

# Wi-Fi on trial

We all know wireless networks are a boon for householders who want to share broadband, printers and files around the home. But Guy Dixon asks if we can really trust them with music, photos and video

If 2002 was the year of broadband, in 2003 it was the turn of wireless networks - commonly known as Wi-Fi. Up and down the country in homes, offices, schools, airports, hotels, motorway cafes and coffee shops, the arrival of small, lightweight radio antennas are giving users the freedom to move around within their range.

With users no longer bound by the restrictive fetters of fixed cabling, 2003 saw a massive uptake in home networking. People wanted the kind of network setup they enjoy at the office, but just didn't have the knowledge or the appetite for laying CAT 5 cable throughout their precious abodes.

But the arrival of Wi-Fi in the home has pushed wireless networks way beyond the ability to print from any PC and access files from other computers without leaving your chair. The availability of music and video fileswapping services and the rapid adoption of broadband have fuelled an explosion in PC-based home entertainment. This, along with the PC's tendency to find itself in parts of the home not usually associated with home entertainment, has conspired to make wireless networks the backbone of digital home entertainment.

Wireless networks can bring all your digital entertainment into the living room, kitchen or bedroom while keeping the PC out. In the same way your boiler pumps hot water around the house through a system of pipes, the PC can potentially pump digital entertainment through the air, beaming film, music and photos from your PC to any room of your choice.

But such demands are placing great strain on a form of networking originally designed to share a single broadband connection among family members and print documents to a printer in a separate room.

## Praise the wonder of wireless

Vendors are leaping on the Wi-Fi bandwagon like a new-found religion, embracing it as the next big thing. Wi-Fi digital media adapters that grab content from a PC and channel it wirelessly to a TV or stereo system are appearing from the likes of Philips, BT and Linksys.

One problem is bandwidth. The currently dominant PC wireless standard, 802.11b, with a maximum throughput of 11Mbps (megabits per second) and often five Mbps or less, is not reliable enough to transmit high-quality video. The arrival last year of the much faster 802.11g standard has brought us closer to wirelessly streaming data-hogging media such as video. But can it really rival the quality of a wired connection?

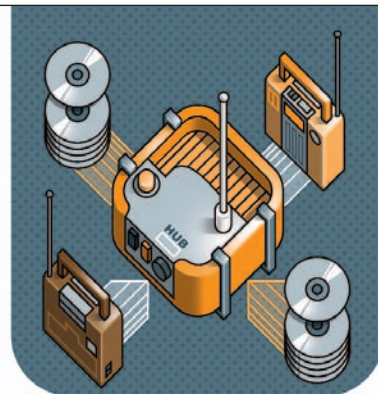
Cynics say the arrival of this first generation of Wi-Fi media receivers is merely an interesting experiment for inquisitive nerds, playing with technology that may redefine our entertainment experience - just not today. At issue here is whether we can really trust Wi-Fi to handle our digital entertainment. PCs are inherently more complex than stereos and TVs - as such they tend to be a bit more temperamental. TVs don't crash and stereos always boot.

To find out whether wireless networks could really handle our high digital entertainment demands, our journalists put Wi-Fi in the dock. ☐



# On your radio dial

Will Head shows how to create your own custom radio station. Listen to what you want, when you want without annoying adverts or inane DJ banter



## Bridging the gap

A wireless bridge simply allows any device with an ethernet port to talk to a wireless network. It contains a Wi-Fi transmitter on one side and an ethernet port on the other. As far as the device is concerned, it's completely transparent and will work with any ethernet device.

The down sides, however, are that it is not particularly elegant or cheap. A wireless bridge is likely to set you back around £100 and the additional power supply and ethernet connection to the player make for a greater likelihood of tangles.

A DMA (digital media adaptor) such as Linksys' Wireless B Media Adaptor is another option. The Wireless B plugs into your TV and allows you to browse music and photos stored on a PC elsewhere. It's bundled with a remote control and supports both wired and wireless networks. The major drawback is that you need a TV to navigate its menus, which limits its location. Not a bad solution but it could be better.

Slim Devices  
Sлимп3



Radio's great - well, apart from the adverts. Oh, and that annoying bloke who talks between the records. And the crap music you don't want to listen to. But apart from that, radio's great.

