broadbandvantage

Samsung Electronics
VoIP and Wireless LANs:
Creating a new category – Voice over Wireless

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Authors:
Barry Castle - Samsung Electronics
Bob Cushing – Broadband Vantage

About this document

This paper forms an introduction to a complete set of white papers covering the commercial, technical and societal impacts of both Voice over IP (VoIP) and Voice over Wireless technologies to be published between June and October 2005.

These new technologies are set to have a significant impact on the way we work and how telecommunications services are provided and these papers seek to discuss these issues. The papers will be developed in different threads as follows

Virtual Enterprise Thread

The impact of these technologies on our working lives and the flexibility they bring support a number of trends that have been evolving over the last few years. This thread is introduced by a paper that discusses these trends at a high level followed by a series of more specific papers examining the following issues:

- Teleworking/Virtual Call Centres
- Relationship capital and social networking
- Collaboration and Presence management

Technical Thread

There are a number of key technology themes that underpin these developments, which are discussed in the following papers:

- WiMAX
- SIMPLE and presence
- NEMO/ENUM
- UMA/SIP
- IMS/Switching

Market Structure Thread

Changing usage patterns create new market opportunities. These will be discussed in a single paper covering the following themes:

- The role of the network operator vs. that of the service provider
- Channels and routes to market
- Infrastructure (physical vs. virtual)

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Handset Thread

Changes in usage drive a change in devices. In a single paper the following issues will be addressed:

- Changes in personal use
- Phone or computer?
- Physical interface choices (keyboard, keypad, stylus, voice activated)
- Multi function devices and their impact on roaming
- In car/mobile/voice recognition

Who should read this document?

This document is designed to aid senior communications decision-makers seeking to understand the key issues to be addressed when implementing mobile telephony across their business.

This document will aid understanding of:

- Changing work patterns
- The drivers for VoIP over Wireless
- Technological development
- How the technology works
- New applications
- Benefits
- Successful implementation
- The future: fixed/mobile convergence

Introduction

What is Wireless for?

As the technology that delivers data networking has stabilised around a well understood architecture (including Ethernet and TCP/IP) and the technologies themselves have developed to the point where they provide all of the capability that most people need, new developments have focused on the application of data communications in a mobile/wireless context. The evolution of wireless LAN (or WiFi) technology has had two principle drivers:

1. A need to address the requirements for networking where physical cabling is not practical or not desirable, especially where the number of connections is relatively small.

2. A need to provide mobile or nomadic access for people working outside of the traditional office environment. This was itself driven by a growing dissatisfaction with the high costs and poor performance of data communications over 2G mobile phones.

The former application has become the method of choice for networking in the home, especially in a broadband context. Where the DSL or Cable line comes into the building is rarely optimal for PC usage, and so domestic users have deployed Wireless LANs to get Broadband to the best place in the home, especially where a significant amount of homeworking is important to their overall uptake of Broadband. The explosion of Broadband has driven people into retail stores looking for an easy to install technology which is available off the shelf at a cost that is manageable for small numbers of nodes, and WiFi fit the bill.

Similar requirements have driven WiFi in business use. Some homes and offices are not really suitable for re-cabling – the cost and disruption of retro-fitting LAN cabling make it impractical. There is also the case that some landlords will not allow tenants to drill holes in walls or do the other work necessary to deploy LAN cabling. Unless the user is happy to have cables trailing across floors, WiFi is the perfect solution. It is also true that many businesses have a changing population of users and again WiFi's ability to flex across a dynamic population of users makes it ideal for this application.

This latter attribute, the ability to accommodate a shifting population of users, has driven the WiFi "Hotspot" market, in response to the requirement in the second point above. Airports, business centres and hotels are natural applications for this and speculative business plans have seen hotspots installed in coffee shops and pubs.

From a technology perspective the primary driver for WiFi usage has been simple availability. Most new laptops (which are taking an increasing share of the PC market) and many PDAs have WiFi capability built in, either at the chip level (Intel's Centrino product) or on the mother board. This drives the perception that WiFi is "free" and drives up its utility.

As WiFi and Broadband become pervasive users are looking for new ways to harness this newfound communications power and their attention rapidly transfers to voice traffic, which still accounts for the majority of most peoples spending on communications. In the early stages of VoIP (Voice Over Internet Protocol) deployment at the user level it was mostly invisible to the user and was driven by a strategic choice in larger companies. Latterly VoIP has become reliable and easy enough to use at the user level and the migration of this use from fixed broadband to wireless is inevitable. Where a specific choice is being made it is often driven by an awareness of the high cost of mobile calls.

Market dynamics

This new market is attracting sufficient attention to get on the radar of the analyst and market watching firms, who are starting to measure shipment and deployment volumes at the handset level. Although much VoIP usage is driven by “soft client” usage, this is difficult to measure. Handset shipments are a good proxy for the overall growth in the Voice over Wireless market, even if they account for only a portion of that market. Infonetics estimate that 113,000 units shipped worldwide in 2004 producing revenues of $45m with more than 8,000 handsets supporting both Voice over Wireless and cellular. Although this latter market is clearly in an even earlier stage, it looks likely that Voice over Wireless will create a further dynamic in the convergent telecoms market. Early shipments have featured take up in healthcare and logistics where fixed line phones have real limitations. In the US IDC estimate that the residential market for VoIP will grow from 3 million subscribers in 2005 to 27 million in 2009. Apart from the value of this market on its own, these sorts of volumes flush additional development investment into the technology and service provider markets. In Western Europe IDC estimate that overall IP telephony shipments grew 13% to $77m just in the fourth quarter of 2004. Their prediction for 2005 is that the market will grow 53% overall and revenues will reach $350m. Ovum estimate the VoIP market will reach $1.4bn in 2008.

Outstanding issues

There are still issues that need to be addressed and managed. The ones that have gained most attention so far have been quality of service, the ability to roam between different wireless platforms (or even between different access points on the same network), the relatively short range of unlicensed spectrum systems and their ability to support relatively low densities of users. As most users leave access points on their default settings, security is also a consideration.

