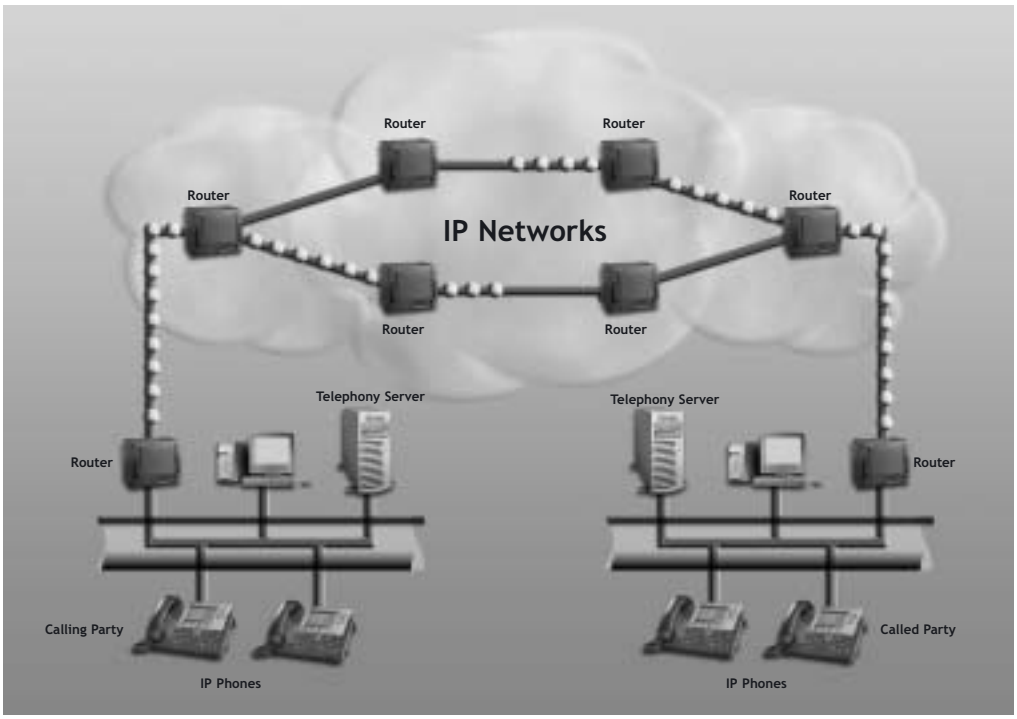


Figure 2. Calls between two parties are established by routing a flow over packets over an IP infrastructure. The telephony server identifies each packet, i.e. the address to which it is sent and its sequence. Packets can travel by different routes, as illustrated.

Packet switching is therefore more efficient than circuit switching and bandwidth requirements are also drastically reduced, e.g. 12 kbps or less instead of 64 kbps. No circuit-switched networks need be involved in these IP network calls so the need to base tariffs on distance is also eliminated. For local PSTN calls and calls to non-IP based telephony systems (i.e. PABX's), gateways are employed to interface between the two environments.

In a packet-switched VPN the various locations interconnect to the nearest POP (point of presence) of the carrier. At least one location must have an IP PABX, but normally at least two systems will be employed so that there is no single point of failure. Smaller sites only require a router/gateway, a LAN switch and the IP phones. Bringing a new location on-line can be done in a matter of hours. An enterprise-wide private numbering scheme can also be employed.

The IP phones have physical locations and regular extension numbers are dialled to call them, but these locations and numbers are 'mapped' to IP addresses, which are logical. These addresses can be permanent or they may be dynamically assigned by the system when the device is logged onto the network. This means that the phone number can be reallocated to another location simply by re-mapping the IP address and the network manager can do this in seconds. Packet-switched VPNs are therefore almost unbelievably flexible.

Key benefits of VoIP and IP Telephony

The business case for IP Telephony is built upon the key benefits of IP and VoIP. As illustrated, the IP network is the foundation. VoIP enables voice to be transported over this network. IP Telephony is the umbrella term we are using to cover the communications applications that are enabled in a homogeneous IP environment. Network management (not shown) resides at all levels and significant benefits result from the fact that voice is now just another data type.