Who am I kidding? What I need is a custom-made radio station that only plays tunes I like and is available throughout my house. You could, of course, achieve this with a wired network. Except wires are messy and not that many people have their homes wired up already.

The 11Mbps (megabits per second) maximum transfer rate for Wi-Fi may be too low for video, but it's more than adequate for music. Even if you rip your MP3s at the highest quality - 320Kbps (kilobits per second) - it isn't going to put that much of a strain on your wireless bandwidth.

So how can you create your own radio station, accessible anywhere in the house with music you want on it? One way would be to take a network media player, like Slim Devices Slimp3 (see *Digital World*, November 03) and hook it up to a wireless bridge.

## Media server

If you want your music available from any room in your house whenever you please then you're going to have to find a suitable place to store all the tracks. You could just use your main desktop PC, but if someone's using it at the same time and it crashes then your carefully chosen relaxing whale music is going to quickly turn into silence. Ideally you need a media server such as a dedicated PC with a large amount of storage. It doesn't need to be particularly fast. Anything above 500MHz should be fine and a healthy amount of RAM also helps.

If you're planning on leaving the system on all the time then invest in a low-noise power supply from QuietPC.com. A less powerful PC generates less heat and equals fewer noisy fans.

Install Windows XP and the bare minimum of software necessary for the job and the PC should run happily for months at a time. Your music will be available whenever you wish.



Linksys' Wireless  
B Media Adapter

Creative's  
SoundBlaster  
Wireless Music



In the end, I settled for Creative's SoundBlaster Wireless Music player. This wireless-only product is designed solely as a music player. Plug the base station into your stereo, load up the server software and navigate it using the remote control handset.

The base station has no display itself, bar two LEDs to show that it has switched on and found the server. All interaction is via the handset, which communicates with the base station via radio frequency so that it doesn't need line of sight like an infrared remote control.

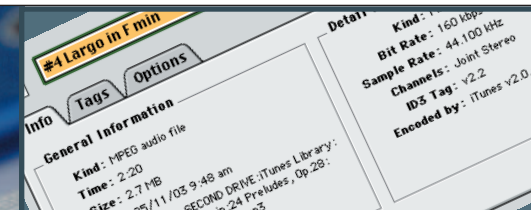
## Sit back and relax

The SoundBlaster's handset has an LCD screen, so you can navigate your music collection from the comfort of your armchair. If you're familiar with Creative's Jukebox music players then the interface won't seem that different.

If you've got a large music collection then browsing can be a little slow at times. This is because the handset has to talk to the base station and then the base station to the server. Having said that, it's not unbearably slow.

In addition to user-defined playlists, there's also an option for Smart Playlists - things such as music added in the last 30 days - which are a useful addition. In terms of looks the Wireless Music player leaves a little to be desired, but it's not that ugly and it makes up for it in ease of use.

The SoundBlaster Wireless Music was only available in America at the time of writing, but should get a UK launch around the time you're reading this. So if you want your own dedicated radio station with all the music you like on it, it's an ideal solution. ☒



## Media management

If you want to make the most of your digital music collection then it's important that you can find the music you want, when you want it. This ultimately comes down to having correctly tagged files.

Tags are embedded information in your music files, generally put there when you first ripped the CD. Most CD rippers can connect to the CDDb (compact disc database) of track listings so you can ensure that all songs are tagged appropriately. Tags can also include information about the genre, year and comments - so you can search for music that meets certain criteria.

If you haven't tagged your files from the start, going back and manually adding them can be a real pain. In some cases it would be quicker to re-rip the tracks rather than edit the individual files.

If you find yourself in this situation, help could be at hand thanks to MusicBrainz's handy Tagger application (go to [www.musicbrainz.org](http://www.musicbrainz.org)). MusicBrainz holds a similar database to CDDb and Tagger allows you to easily assign tags to your music collection.

Tagger has got a really clever trick up its sleeve: it can match songs to the database based on audio signatures. This allows it to scan through folders of music and automatically assign tags to tracks it recognises. For the ones it fails to recognise, simply manually browse the database and assign tags with one click. If you've got a lot of songs with missing or incorrect tagging information, Tagger will make the task of sorting it all out much easier.