Another issue at play is the shift in revenues between fixed and mobile telephony. In most markets there are multiple mobile operators, even where there is limited competition for the incumbent national carrier in fixed telephone services. This shift has challenged the business models of even the most monopolistic fixed line operators, who are seeing traffic levels falling rapidly in the one area of their business where most of the revenues and margins sit. Despite attempts to counter this with pricing action they have universally found the mobile proposition difficult to counter, to the point where, in some countries, the number of mobile handsets exceeds the adult

population and where many people choose to not have a fixed telephone line at all. Voice over wireless is seen by many operators as a partial answer to this challenge and as a way of defending their revenues against cannibalisation by mobile traffic. The VoIP "free on net" calls model can appear to makes their situation worse and yet many operators realise that they have to find a way of addressing these challenges. Embracing VoIP seems a bitter pill to swallow but the ability to challenge mobile erosion with Voice over Wireless makes this more palatable.

Changing Work Patterns and the "Virtual Enterprise"

Samsung has a vision of how business communications need to change to match the changing requirements of business which it has dubbed "The Virtual Enterprise" This vision reflects many of the changes identified in this document.

The core of this vision is that businesses need communications capabilities that reflect their increasing operational flexibility. Put simply, the traditional office-centric view of how businesses work, and how communications services are delivered, no longer fits the increasing drive towards mobility and the need to drive down fixed costs.

Traditional models for how offices worked changed for ever when the "job for life" contract was broken in the 80's and 90's. The speed of change in business put a premium on knowledge and the growth of IT as a means to reduce cost became embedded in the standard business operating system. More recently the traditional "command and control" method of management has been increasingly eschewed in favour of structures and mechanisms that put the emphasis on control by output rather than control by input. In other words, it's what you produce (rather than what you do) that matters. This in turn favours knowledge management and supports personal empowerment.

As a result what people expect from work, and by correlation, from an office has changed. With increasing numbers of people employed on short or fixed term contracts, and the move towards home working, people's relationship with their workplace and the systems in it has changed.

- Managers and employees want increasing flexibility in how they do their work.
- Traffic congestion is on the increase and many people are increasingly seeking homeworking and flexible working patterns as a method for improving productivity and quality of life.
- Government wants to meet environmental goals and has set goals for its own "virtual enterprise" initiatives.
- People who work from home tend to be much more productive and experience lower levels of stress
- The role of the secretary has largely disappeared to be replaced by a general admin whose main role is to keep track of people, act as a

communications hub and control the distribution of resources in a group or team.

All this means that people expect to get access to resources on demand and when the office is full, often for a cycle of meetings, resources are in short supply. With the increased incidence of meetings which seek to keep people synchronised in this fast moving world, use of desk space and the systems traditionally associated with it is changing.

In the traditional office model everyone had their own desk, more recently with a desktop PC and a PBX phone. These were hardwired in and any flexibility to even move a desk was severely impaired, not just by the cabling, but by the availability of sockets into which to plug everything.

Thus the birth of hot-desking. With hot-desking everything is either provided on a permanent basis and the workers move around (meaning most of the equipment is unused most of the time) or individuals are provided with their own portable computer and mobile phone. A hot desk becomes just a place to charge mobile devices and, possibly, to connect PCs to the company network (assuming it can be made to work in an acceptable timeframe). Besides, a lot of the time spent in the office is in meetings, so are these facilities really necessary? Access to networks and power become an issue of right rather than need.

When what people do when they are not in the office is added to this, the realisation dawns that the dominant phone model, for many people, has become the mobile. The handset is associated with the user, rather than an arbitrary extension or port number. Most of the calls made do not involve dialling a number but selecting a user from a contact list, and this style of usage is increasing. For many users the mobile is the device of choice even when they are in the office and they have changed the use of telephone handsets for ever.

The drivers for VoIP

Societal drivers

These changing working practices and the change in how phones are used are also linked to other societal changes.

Quality of life

One of the drivers behind changing working practices is a desire to work to live rather than live to work. Because the guarantees that were implied in people's relationship with work have been broken they increasingly seek to achieve a better balance between work and life. The pace of change and the speed at which business is conducted have accelerated over the last 20 years to such a degree that people are now routinely experiencing some of the demerits of all this, especially longer working hours, stress and health problems. Many people are now realising they need to exercise some control over the impact work has on their lives and are using flexible working practices to improve their quality of life.

Commuting and the environment

The relationship between commuting and pollution is clear and government is encouraging the trend to break up accepted working patterns in favour of spreading the traffic load to reduce pollution.

The pension gap and downshifting

Many people realise that the pension system is unlikely to provide them with the support and the lifestyle they want and so people are going to carry on working for longer, although increasingly on a flexible basis in terms of time and location. Business systems need to track and reflect this to enable these types of working to be supported. Historically office phone systems, with their static paper-based directories, made this kind of flexibility difficult to achieve. The newer applications positively facilitate this. Correspondingly many people wish to reduce the stress they experience by downshifting their work, often to a more rural and homeworking basis.

Financial drivers

IP telephony and Wireless LANs enable greater flexibility without the fixed costs of traditional wired LANs and PBX's. People's relationship with their handsets change and in many cases a PC client is perfectly suited to how they want to work, removing this cost element entirely. With the ability to redirect traffic to wherever someone appears on the network, you no longer need to schedule desks or physical locations. Many large companies such as BT have been able to reduce their investment in property and fixed IT infrastructure by adopting these flexible working practices. There was a time when flexibility was expensive. Now it can bring even lower cost. Over time smaller businesses, who often have a more direct relationship with costs, (especially where they are owner managed) will seek this flexibility and functionality from their telecommunications and IT infrastructure