Vendors will normally include a number of mainstream applications in their IP Telephony solution. Most will, for example, offer unified messaging, personal assistant and intelligent contact management. Some vendors, such as Cisco go further and offer APIs (application programming interfaces) to facilitate the development of applications by third parties. Programmers write to the interface, which removes the need to know anything about the lower layers. This means that there is no shortage of innovative communications applications. APIs are also used to 'telephony enable' business processes such as CRM, ERP, Supply Chain Management and E-commerce.

Locations are virtual, not physical

A mobile worker can log onto the network in any office around the world and after that person has been authenticated by the network security system an IP address will be assigned. E-mail would then be delivered to that physical location. Now imagine applying that concept to voice. Calls now follow the user because they are not tethered to a physical place. Moves and changes are no longer an issue. People can join the company, leave the company, move to another office or another country. They still have an extension number, but that number is linked to their profile, and that in turn is linked to the IP address that is generated when they log on. The cost savings in this area can be very significant.

Basically, IP Telephony allows IT departments to manage voice the same way as data. A network manager can sit anywhere on the WAN or even dial in from a remote location and see exactly what is going on and make any necessary changes. This is impossible with most regular PABX and when it is possible, very expensive. All adds, moves and changes have to be made on site. Converging voice with data also means a single database can store all aspects of employees' profiles and IP phones can be used to access corporate directories and intranet services.

The media often employs the phrase 'IP eliminates distance'. We have seen how this works for the moves and changes issue and network management. However, it also applies to the systems that control the calls and run the applications. These can reside anywhere on the WAN and their resources are immediately available to all users, regardless of their location. Thus, there is not need for a small office to have its own dedicated telephone system; all that is needed is access to the IP WAN.

Another important benefit that is easily overlooked is the ease and speed with which IP Telephony can be introduced into an organisation. In October 2000 New Zealand's Ministry of Social Policy, for example, migrated a nation-wide network to IP Telephony in just four weeks. This involved replacing 130 PABXs with 10 software switches that served 8000 IP phone users in over 200 offices. The Ministry has in subsequence improved the reliability of the voice network, saved on PABX maintenance charges and built a platform on which to offer new IP telephony applications such as Unified Messaging. The network now carries more than 150,000 calls a day.

The list of key IP Telephony benefits is long, as we have seen, and it's growing since this is a very dynamic technology. It is hard to put financial figures onto individual areas such as personal productivity or moves and changes, and they vary from one organisation to another, but feedback from the market is very positive. One thing, however, is very clear and cannot be contested: the total cost of ownership of an IP-centric solution is significantly lower than that of conventional PABX-based telephony.

Applications, applications, and applications

This is what IP Telephony is all about. Just about every telephony application you can imagine is not only available, but they are all incredibly easy to employ. Instead of cryptic codes that nobody can remember, IP Telephony offers the intuitive point-and-click 'browser-type' interface. It may be a cliché, but the ease with which advanced features such as a conference call can be set up has to be seen to be believed. And because all profiles are held on one database, there is no need to remember extensions numbers. You can search by name and then click to call. It is also incredibly easy to set up one or more personal address books.

Call centres take on an entirely new complexion when IP Telephony is employed. Anybody who is on the IP LAN or WAN can be an agent; the location is irrelevant so there is no need for a physical centre. Calls can therefore be handled around the world and around the clock. Agents can be added or removed in seconds. Skills-based routing also becomes much easier. If the relevant expert has logged onto the network then his/her location is known immediately. Calls can even be forwarded to mobile phones.

In addition, it is easy to add teleworkers at peak periods, e.g. in the summer months for travel agents, at the end of the year for a mail-order company. All that's needed is a multimedia PC or IP phone and broadband access.

Voice as just another data type

When voice is just another data type applications that used to be difficult and/or expensive to enable suddenly become easy and economic to implement. Unified messaging, for example, is an application has been long on promise and short on delivery because voice mail and e-mail belong to alien environments. However, digitised voice messages can be brought into messaging applications such as Microsoft Outlook or Lotus Notes, thereby allowing voice mail to be read and processed in the same way as e-mail. Thus, instead of having listen to messages sequentially and wasting a lot of time, you can now listen to the important voice mails first. In addition they can be archived and forwarded.