# Share the vision

**You've got a stack of photos on your home PC and want to display them on your living room TV. Rosemary Haworth finds out if Wi-Fi can do the job**

I'm one of life's natural hoarders as both my attic and the contents of my PC will attest. I've lately been getting to grips with using a digital camera having finally got my hands on one equipped with a smart memory card. Dumping them on my hard disk once the CompactFlash card is full takes a matter of seconds and means my camera is ever-ready for a bit of spontaneous snapping action. But it's no use if I want to show off my images.

There are good-looking screens now available that have cannily hidden smart memory slots recessed in their frames. Using one of those, it would be simple to insert a card full of images and display them onscreen.

Unfortunately, neither a journalist's wages nor the perks of being able to play with review kit extend as far as a beautiful flat-screen TV display like that. I'll just have to find another way of showing off my photos to friends and family.

The next best thing to lugging my PC downstairs is to bring my photos into the living room. I could do this by burning a few CDs of my favourite pics and sticking them into my ageing laptop to pass along the sofa.

But I'd rather give a running commentary of the photos I took on my recent travels by displaying them on a large screen that the whole family can look at. What I need is a proper way of keeping my captive audience rapt. The telly it is then.

## Teething problems

My plan was to set up a wireless network and beam as many photos as the whim took me down the stairs and on to the TV screen which I'd have hooked up to the laptop receiving the digital image info.

My PC has a built-in network card so there was no need to open the casing to install one. It also runs Windows XP which makes peer-to-peer networking dead easy as you can pretty much get XP's wizard

to do all the hard work. But according to the wireless hardware maker I shouldn't need to enlist the help of XP either. D-Link, whose products I was using, seemed very confident that as long as I installed the necessary hardware on the laptop before inserting the wireless PC card and attempting to install the drivers, I'd soon be all set.

At first it went like a dream. I'd already set up the wireless access point by plugging it into the mains and connecting one end of the ethernet cable provided to the D-Link 7000AP box and the other to the corresponding socket on my PC's network card.

And after clicking on the troubleshooting option when the D-Link laptop card didn't take to its drivers, I soon had that end of things licked too. A message confirmed that one or more wireless networks had been automatically detected.

Had the necessary CD-based manual been in the box when I



unpacked the wireless access point, chances are setting up my ethernet-connected PC would have simply and unfussily announced its presence to my laptop's wireless card. As it was, the CD was nowhere to be seen and my browser (which I was instructed to use to finish setting up the wireless access point) couldn't find the IP address I typed in.

Pinging the server eventually revealed the static IP address was out of the range D-Link specified, though a trawl through the Help and Support Center in XP had assured me this was unlikely.

Asking my more technically minded brother revealed that the static IP address was likely to be at fault. I'd already had a mild panic upon rereading the scant instruction booklet and learning that I may need to reassign the static IP address on my PC to suit the range of the D-Link kit. 'See the manual on the CD-ROM if you need assistance', it cheerfully advised.

Manually changing this, disabling my TV tuner card and restarting a couple of times solved the problem. But then my laptop decided to lose

its Wi-Fi connection and the whole merry dance started all over again.

## Keep on smiling

Eventually, with some gentle coaxing, each component of the Wi-Fi setup decided to play ball and recognise each other as kindred spirits. I was then able to hook up my laptop to my TV via the VCR's S-Video connection and test how it all worked. Thankfully, the Wi-Fi connection decided to behave itself. Accessing the photos from the PC that I was using as a server caused no further problem, appearing onscreen pretty much on cue.

Sadly my guests were rather more troublesome. But then I guess getting your restless family to keep quiet while you explain to your gran for the umpteenth time that the photo on the TV screen of that good-looking chap in the leather garb is not your new fella but an international Formula 1 driver is the kind of gripe we all face one way or another.

Technology can't help here. You just have to keep the grub coming, pour yourself another generous glass of wine and keep smiling. ☒