Cost drivers for the small business

Small businesses are often driven by sensitivity to cost or by a desire to grow their businesses, or some mixture of the two. VoIP is likely to become quickly adopted as it brings services such as international teleconferencing into the reach of the smaller business and goes one more step to breaking down the geographical boundaries that often hold back the smaller business. Globalisation will become an issue not just for larger businesses. The ability to get all (or at least a portion) of "on net" calls free of charge is compelling. It is interesting to note that what "on net" means will also change as operators seek to make their boundaries more visible and thereby encourage their clients to bring more of their regular contacts "inside the rope". Word of mouth (or Friend of a Friend as it is sometimes called) has always been the most powerful marketing tool. "On net" encourages the customer to bring people onto the network to reduce their own costs and VoIP is a powerful tool in delivering this, especially for the competitive carriers. The higher percentage of regular contacts that are "on net" the smaller the billed cost will be. In fact VoIP changes the overall billing model from "calls and lines" to a combination of personal subscriptions, some free calls and some charged calls. This is a huge change for the telecommunications industry and organisations should expect to see the sort of bundling and packaging that is currently endemic in the mobile industry coming into the "fixed" network as operators seek to press

a competitive advantage through price based differentiation. One of the casualties of such a change is customer loyalty with people changing to take advantage of new packages and tariffs.

Competition in the telecoms market

One of the dynamic factors driving the development of the market for VoIP in general is the support of the carriers. For BT, VoIP is both a defence and a "win back" opportunity; they see the need to ensure that their new IP infrastructure (dubbed the 21st Century Network) stretches right to the edge in order to fend off the competition of alternative carriers. With such a high percentage of revenues (and an even higher percentage of profit and cash generation) accounted for by voice traffic, BT cannot afford to stand still. These alternative carriers, in turn, see VoIP as a method for changing the voice business model to the detriment of the incumbents (BT) market share. For them the business is to be won rather than defended and VoIP offers them the opportunity to keep traffic away from the BT network and under their cost control. Cable and Wireless, Kingston and Colt have all launched Voice over IP strategies with C&W refocusing its efforts on the SME marketplace.

Many of these aspects will be discussed further in the Virtual Enterprise and Market Structure threads.

Technological development

The Broadband revolution means that business grade connectivity is available pretty much everywhere at a fixed cost. This connectivity is now set to move from the fixed network to wireless and mobile networks further increasing location flexibility.
When working from home the idea that the user would re-cable their house was one that very swiftly died to be replaced with the explosion of wireless LANs. Once broadband is in the home the need then becomes to distribute this resource to the appropriate work areas. Broadband usually comes into the house at a fixed point, rarely where it's wanted. Wireless LANs become the ideal way of getting the resource to where it is needed, especially in multi PC households.

So if wireless LANs are a convenient way to distribute IT resources around a building in a low cost and flexible way, are they the right technology for distributing telephone services around a building? The simple truth is that the technologies to deliver this are now at the point of maturity that they are ready for mass deployment.

For some time now there have been multiple technologies available for carrying telephone signals within a property including DECT and Bluetooth.

DECT was essentially an air interface coupled with a telephony interface. No standards were set for delivering advanced applications which meant that implementations tended to be proprietary with functionality often limited to caller ID. DECT also failed to provide a mechanism for handling data as well as voice so one of the key benefits was missing available today with Wi-Fi was missing.

Bluetooth's main drawbacks have been range and ease of use. It is simply not straightforward to set up a Bluetooth phone and have it work reliably. Wireless LANs are simple to use and usually work out of the box. Security, originally a problem, is largely resolved. The chipsets are produced in such volumes that cost is rarely a factor.

The Skype phenomenon

The next change in telephone usage we can largely attribute to one free service, Skype. The idea that you can make free phone calls long distance has taken off like wildfire. At any one time upwards of 2 million Skype users are online. Skype is the next phenomenon after illegal downloads to really hit the Internet. And curiously it was invented by the same team as created Kazaa, which set the standard for music downloads.

There are several aspects to the Skype service that change the way we use telephones apart from the obvious cost savings. Firstly, like with many mobile calls, you don't dial a number. You look at whether your contact is online and free and then open a call in almost exactly the same way as you initiate an Instant Messenger session. In fact the Skype interface looks most like an IM client and even supports chat capabilities. This type of multi function capability pinpoints a trend towards a single "window" for controlling all of your communications systems whether they are email, voice, chat, video or fax. Some years ago there was a trend towards personal numbering and Unified Messaging. This may well now have arrived, if via a torturous route.

There are two aspects to this interface that are key:

1. **Presence**
   Presence further develops the idea, borrowed from IM, that communication is enabled with people only when they are visible. This comes with its own set of pro's and con's. Firstly users have to be online a good percentage of the time for it to be valuable (or in the case of our children, at predictable times) but the key advantage is time isn't wasted communicating speculatively with the "Voice mail dance". Every call is productive.

2. **Identity**
   This enables collaboration and also networking, particularly if users can search for certain parameters that match their requirements. In fact this kind of online networking is becoming an application in its own right with the explosion of usage on networks such as Ecademy, Ryze and LinkedIn. These are business oriented sites, even though the process can seem a bit like a lonely hearts club. In fact business has always been done via networking – originally via church, the Masons or other business clubs such as Round Table – it's just that now it is done online. As a way for finding customers, suppliers or partners its use is growing especially amongst small businesses looking to expand the scope of their coverage. So identity becomes a critical way of marketing both at an individual and at an organisational level.

If these two aspects are put together they create the drivers for Voice over Wireless. Flexibility and changing working practices drives a need for the sort of flexibility and dynamics that wireless networks deliver. People's changing use of telephones drives the need not just for VoIP but also for networking and collaboration applications that drive greater value.