Digitised voice also means that IP Telephony can follow the classical client-server model. Computer servers deliver applications to client devices over robust IP networks. These can be on the corporate LAN/WAN, but remote offices as well as small- and medium-sized enterprises (SMEs) can also run these apps over a narrowband (e.g. ISDN or Frame Relay) or broadband (e.g. ADSL) connection. In the latter case the SME would be connected to an Application Service Provider (ASP). Only a router/gateway, a LAN switch and the IP phones are needed at these remote locations. Moreover, applications can be turned on and turned off: you can think of the concept as a kind of communications shopping list. It is even possible to offer applications, including call centre agents, on a 'try before you buy' basis.

The intrinsic flexibility of IP Telephony means that very small offices can have all the functionality of the headquarters. And if the company opens a new office it can come on stream in a matter of hours. As stated earlier, almost everything and anything is possible.

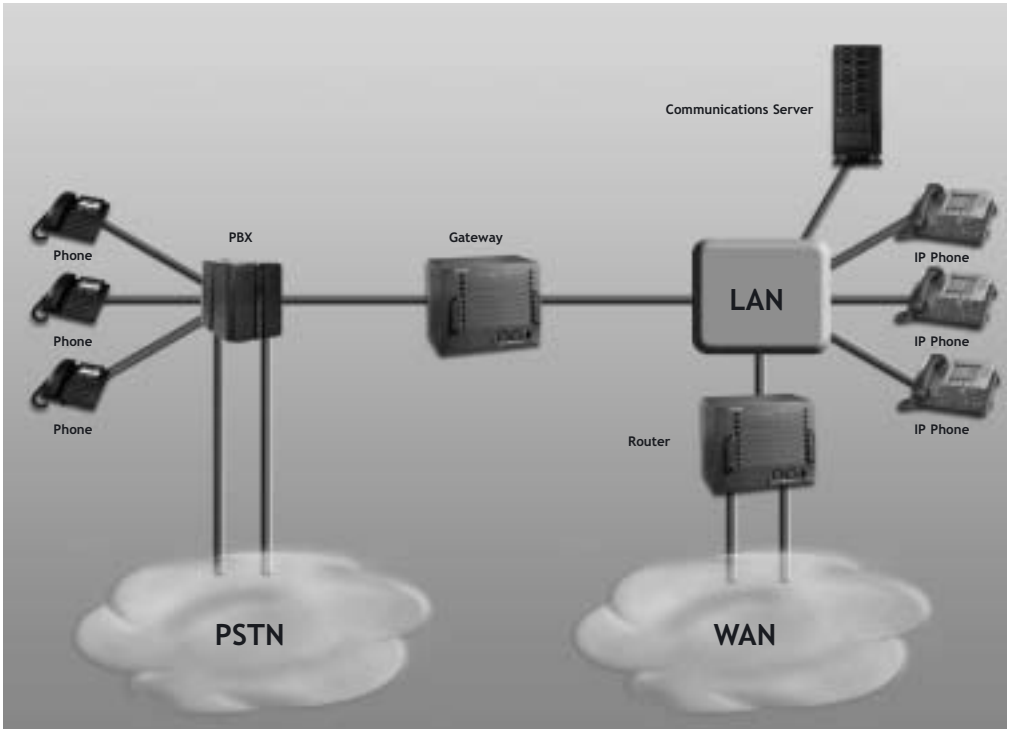
An SME with offices in Sweden, for example, could use an ASP located in another country, e.g. the UK. They might open a very small facility in Germany but need to look like a major player. In this case incoming calls could be routed to the ASP, re-routed to Sweden, be answered by an auto attendant in German, the caller then hears various options, e.g. press 1 for sales, 2 for service, etc, the call then goes back to the one-man office in Germany where the relevant response is given, e.g. "sales department, how can I help you."

Only one significant issue

This is a serious, stable technology that offers unrivalled functionality. Any messages that say anything else should be filed away under FUD (fear, uncertainty, and doubt).

The one significant issue is very simple: should you rip out perfectly good PABXs and replace them with an IP Telephony solution? The answer is obvious: No, you should not. But if the legacy hardware has been amortised and/or if it can no longer handle the communications traffic, it makes sense to develop a migration plan while evaluating the concept in a department or at a branch office.

The next schematic illustrates the architecture of an IP Telephony solution and also indicates how the new technology can coexist with a PABX and its wireline phones. Via the experience gained during the pilot, a management decision can then be made about transferring more employees over to the new system. Others could very well stay with the regular phones until such time as the PABX has come to the end of its working life.