## Technobite

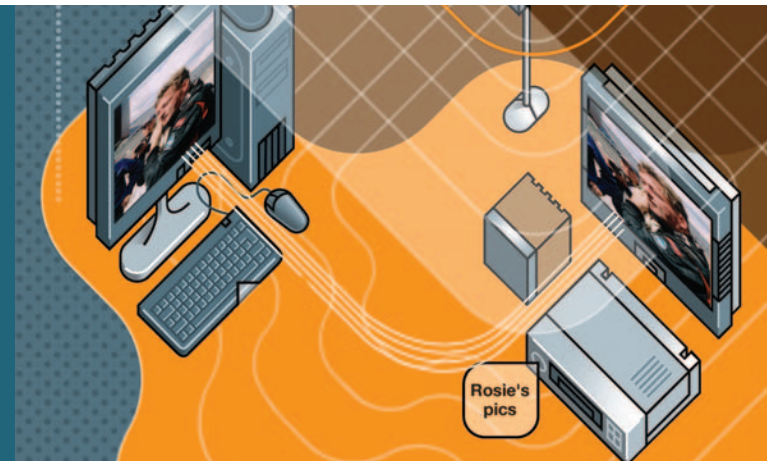
I used D-Link's 7000AP Tri-Mode Dualband Wireless Access Point, a 3Com ethernet card and a D-Link DWL-AG650 wireless PC Card plus a PC and laptop both running Windows XP Professional.

The wireless components hedge their bets by supporting all three mainstream wireless varieties: 802.11a, b and g. I was able to take advantage of the theoretical transfer rate of 54Mbps (megabits per second) – enough to access largish image files but not yet smooth enough for streaming video.



## The verdict

The scant instructions promised setting up a Wi-Fi connection would be a doddle. It wasn't that tough but I was glad to have the telephone support of a more technical-minded sibling when I veered offtrack with static IP addresses and manual configurations. Once installed and recognised, the Wi-Fi network performed magnificently, even through a couple of walls and a ceiling. But I'd be interested to learn whether it's up to streaming video rather than simply displaying static images.



# TV where you want it

Fancy watching a digital TV programme in the kitchen or a DVD from the comfort of your bed without moving the player? Andrew Charlesworth takes his wireless video transmitter for a spin



transmitter in conjunction with a Packard Bell TCX170 digital TV decoder.

Now, I live in a five-room flat and that's counting the kitchen and bathroom. We are not talking vast distances here and a second TV seems, well, opulent. But even in this limited setup I found the convenience of walking from living room to bedroom and having BBC3 available quite seductive.

The 100v uses the 2.4GHz band and had no problems with my solid Victorian internal walls. Maybe I'm a sucker for this kind of novelty, but I reckon I could get used to this. If I lived in a four-story house with Sky and a DVD player in the living room and a couple of TVs on other floors, wireless video transmitters/receivers would really come into their own.

## The Sky solution

Talking of Sky... Murdoch's official take on this issue is that if you want to watch the same Sky channel on two televisions, buy a second digibox. Alternatively, invest in a Remote Eye, Sky's own-brand wireless video transmitter that costs about £50.

There are some drawbacks with video transmitters. Although they are wireless from transmitter to receiver, both ends have to plug into the sending and receiving TV sets and they have to be powered.

This means yet more electrical tagliatelle in that critical behind-the-TV-area already cluttered with VCR-to-TV, DVD-to-TV and digital-decoder-to-TV scart cables and all the ensuing power leads.

Furthermore, the 100v comes with scart or RCA (red, white and yellow) connectors only. So if you've got an old second TV with UHF (aerial connector) only, you're out of luck. ☒

**Y**ou don't have to own more than one PC to benefit from a rudimentary wireless network at home. In fact, you don't have to own a PC at all. You can buy easy-to-set-up products that allow you to send the signal from one TV to another.

Why would you want to? Well, you know that scenario where you're watching a TV show but you know you should be in the kitchen preparing dinner? You end up bobbing to and fro, burning the dinner and missing the programme.

Clearly this is easily solved by buying a mini-portable TV for the kitchen (or for whatever room you need it), but that only works for analogue broadcast TV. It won't do if the channel you're watching is Freeview, satellite or cable. And obviously it won't work if it's a DVD movie.

This is where a wireless video transmitter comes into play. The device will beam any TV signal to a second set, so you can carry on watching a digital TV programme in the kitchen or enjoy a movie from the comfort of your bed without moving the DVD player.

To put this to the test, I used Trust's 100v wireless audio/video

Trust's 100v wireless audio/video transmitter



## The verdict

**W**ireless video transmitters are a quick and dirty way of beaming TV from one set to another and therefore a good solution for large households with more than one telly. But they won't replace a full-blown wireless LAN (local area network). And remember wireless only means between transmitter and receiver. You still have to connect them to the TVs and to a power outlet.