Both the VoIP and Wireless markets are the scene of explosive growth in new technology investment, both in terms of new business start ups and innovation. Criticisms of the suitability of wireless for voice transmission revolve around the lack of standards for quality of service, flexibility and density of users supported. Development such as MIMO which seeks to improve the density and new developments in roaming technology such as Syncscan, which enables the user to move between multiple access points without losing connection further close the functionality gap between VoIP over wireless and mobile. However the development most worthy of attention is WiMAX which promises the ability to address virtually all of the concerns in early versions of the technology including not just range and density/bandwidth but also the ability to support not just roaming between fixed access points (nomadic usage) but ultimately near full mobile usage (i.e. the ability to use it on the move). Samsung's leadership position in the WiBro developments with LG offer the prospect of early advantage in the physical interface selected for the later stages of evolution of the standards. With volume shipments of the 802.16d product due in the autumn of 2005 work has already started on addressing extensions to this technology to support VoIP at the silicon level. Further down the line the prospect of the 802.11n fast WiFi standard indicates even further scalability in the technology.

These elements will be discussed further in the Technical Thread

How the technology works

This section is intended to provide a 'plain language' description of the underlying technologies for delivering voice over wireless networks. Its purpose is not to provide a detailed technical reference (there is enough technical reference material in the public domain) but rather to describe the underlying material in sufficient depth to enable a decision-maker to weigh up the issues and to anticipate the challenges associated with a major WiFi deployment. Further discussion can be found in the Technical thread.

IP

TCP/IP emerged as a standard protocol for supporting heterogeneous networks and applications. It effectively linked the physical and media access layers to the layers above, allowing programmers to focus on applications without having to worry about the physical devices and infrastructure their applications would transit over.

While TCP/IP was certainly in broad use, it was the World Wide Web (a TCP/IP application) that started to take off in the mid-90's that provided the impetus for a massive shift to TCP/IP on a global basis.

IP is a layer 3 inter-networking protocol in other words it sits above physical layer 1 (cables and radio frequency) and the data link or single network layer (Ethernet Media Access Control) at layer 2 and provides:

1. The ability to connect multiple networks
2. A technology independent presentation layer for use by applications

It is this last point that makes the protocol so interesting for fixed mobile convergence. Historically carriers have used SS7 protocols encoded using ASN.1 for telephony applications, whereas businesses now rely almost exclusively on IP. With a single, easily understood protocol spanning both environments a whole range of business and consumer applications can be developed for mobile devices.

There are hundreds of higher level protocols defined by the IETF for use with IP and a very small subset are listed below firstly to illustrate how widespread IP has become and the extent to which our businesses rely on it and secondly to highlight some of the current work related to IP telephony and mobility:

- SMTP – Simple Mail Transfer protocol – used for email
- HTTP and HTML – Hyper-text transfer protocol – the basis of the World Wide Web.
- DNS – Domain naming system – used to convert IP addresses to names like www.samsungbusiness.co.uk
- SIP – Session Initiation Protocol – used for Voice over IP telephony
- RTP – Real-time transport protocol – used for transmitting time-sensitive information like voice and video
- SIMPLE – the ability to use SIP to transport instant messages and presence information
- NEMO – Network mobility – used for mobile devices and mobile networks to connect to the Internet
- ENUM – translation between IP addresses and E.164 telephony numbering and the support of number portability. This is used for merging VoIP with traditional PSTN (Public Switched Telephone Network)

IP and many of its higher-level applications are publicly available from organisations like Open Source resulting in an almost constant flow of new applications written to work over IP. These applications often challenge existing approaches and provide new business opportunities.

As has been discussed elsewhere in this document it is expected that hybrid GSM/WIFI handsets will become available and that these devices will, for the first time, use voice over IP for both business and public telephony. Applications developed for the business environment will be equally available outside the confines of the office or campus. It is anticipated that a new market for integrated business applications that leverages the processing power and connectivity of these new devices will develop.

Many of these newer technologies will be discussed in detail in later papers.

Wireless

Wireless communications use radio emissions rather than electrical impulses to communicate. In the same way that data can be sent on copper cable assigning numeric values to electrical frequency vales, wireless communications use a similar mechanism with radio waves.

The frequency spectrum is a limited resource and to avoid cross interference, frequency allocation is controlled by a governing body that determines how the spectrum can be divided up and used. The bodies that control our spectrum include: ITU, ETSI, FCC and the regulatory bodies of national governments (OFCOM in the UK). Unlike 3G frequencies which were auctioned, Wi-Fi is unlicensed.

The list below shows how different communications systems have been assigned across the spectrum:

GSM (US)	850 and 1900 megahertz
GSM (EU)	900 and 1800 megahertz
DECT	1.88 - 1.9 gigahertz
802.11a (WiFi)	5 gigahertz
802.11b (WiFi)	2.4 gigahertz
802.11g (WiFi)	2.4 gigahertz
802.16a (WiMAX)	2-11 gigahertz
802.16e (WiMAX)	< 6 gigahertz
Bluetooth	2.4 gigahertz

802.11 – WiFi

802.11 refers to a family of specifications developed by the IEEE for wireless LAN technology. 802.11 specifies an over-the-air interface between a wireless client and a base station or between two wireless clients. The IEEE ratified the specification in 1997. Although WiFi technically only applies to the 802.11b standard, it is applied here to refer to all 802.11 implementations

There are several specifications in the 802.11 family:

- **802.11** -- applies to wireless LANs and provides 1 or 2 Mbps transmission in the 2.4 GHz band using either frequency hopping spread spectrum (FHSS) or direct sequence spread spectrum (DSSS).
- **802.11a** -- an extension to 802.11 that applies to wireless LANs and provides up to 54 Mbps in the 5GHz band. 802.11a uses an orthogonal frequency division multiplexing encoding scheme rather than FHSS or DSSS. As result 802.11a generally suffers from lower levels of signal interference and more predictable performance
- **802.11b** (also referred to as *802.11 High Rate* or *Wi-Fi*) -- an extension to 802.11 that applies to wireless LANS and provides 11 Mbps transmission (with a fallback to 5.5, 2 and 1 Mbps) in the 2.4 GHz band. 802.11b uses only DSSS. 802.11b was ratified in 1999 as an extension to the original 802.11 standard, allowing wireless functionality comparable to Ethernet.
- **802.11g** -- applies to wireless LANs and provides 20+ Mbps in the 2.4