A gateway enables seamless communications between the two environments and it is also used by IP phones when receiving calls from the public infrastructure. External calls from these devices go over the WAN or a carrier-class IP network.

In a green field situation you forget about yesterday's technology and implement IP Telephony immediately. An IP solution will cost less because standards-based equipment is used. PABXs are based on proprietary hardware and software. But even bigger savings come from the use of one converged network for all media types instead of two.

Communications costs may also be reduced since a corporate intranet or a packetised carrier-grade service (i.e. an IP VPN) can be employed instead of the public (PSTN) infrastructure. Network management costs will be lower since there is only one network to administer, which can be done from anywhere on the network. Adds, moves and changes will cost almost nothing. If a centralised IP telephony call billing application is deployed (and many are now available) the capability to

monitor and thus control telephony costs throughout the entire network can also produce significant savings.

In addition, productivity will be enhanced since (a) the better IP phones are intuitive to use and (b) the enhanced IP Telephony functionality is available to all employees who have an IP phone, wherever they work. This is not the case in a circuit-switched environment: for example, typically only 10% of the staff would have voice mail.

Thus, the combined impact on the company's bottom line will be dramatic.

There are two minor issues. The LAN and WAN will be carrying additional traffic so the IT staff will have to ensure that the infrastructure can handle it. In addition, the IP addressing scheme must be able to handle the new voice IP applications.

IP phones

Currently there are eight global vendors of IP telephony systems: 3Com, Alcatel, Avaya, Cisco, Ericsson, Nortel and Siemens. By Spring 2001 around half a million devices had been shipped, but this figure is rising rapidly. Moreover it is an impressive figure for a technology that only started serious pilots in 1998. IP phone prices range from $300 for a basic IP phone to $700 for a full feature IP display phone, but these figures will fall as volumes ramp up.

The IP phones in following illustration come from 3Com (left) and Cisco (right). They can be used as a regular device, i.e. pick up the handset and enter a number. However, the screen size of the Cisco model is similar to that of a PDA and this allows date and time, calling party name, calling party number, and digits dialled to be displayed. In many ways these devices resemble a small computer and they can be employed as a thin-client device. There is a point-and-click graphical interface and other PC-type features such as the ability to search the corporate directory and set up personal directories. In addition, IP phones will normally have flash memory in order to facilitate software upgrades.

The IP display phone (right) is a top-of-the-range model that exploits the full potential of IP Telephony. However, vendors also offer models having less functionality and smaller screens (left) in order to match the different communications requirements of different employees.

Earlier on there was a reference to the ease with which end users can set up advanced telephony applications such as conference calls. For example, participants can be invited by dragging and dropping directory entries onto the user interface. This creates a virtual conference room and once the voice conference has been established, the participants can share the applications running on the different desktops.

This kind of telephony applications is quite impossible when PABXs and circuit-switched telephony are employed. Voice and data not only run on separate networks, they are alien to each other.

IP Telephony can also be implemented on a desktop or notebook PC. In the latter case users literally take their extension with them and can receive calls wherever they are connected to the corporate network.

Cisco has also extended the thin-client potential of their IP screen phones via the inclusion of XML technology. XML (eXtensible Markup Language) is an open standard that is used to define data elements on a Web page and business-to-business documents. This effectively turns the device into a web-enabled phone, which makes it possible to access information that is hosted in the intranet without a PC. Employees who would not normally need a PC for their work can therefore use this type of intelligent phone in order to better informed about the company's activities.

This is a brand-new concept and it is not clear what sectors of the market will make optimum use of this concept, but one can foresee its use in vertical markets.

Wireless IP

So far we have looked at conventional convergence, replacing the PBX with a server that handles switching plus call control and using IP phones that connect with the LAN. That is a commendable objective, for which there is a solid business case, but what about wireless? Over half the workforce in the average company is mobile and in many organisations the figure is much higher. Staying in touch is not a problem because everyone has a cellular phone and these are very useful devices, so useful in fact that they continue to be used inside the office. As a result, phone bills are higher than necessary.