# Hitting the hotspot

Judging by the latest advertising campaigns from Intel, you'd be forgiven for thinking that owners of wireless-enabled laptops and PDAs are gleefully logging on to the web from all points on the globe. Not so, says Simon Easternman



## Hotspot prices

T-Mobile (Starbucks)	£5.50 per hour	£16.50 per day	£47 per month
Surf and Sip (Caffe Nero)	£5 per hour	£20 per week	£20 per month on a year contract
The Cloud (pubs, service stations and more)	£6 per hour (or BT OpenZone pass)		
BT Openzone (Costa Coffee, hotels)	£6 per hour	£15 per day	£10-£85 per month depending on usage
Ready to Surf (Bagelmania, cafes)	Free until end of 2003 then £1 for 15-30 minutes depending on location		

While there are hotspots at the Mount Everest base camp and on Sicily's Mount Etna, most of the ones you or I will ever use are more prosaically positioned in coffee shops, bars, stations and hotels.

But while the hotspot providers have (mostly) decided there is little margin in setting them up at random points in the countryside, they seem to think the public is gagging to do a bit of surfing with their mid-morning coffee. Ever diligent, I decided to

work through my break to find out if this was true.

Central London is peppered with hot-spotted coffee houses, so I didn't have to stray far from the office to find one. Caffe Nero was the first I stumbled across - it serves the best coffee in my opinion so my feet took me there automatically. The signal was strong and it didn't take too long to go through the home page form-filling. I was soon up and running, accessing websites and sending a few emails.

It all worked well but I felt as if I was doing it just for the hell of it. Personally, I use email and the internet at the office and occasionally at home. I certainly never get the unbearable urge to surf while I sip a grande latte. And if going online seemed to temper the enjoyment of a nice cup of coffee, the price of my web time nearly sent the beverage flying all over the settee.

## Loads a dosh

Hotspot charges vary between providers. Some, like Broadscope, offer the service free with a sandwich. Where I was, though, the short-term rate was a shocking £5 an hour and some charge even more. It seems you'd have to be careful where you lay your laptop if you don't want to be fleeced. You also have to be careful where you put if you don't want it covered in coffee - or beer, if you're in one of the 2,600 pubs now boasting hotspots.

But am I just being a misery guts here? I decided to put my own

misgivings aside and find out if others were a bit better disposed to surfing and sipping. There weren't any other surfers in my local Caffe Nero, so I thought I'd cruise a few coffee houses in search of happy hotspotters.

Several coffees later I shipped up at a Starbucks in Soho still disappointed. I decided to collar the manager, Matt Hanger, and asked him whether there had been much uptake since the hotspot had been installed. He assured me that they had an average of 60 surfers a day

in his branch - I must have missed them that day.

Because it would have been cheeky to ask him where they were, I opted to enquire who they were. "Often you see the same faces every day. This being Soho you see a lot of creative types with fancy Apple iBooks - groups as well as singles, but there are some suits as well," Matt explains.

So it seems that many of the early adopters are people using the hotspot as an extension to the office.

## It's an office thing

Steven O'Hara, business development manager at Intel, confirms that this is the case: "Adoption today is business people. Being able to work and communicate when you're out of the office on the road, that's the attraction now."

Obviously the software giant's collaboration has focused in no small part on this sector. The top hotel chains (the Hiltons, the Marriotts and so forth) have all sprouted hotspots, as have many airports, mainline city

stations and conference centres. And while O'Hara stresses that this is only part of the target audience for the country's new rash of hotspots and that leisure surfing is an integral part of the strategy, it seems very much as if this far more difficult market is being tagged slowly on to the dependable interest of business users.

Checking out the hotspot at Paddington station, I come across a charming lady from New Zealand who does have a reason to use hotspots. Morticia Cumberbeach has been travelling the world for about two months, taking in the Mediterranean, north Africa, London and the Far East. Her wireless-enabled mini-laptop has given her invaluable access to the internet.

"When you're travelling there's so much to communicate," Morticia enthuses. "You're out of sight for the folks back home but you don't want to be out of mind. With email you can send pictures and messages whenever you like - especially when you can get access in so many places," she continues.

"It's about convenience and timing," Morticia goes on, sounding more and more like the marketing managers I've been talking to recently. "Email means you can communicate with people when it suits both of you, even when they're on the other side of the world."