GHz band

There are a number of key features of 802.11 that have driven its wide takeup:

- **Unlicensed spectrum - i**n most cases 802.11 a and g do not require a specific license and 802.11a operates under a “light license” regime. The main limitations in operating in an unlicensed context are limitations on power (and therefore range) and competition for the spectrum from multiple access points. The most commonly used (a and g) can therefore suffer from performance problems in busy environments

- **Low cost -** with the delivery of onboard wireless capabilities in most standard laptop chipsets 802.11 has become widely perceived as free

- **Simple install -** most people set up wireless LANs using the default configuration as the product comes out of the box. As a result there has been a proliferation of unsecured LANs, which in turn has driven the perception that 802.11 is insecure

- **Ease of access -** partly because of the fact that many LANs are still unsecured, it is very easy to find a network which you can access free of charge. This ability has been extended by the activities of “war chalkers” who mark locations on the pavement from which a free signal can be found

802.16 – WiMAX

WiMAX is the technology which is most likely to not only revolutionise Wireless Data applications but also throw a significant spanner into the works of Broadband operators reliant on copper and fibre networks. Because it resolves the issues which have limited widespread wireless LAN deployment outside low capacity, low density deployments in offices, homes and Hot Spots, WiMAX is likely to turn the networking industry on its head. In term of capacity, quality, reach, range and security WiMAX is a direct competitor to the highest quality leased line services available today, but at the sorts of prices we have become used to for cable and DSL deployments over copper wires

802.16 supports a point-to-multipoint architecture in the 2-66 GHz range, transmitting at data rates of up to 120Mbps. At the higher frequencies, transmission requires line-of-site, and roofs of buildings provide the best mounting locations for base and subscriber stations. The base station connects to a wired (or wireless) backbone and can transmit up to 30 miles to a large number of stationary subscriber stations, possibly hundreds. At this level it has specific applications for point-to-point and backbone-type implementation. The current version of the standard is 802.16 2004. Work is still being done on interoperability but for an operator deploying both the main masts and the subscriber aerial the technology is ready for use now. It was designed from the ground up as a data networking technology.

To accommodate non-line-of-site access over lower frequencies, the IEEE published the 802.16a standard in January 2003. 802.16a operates in the licensed and unlicensed frequencies between 2GHz and 11GHz using orthogonal frequency division multiplexing (OFDM), which is similar to 802.11a and 802.11g. It will, in most cases, give bandwidth up to 75mb and ranges from 1-5 miles subject to terrain and other variables.

The next step for the 802.16 working group was to add portability and mobility to the standard. In March 2002, the working group began the 802.16e Study Group on Mobile Broadband Wireless Access. This group will address many different mobility issues, including providing connectivity to moving vehicles within a base station's sector. Standards in this area are expected to be delivered in 2005 and 2006

WiMAX addresses many of the limitations of WiFi, specifically in terms of coverage, bandwidth and range. It enables operators to set up “zones” of coverage instead of “hotspots”

The specific advantages of WiMAX over previous Wireless technologies break down into a number of key areas:

- WiMAX is designed to support IP and ATM quality of service so can be used for a range of time and quality sensitive applications such as voice and video
- WiMAX can support very high data rates especially in Line of Sight applications. It is ideally suited to leased-line replacement services in the 2mb range. Non Line of Sight implementations enable lower cost/lower bandwidth implementations.
- WiMAX is adaptive enabling it to cope with different interference and performance issues which in turn enable it to support high data rates and quality in relatively “noisy” environments. Depending on the frequency allocated different numbers and width of channels and different coding and modulations can be used to negotiate the best combination of bandwidth and quality. Different service flows can be created which makes it ideal for Class of Service operations and multiple VLANs can be supported
- WiMAX is relatively quick and cheap to deploy

WiMAX and spectrum licensing in the UK

Wireless bandwidth comes as a result of the interplay of a number of variables. The comments below are simplifications and generalisations. The reality is somewhat more complex:

- Frequency. Lower frequencies (say below 10GHz) are best for short distances and Point to Multipoint and Non Line of Sight deployments. Higher frequencies are classically used for longer distances, higher bandwidth and Point to Point deployments.
- Bandwidth. The width of the band at any available frequency has a major impact on the data throughput

- Power. The power of the transmitting station (and the receiver) affects performance. As a comparator a WiMAX mast might have an aggregate power output of 2 watts compared with a mobile phone mast's 2 kilowatts. 2 watts is roughly the power output of a mobile phone handset
- Interference. Other users and the topography make a big difference to performance.

Following the success of the 3G auctions, the government followed up with auctions of a number of frequency bands for Fixed Wireless Access, fully expecting wide deployment to follow and a competitive wireless data market to develop. As the industry came to terms with straitened circumstances in the period after 2001 when financial markets were no longer able to raise vast sums of money for network deployments, wireless data became a damp squib. Auctions in the 3.4 GHz, 3.6-4.2 GHz and 28 GHz ranges were completed but industry consolidation followed.

This has created pressure for a new approach to wireless licensing a number of principles have evolved.

As we have seen, power output has a big impact on range and performance but also can mean that interference between users of a slice of spectrum increases. A whole range of Short Range Devices with low power have now been removed from needing a licence.

WiMAX in the UK can be made to operate at 2.4GHz, 3.5GHz or in the different bands at 5GHz (A, B and C). At these frequencies both Point to Point and Point to Multipoint deployments can be used. Different licensing approaches have been taken, again influenced by the power output of masts and receivers, which mean that use of the spectrum, can be on an unlicensed or "low-licensed" basis. Much interest has been shown in the 5GHz Band C spectrum, which was released at the beginning of 2004 and is administered by Ofcom. At 5.8 GHz the frequency is high enough for range and capacity and the breadth of the band enables sufficient channelisation for quality deployments. The light license regime (at a £1 per subscriber) is cheap enough to encourage commercial low cost deployment but the very existence of a license requirement discourages casual usage.