The circle that has to be squared here is to retain mobility inside the enterprise while minimising the cost of internal communications. There is a generic solution; it involves a wireless interface to small base stations that are linked to the LAN. These stations also digitise the signal and convert it to VoIP, thereby enabling communications inside the office. In this case another server is used to switch and control the calls. However, the spectrum used by network operators is not free and a business arrangement has to be made so that a flat fee covers all internal calls, i.e. they are not metered.

How this idea will work out in future is not clear and some observers think operators will not cooperate. On the other hand large enterprises pay large phone bills and they can always switch to another supplier. Thus, while the incumbent carriers may be reluctant the smaller, more nimble competitors will certainly jump at the change of getting into the enterprise market.

The LAN itself is going wireless and in this case the spectrum is free and it can also be used for telephony inside the office. People who are mobile inside the enterprise can therefore use cordless phones for 'free' (unmetered) internal communications. (Internal calls made from wireline IP phones are also unmetered).

Cisco (www.cisco.com) is suggesting an internal mini GSM system. Downside: deals have to be struck with operators. Upside: no need for new phones and access points can also double up for regular W-LAN data.

Symbol (www.symbol.com) is leveraging its position in niche markets, i.e. phones and PDAs that incorporate bar code readers. These devices use the W-LAN interface. Downside: need to buy new phones and they only work for internal communications. Upside: the spectrum is free.

Fear, Uncertainty, and Doubt

PABX vendors continue sending confusing messages to the market and at times they overstep the FUD mark and start becoming extremely economic with the truth. The main missile that gets lobbed in the general direction of IP Telephony concerns reliability. Can you rely on computers when it comes to a mission-critical application like telephony? Can they match the 5 x 9 (99.999%) uptime of PABXs? The implication is clear: computers break down all the time and PABXs do not. But since IP cannot be ignored, the solution they offer is to plug VoIP cards into PABXs and get a 'best of both worlds' solution, i.e. the benefits of IP Telephony plus the reliability of this proven hardware platform.

What we have here is a couple of myths.

Myth one: PABXs don't break down. They do, but the customer doesn't notice. PABXs have a lot of redundant hardware and big systems come with expensive maintenance contracts. If something goes wrong the remote diagnostics program detects it and the card is replaced. A more honest claim would be: "there is no single point of failure; systems stay up 99.999% of the time." However, this figure doesn't stand up to close examination.

The granularity of the 5 x 9 claim is a line or trunk card, i.e. if a card goes down it doesn't count because the rest of the system works. According to BellCore 512 standards, outages of 64 ports or less are not counted in the reliability calculations, which is tough on the guys who were connected to that card. As far as they are concerned the system is down. Period. They cannot make or receive calls, but that's the way PABX vendors define reliability.

It's easy to bring up failure figures when talking about cheapie PCs, but this is not a fair apples v apples comparison. Enterprise-class servers are employed in IP Telephony and these are interconnected so that there is no single point of failure. This means that five times nine reliability (or better) is achieved.

Myth two: putting VoIP cards into PABXs enables IP Telephony. It does not. Recall that the term VoIP refers to a transport mechanism. This technique does allow the LAN to carry both voice and data and it also enables toll bypass, but this is not a big deal anymore.

IP Telephony sits higher up in the communications stack: it enables a whole raft of communications applications that PABXs cannot match. These cards do work with IP phones that live on the LAN, but there is no win. You're still locked into the feature set of the PABX. Yes, PABXs do come with 500 features, but very few are used. Entering *123 to transfer a call, for example, is the telephony equivalent of a UNIX command line instruction. Moreover, the codes vary from vendor to vendor and even from one model type to another.

So why do it? Why pay for another device that only does the same thing as the phone you already have? The real message is clear: don't confuse VoIP with the real thing, which is IP Telephony.

Competition is healthy; FUD is not. It only confuses the market and a confused market does not buy, it waits.

Conclusions

IP Telephony works. It's working at several thousand sites around the world and sales are increasing, while those of PABXs are declining. Every imaginable telephony application is available plus some that are brand new, e.g. the virtual conference centre described earlier and full colour IP video phones that will become available early in 2002.

To PABX vendors this represents a seriously disruptive technology, but the business benefits are considerable: IP Telephony saves money, improves communications processes and enables integration with other applications and corporate databases. The business case could hardly be more overwhelming and in a few years there will be no need to make it.