After this hard sell, I've begun to believe there is a use for hotspots in public spaces. But until I find myself actually wanting to use one, I think I'll remain sceptical. ☒



## Hotspot spotting: where are they all?

Unsurprisingly, London has the highest number of hotspots of any town in the UK. But on a per capita basis, the Wi-Fi top 10 holds some surprising contenders.

- The Wi-Fi Top 10
1. Exeter
  2. Bangor
  3. Newcastle
  4. Loughborough
  5. Oxford
  6. Exmouth
  7. Banbury
  8. Cardiff
  9. Portsmouth
  10. Southampton

# What's your flavour?

So you want a wireless network at home but what should you opt for? The Wi-Fi community has done such a good job solidifying its brand, it's only when you look closer that you notice there are three flavours currently available

Don't worry: the confusion surrounding the various Wi-Fi standards need only be short-lived. The only thing that's confusing about the different flavours is the names given to them by the standards body which created them, the Institute of Electrical and Electronic Engineers.

### RAISING THE STANDARD

There are three Wi-Fi flavours: 802.11a, 802.11b and 802.11g. For domestic networks we recommend 802.11g, although the 802.11b used in most hotspots is perfectly adequate.

### On a different plane: 802.11a

This is the odd one out of the Wi-Fi standards. It uses the 5GHz band in order to avoid interference with Bluetooth and other systems in the 2.4GHz band. It is faster than bog-standard 802.11b, giving 54Mbps (megabits per second) close up to the access point but tailing off fairly rapidly with distance. It has 12 non-overlapping channels so you can have more access points in the same area without interference, giving more overall throughput. In other words, this standard will be useful in a business setting where a lot of people are using a wireless LAN (local area network). It is more expensive and not required

for home use, where 802.11g can give you faster speeds at a much cheaper price.

### The usual suspect: 802.11b

Here is today's most popular Wi-Fi standard. Virtually all public hotspots and most workplace wireless LANs currently use 802.11b, which gives 11Mbps on the 2.4GHz band. If it doesn't make 11Mbps it will fall back to 5.5, 2 or 1Mbps. Whatever speed there is will be shared by all the devices connected to the network.

### An affordable boost: 802.11g

Giving roughly five times the speed of 802.11b, 802.11g is compatible with it the standard as it operates in the same 2.4GHz band. Some 802.11b access points can even be upgraded to 802.11g by firmware. Both 802.11g and 802.11b cards can be used to communicate with 802.11g or 802.11b access points. Obviously, though, you only get the faster speed if both the card and the access point are 802.11g. The 2.4GHz band (where both 802.11b and 802.11g operate) can be crowded with other devices, particularly Bluetooth and some microwave devices. However, these problems are usually surmountable. Because the available bandwidth is smaller, 802.11b and 802.11g access



## Glossary

• **802.11a, 802.11b and 802.11g** Different varieties of Wi-Fi networks.

• **802.11i** A security standard that is due to be completed in 2004. Until then, networks use WEP (wired equivalent privacy) or the improved interim protocol WPA (Wi-Fi protected access).

• **Access point** A base station that can connect a network to several wireless devices.

• **Band** The part of the radio spectrum used by the wireless LAN (local area network). The standards 802.11b and 802.11g use 2.4GHZ, whereas 802.11a uses the 5GHz band.

• **Bluetooth** A short-range wireless technology intended for so-called 'personal area networking', replacing cables on devices up to a couple of metres apart such as phones, PDAs and printers.

• **Centrino** An Intel brand that denotes a PC includes a low-power consumption mobile chip and built-in Wi-Fi facilities.

• **Ethernet** The standard wired LAN (see opposite).

• **Firewall** A security device intended to block malicious attacks from the internet, either running on a PC on a router or on a separate device.



## Which standard suits you?

	Pros	Cons	Advice
802.11a	Less congested band so less interference with other devices. More channels so more capacity. Faster than 802.11b.	More expensive than 802.11g. Incompatible with all current public hotspots. No faster than 802.11g.	Leave to those who require the advantages.
802.11b	Cheap. Well understood. Good product compatibility.	Poor value compared with 802.11g.	Use 802.11b cards on devices that don't need high throughput or which mostly use public hotspots. 802.11b is a cheap option for a home Wi-Fi network.
802.11g	Cheap compared with 802.11a. Only slightly more expensive than 802.11b. Five times faster than 802.11b. May have more up-to-date security than 802.11b kit.	The high bandwidth may only reach a short distance. Will suffer from more interference than 802.11a	Buy 802.11g where possible.