Wi-Fi Security

The very nature of wireless communications means that organisations must take extra care concerning security. Common risks include:

- **Squatters** – individuals who make unauthorized use of your network resources
    - Signal coverage may go beyond the physical walls of the building and the SSID used by access points is transmitted in clear text
    - Users can plug in their own access points and extend the physical reach of the network
- **Eavesdroppers** – individuals that capture and listen to Wi-Fi

transmissions potentially obtaining corporate intellectual property and intelligence
- **Malicious attackers** – individuals that proactively attack the IT resources of the company by either Virus insertion or Denial Of Service attacks

Voice conversations are equally vulnerable to these attacks and network designers must consider both voice and data attacks when designing their solutions.

Most casual attacks can be eliminated by encrypting any information transmitted and the WEP (Wired Equivalent Privacy) scheme, which encrypts communications for specific access points using the SSID (Service Set IDentifier) combined with an encryption key, enables this.

It is however possible to crack the WEP scheme and business applications should make use of access controllers in conjunction with their wireless implementations. These will authenticate users and use dynamic encryption making it much more challenging and time-consuming for malicious attackers to gain access to the network.

Voice over IP

Work on standardizing a protocol for delivering Voice over IP networks began in the mid-90's with an ITU standard: H.323. This defined three key components:

- **Gatekeeper:** Handles call setup and tear down and gateway registration
- **Gateway:** Converts telephony media streams to encoded IP packets and vice-a-versa
- **Terminals:** Telephones (essentially a single user gateway)

With these three components the necessary elements to construct an enterprise PBX (IPBX) or even to replace a carrier class switch (Softswitch) exist. More recently there has been a shift away from H.323 in favour of an IETF standard: SIP (Session Initiation Protocol). The reasons driving this shift are as much about politics as about technology. However, one real and broadly accepted reason driving this change is that SIP is an easier protocol for applications development. As with any technology shift in the IT industry, the applications inevitably drive the benefits – and today SIP is emerging as the protocol of choice in the enterprise voice system market and intriguingly as the underlying protocol for 3G mobile communications.

SIP defines the following components:

- **SIP Proxy -** Sets up calls on behalf of UA's that don't know where to find another UA or GW they would like to call.
- **SIP Gateway -** Similar to the gateway defined in H.323
- **SIP User Agent -** A single user gateway.

With these components it is possible build a complete voice system.

An uncompressed voice stream on a circuit switched telephone network requires 64 kbits/sec of bandwidth. It is possible now to compress voice down to 16 (or even 8) kbits/sec using standard codecs like G.729a or G.723.1. However, the media stream still has to be sliced up into IP packets in order to be routed over the data network

To do this effectively a special-purpose wrapper (protocol) called the Real-time Transport Protocol (RTP) is used. This will help with the reconstruction of the media stream at the other end – it includes information about clock cycles so that the packets can be correctly ordered or even discarded if they don't reach the end point fast enough. The RTP header can be compressed to minimize the additional overhead above and beyond the actual media stream.

Because IP networks are not specifically designed for real-time traffic, signalling programmers use certain strategies to avoid potential voice quality degradation that might occur if packets have to be retransmitted after getting lost or delayed somewhere along the way.

1. Tag voice packets so that they get priority handling by the network switches and routers
2. Include predictive information in the current packet so that if the next packet fails then an approximation of the sound can be generated
3. Keep packets small so that lost packets can't be perceived as gaps by the human mind
4. Forget about packets that don't arrive within a certain amount of time

Getting back to the description of the media stream, having chopped it up into packets and wrapped an RTP information around it, its source and target addresses are assigned and it is handed over to the physical media for transmission –Ethernet and Wi-Fi.

The packets are transmitted, switched and routed to their destination where they go through the opposite process of being converted back to sound so that the person on the other end of the conversation can hear what is being said.

In an enterprise environment, this entire process needs to be done in less than 100 milliseconds, otherwise customer satisfaction issues occur along the lines of: "it sounds better on my cell phone". Typically delays will only appear when communicating across sites where routers tend to need special admission control to ensure adequate bandwidth is allocated for voice.

The complete solution

Having described the various building blocks for wireless telephony and having shown how these building blocks interact to deliver a compete system, an end-to-end system now exists:

- VoIP standards for call setup and media conversion
- IP for global networking and a common application interface
- Physical infrastructure to convert IP packets into electrical impulses

and radio waves transmitted from one place to another based on Ethernet

It is predicted that this same collection of components will be equally applicable for business, residential and mobile users. What sort of applications are in the pipeline?

New Applications

As was briefly discussed, presence is not merely a technical capability – it actually changes the way things are done. Communication (whether it is voice or data-centric) is enabled when the various parties are available. This represents a fundamental change in the way calls are made and is similar to how Instant Messaging applications are used. This in turn changes the model for how telephony services are charged. The prevailing model is likely to involve personal subscriptions (i.e. a per user charge) rather than a line or extension charge, plus a call charge for calls that go off net. This is similar to how mobile phones are charged which in turn reinforces a "personal handset" model where the users most commonly used numbers are stored as part of the subscription or on the handset itself. With Voice over Wireless handsets the form factor and styling is likely to echo mobile and users will carry them around the office or when they go out and about. Dual function phones with both Voice over Wireless and true 2G/3G capability will be available in identical form factors and styling options to the pure mobile handsets they replace.

Presence

Voice systems have traditionally shown the current call state of an extension on the system. What was not provided was information about whether the person was actually at their desk even when the phone was idle. Over recent years applications like AOL, AIM and MSN Messenger have emerged which provide presence information based on keyboard strokes or mouse movement. This information can be linked to the user's calendar and geographic location to deliver more meaningful information: In a meeting, or don't call he's in Japan where it is currently 3am. Combining this functionality with the telephone is a natural next step and the SIMPLE protocol is currently being worked through the IETF to support both instant messaging and presence.

Identity

As organisational boundaries change, become transparent or disappear, the ability to assess whether another party is someone one wishes to initiate or even permit communication with becomes even more important. There will always be organisations and individuals who want to restrict their visibility and these tools will enable this as much as they will improve visibility. It is key that the individual has control over these parameters for these tools to become accepted. With identity comes security to protect organisations and individuals from illicit or damaging behaviour.

Collaboration and networking

Once presence and identity management exist in the network it becomes possible to foster interpersonal networking and collaboration. These applications have a hierarchy with communications based collaboration following on from presence and identity with workflow collaboration (shared documents and processes) following for some knowledge workers who need to collaborate at a task level. The ability to collaborate at these two levels creates a business accelerator effect especially for small businesses, as they have traditionally been the domain expertise of the larger organisation.

Key to the development of composite applications and the integration of applications from different vendors is the relentless migration of the core protocol to SIP. SIP capability is now being embedded in many client applications to facilitate this integration, so critical especially to collaboration applications. Although not classically seen as a core Telecoms supplier, Microsoft's adoption of SIP in products such as Live Communications Server (LCS), signals an intention to ensure that these new applications are properly tied back into their market dominant desktop applications. Vendors are already developing new capabilities based on this platform.

Text To Speech and Speech To Text

Text to speech provides various enhancements to the classic telephony interface and voicemail applications as follows:

1. Speech diallers. The ability to initiate calls by voice rather than keystroke
2. Interactive Voice Response. The ability for calls to be handled by a machine rather a human

Increasingly organizations are hoping to use this technology to increase productivity. One example is call monitoring, which has long been used in call centre environments to review agent productivity (and, in some cases, to ensure regulatory compliance) – ultimately voice has not been considered as a company resource but as a communication stream – and adding keyword searching and indexing to the storage of this information will potentially remove the current requirement for double-work (such as email confirmation of actions). Some examples of how this might work are:

- keyword searches in recorded proceedings of conference calls,
- unified messaging for voicemail

Conferencing

Conferencing, whether audio or video, and especially International has been another application classically limited to larger organisations. As organisational boundaries break down and collaboration tools really deliver on the promise of the virtual organisation it is very likely that these tools will be in common use in the smaller business. The ability to manage down the cost of long distance calls and set up dynamic conferencing on the basis of availability will deliver benefits to the first time and the experienced user as traditional conferencing can be awkward and time consuming to coordinate. This in turn migrates into a "chat" methodology where

calls are enabled rather than made in the formal sense.

Follow me (Unified Messaging)

As the number of phone numbers users "own" has increased the ability to find the right person without making multiple calls has become a challenge. With the development of Intelligent Networking (IN), driven in large part by the growth of call centres, calls can be routed across a telephone network based on a number of commands or policies. Most people's experience of this starts with the Intelligent Voice Response (IVR) systems commonly in use in Call Centres. Most people have become used to having calls queued and being given choices to make as to how they are handled. The inverse of this is having a system that finds the user. Early versions of this required individual schedules and locations to be set up. IP technology and presence means that calls can be routed dynamically to wherever the user shows up on the network, but can also be overridden if they do not wish to receive the call. This level of control creates a virtuous loop with presence management. The user can now look to see, not only if the other party is available but whether it is a good time to call.

Call centres

IP telephony has been gaining ground in Call Centres for some time. The trend towards offshoring, virtual call centres (where calls are routed between multiple locations) and homeworking has accelerated this trend. Much traffic going offshore is converted to IP to enable more efficient use of international trunk capacity and the ability to integrate telephony into other applications makes it a good fit for this type of usage. Datamonitor believes that IP telephony will become mainstream in the Call Centre market over the next four to five years although much of this growth will come in "Greenfield" deployments. However, even allowing for legacy upgrades, they predict that IP shipments will reach parity with TDM by 2008. A key development in this deployment is the migration to virtual and smaller call centres, especially where there is a premium on individual service and higher levels of sophistication (see Thomas W. Malone, MIT School of Management "The Future of Work", 2004). This is especially true in the knowledge economy sector which itself accounts for 8.4 m workers or 30% of the total working population (Rebecca Harding, The Work Foundation published in the FT, 18th October 2003). The overall market for call centres is estimated to reach 1m agents in the UK by 2007, by the DTI

Hot-desking/remote working

As has been seen in previous sections, the changes in working patterns can themselves spawn new applications. Hot-desking becomes a set of technology options that might include presence, follow me and other routing and management capabilities. To gain the security we need to divert traffic over the public Internet "Homeworker" systems classically include Broadband connectivity, a telephony capability, a Virtual Private Network to tie them together and routing and directory services to make them usable

Number portability (ENUM)

In the same way as number portability has been key to the competitive development of the mobile market, numbering in general and porting between

traditional and IP environments specifically, are becoming gating factors to the development of VoIP and Voice over Wireless. Following the recent furore over emergency access over VoIP, expect to see increased focus on these issues at the regulatory level. There are two key issues that underpin these discussions:

- Geographic numbers and physical location. A key benefit of VoIP is location flexibility. The UK numbering scheme associate number ranges with specific geographies and form the basis for how calls are charged. If users can roam around the network what number should be associated with them in different locations?
- Charging. Although specific number ranges have been allocated for VoIP destinations, non-geographic numbers attract a premium over geographic numbers.

The issues around numbering will be discussed in a specific paper on ENUM within the Technical Thread

Benefits

The benefits of VoIP and Voice over Wireless can be summarised into two categories:

Flexible working

As the pace of work increases (and with it stress), employees are asserting their desire for a better work/life balance through improved flexibility. This has a number of manifestations, all of which are simplified or enabled through a combination of VoIP and Wireless technology

- Mobility. Work is becoming less and less office based. Then impact of globalisation and reduced timescales drives a greater need for speed of response. This results in an “always on, always available” mindset where there are very few circumstances in which we are not available. Mobile phones have either poorly or expensively addressed the issues of data connectivity. Wireless technology addresses the cost and quality of the data connection and as a result provides an alternative conduit for voice communications
- Home working. As most Western societies reach full employment, many people who would not normally be part of the workforce, for reasons of age, disability, childcare etc. are being lured back into work by the opportunity to work from home. By contrast the “always on, always available” culture drives a need to work from home at evenings and weekends even for the full time employed
- Presence/collaboration. Much business communication is unproductive due to unavailability or difficulty in reaching people. This causes “the Voicemail Dance” where repeated messages are left in an attempt for two parties to make contact. Presence and collaboration technologies, enabled by IP and “always on” technologies enable us to see when people are available and to screen communications for productivity, improving choice and control
- Single number contact. As we have become more location independent our contact numbers have proliferated (office, home, fax, mobile). IP

technologies enables us to use a single number and then have the intelligence of the network forward and convert all communications into the most suitable format for our current circumstances, without the caller having to know anything about our current state.

Economic benefits

- Access to free/low cost calls. The most hyped aspect of VoIP is the availability of free calls “on net”. As the meaning of “on net” develops the current model of calls and lines charging for telecoms will migrate to a simpler subscription based packaging where only a decreasing percentage of calls are metered and billed. This trend is already well advanced in mobile. This improves price transparency for the user, although there will always be arguments and confusion over what calls are or are not included in the “bundle”. This inevitably drives the overall cost down where competition is strong
- Software over hardware. Historically a very high percentage of the overall cost of telecommunications has been accounted for by the physical aspects of the network (switches, handsets and cabling). As more and more of this migrates to IP the processing is increasingly provided by extant hardware. This drives a software centric delivery model and pushes down costs
- One cabling system/one network. In most businesses the cost of running two networks, one for voice and one for data, are purely duplicative. Running these on one network or “no network” drives down the fixed costs. These benefits have most impacts in green field sites or expanding operations
- Simpler management. Because traffic is converging on one IP network, management costs and overheads associated with supporting multiple networks are reduced
- Better application integration. As voice and data converge new applications emerge to support new working practices, but the impact on existing applications should not be underestimated. The ability to converge communications at the application level create an opportunity for ongoing economic benefits
- Open systems. Many traditional telephone systems are proprietary and expensive. The impact of open systems on telephony is only just starting to be felt, initially in the areas of added value applications. Over time the cost of the hardware and core functionality will also drop, as is already being seen in the handset market

Successful Implementation

The keys to successful implementation of VoIP and Voice over Wireless share many of the common strands of IP networking generally:

Security

Whilst awareness of security has increased generally, concerns over wireless security have been well documented. Because of early inadequacies in wireless security and because many users deployed networks without

changing the default settings, potential backdoors to networks in general were opened. Improvements to the WEP standard and deployment of general IP networking security have gone some way to assuaging these concerns. Access control and authentication services have become more commonly deployed and as wireless networking moves from a peripheral technology to a generic broadband delivery option, providers and users alike will need to keep pace with security standards. As IP VPNs become more common organisations ability to exercise their own control over the end to end connections they use will increase.

Voice Quality

Whilst the myth pervades that IP Voice is lower quality, it is true that steps have to be taken to ensure consistency of performance. With the rapid development of new codecs, stream sizes have fallen and understanding has grown to the point where unmanaged quality of voice has matched or exceeded that of mobile. In many cases simple, open standard steps such as separating voice and data with VLANS or setting simple priority schemes are adequate to deliver toll quality voice services and much has been made of the ability to deliver quality levels beyond the PSTN standards to CD or even higher levels.

Coverage and reliability

One criticism of the 802.11 standard for wireless as implemented in unlicensed spectrum has been the limited range and bandwidth available. Part of this is governed by power output limitations in the unlicensed space but can also be accounted for by a lack of planning and understanding. Sophisticated mapping and predictive coverage models as applied to licensed spectrum will become the norm for network planning in WiMAX networks delivering the sorts of reliability expected in other network domains. This in turn signals the transition from “best efforts” networking to real quality, performance and reliability.

Tracking corporate assets

As soon as you enable mobility the issue of physical security arises. In unsecured networks it has been easy to access corporate resources either to hitch a free ride or for more malevolent purposes. As wireless and voice transition from niche technologies to the mainstream, corporate networking departments will develop the skills necessary to track and secure assets, The issue of handset security will pervade and the only protection (beyond insurance) is to develop best practice to minimise the targeting of remote workers.

The Future: Fixed/Mobile Convergence

There are a great many factors influencing the ebb and flow of fixed and mobile convergence from personal preference to differing interpretations of economic value.

It is widely accepted, however, that the transition from multiple protocols to a world dominated, and to some extent, defined by IP is

inevitable. This applies equally to the mobile as well as the fixed telecommunications paradigms. The promise of 3G networks over and above telephony was always about their increased capacity for carrying data. In some ways the key convergence trend is voice and data as much as it is foxed and mobile. Network planners increasingly see the telecommunications world as a single network.

As this convergence accelerates competition between differing delivery technologies becomes more acute and price differentials erode. The mobile model of personal communications with an accent on availability and convenience leaves the fixed telephony with few options other than to compete on price; yet users seem increasingly happy to bear the premium, especially as it falls. As we change our usage we expect office systems to ape mobile in appearance, convenience and functionality.

In some instances this trend has been exacerbated by poor availability of fixed network resources, especially for broadband users in rural areas. Demand has, in some cases outstripped demand forcing users to be innovative in their use of wireless and mobile technology to get access to Broadband.

Globalisation has increased the proportion of laptop and mobile users, as our work further eats into our lives. Despite the apparent high cost of mobile our appetitive for connectivity and new services seems unlimited.

This new world is not without its challenges. Multiple technologies have created more not less devices, as people are unwilling to commit to a single technology. This trend will create a whole market of hybrid devices to service the fact that some us are phone oriented and others of us more data or “keyboard” oriented.

With multiple numbers on multiple networks people find it difficult to reach us and new services will evolve to break these barriers. Handover between areas of coverage or even between technologies will improve and users will be able to roam multiple networks while calls stay connected

Knowing when you have cheap coverage – or automatic
Investment protection within the enterprise
Architecture for the future