• **Hotspot** A public Wi-Fi connection.

• **LAN** A local area network - that is, a network that operates over a small area

• **Router** In this context, a device which connects a local area network to the internet.

• **Wi-Fi** The brand for wireless compatibility defined by the Wi-Fi Alliance, as a way to make the technology as friendly as the consumer hi-fi. Sometimes spelled out as 'Wireless Fidelity'.

• **VoIP** Voice on IP refers to using a network to carry voice traffic, such as telephone calls, as well as data. The IP protocol is used in virtually all data networks.

• **WEP** The security protocol used in all Wi-Fi networks until it was shown to be insecure in 2001. It stands for Wired Equivalent Privacy. Although 802.11b and g still use WEP, the new standard, i, will use WPA.

• **WPA** An interim encryption standard proposed by the Wi-Fi Alliance to replace WEP until the 802.11i standard is complete. It stands for Wi-Fi Protected Access.

## Is WEP a waste of time?

Unfortunately, the best thing about security protocol WEP (wireless equivalent protection) is its name. It sums up what we want from a wireless network: we want it to have equivalent security to a wired network. Unfortunately, though, it doesn't live up to its name.

The basic problem with wireless is that anyone can access the air. Wireless networks must therefore authenticate everyone and encrypt all the data that goes across the network. This sounds straightforward but is tricky in practice. Because anyone else might be listening in at any time, it is very difficult for a wireless access point to tell the client what key to use and be absolutely sure that no one else heard.

WEP uses symmetric encryption, where both sides of the conversation use a shared secret key to encrypt the data. At first the standard only allowed 40bit keys but this was improved to 128bit keys as longer keys are harder to crack.

Weaknesses in WEP include the fact that it doesn't check the integrity of packets, so data can be modified undetectably while in transit. And it only protects the user data and its handshake with the access point, so management and control frames are vulnerable.

There are also a couple of ways in which WEP does not specify good enough keys. They are not random enough, so a cracker could get at the key much sooner than 128bit encryption would lead one to expect. A cracker who listened long enough could uncover the overall secret WEP key by listening to enough frames with weak keys.

Tools appeared on the internet to crack WEP and the search was on for a replacement...

**The basic problem with wireless is that anyone can access the air. Wireless networks must therefore authenticate everyone and encrypt all the data that goes across the network**



# Wi-Fi buyer's guide

## Frequently asked questions

**Is Wi-Fi easy to install?**  
Yes it is. Get a wireless gateway or a wireless-enabled router for your home broadband network, plug it in and you have a wireless network. Wireless cards can be easily added to PC. See the buying guide for more information.

**If my laptop works on my home network, can I use it at hotspots as well?**  
Certainly, as long as your home network is 802.11b or 802.11g. At most public hotspots you will have to pay a subscription, although this can be done quite quickly via SMS.

**Is data safe on my Wi-Fi network?**  
There has been a lot of coverage of security fears with wireless LANs (local area networks) and rightly so. However, it's relatively simple to make your network safe.

Wireless networking is inherently more risky than wired networks because the radio signals can be detected by anyone with a Wi-Fi card, even the so-called 'war-driver' parked outside your house. You have to physically connect to a wired network to obtain data.

But most wireless kit has security settings. Make use of them properly and the risk will be very low. Data should be encrypted while it is being transmitted over the air and all devices should be password-protected. The WPA scheme is preferable, but WEP is adequate for a domestic network.

The security scheme can be set up simply using a CD supplied with the access point. Make sure you do this and remember to choose a hard-to-guess security key.

**I have a cordless phone. Will Wi-Fi interfere with this?**  
No. Cordless phones in Europe all operate on a different frequency to Wi-Fi. This includes both older phones and digital Dect phones.

*continued overleaf*

points have fewer channels to use. Anyone putting together a network with multiple cells will have to site the access points carefully because only three access points can overlap at any one location.

In a normal domestic network with one access point this is not an issue. It may become more of a problem when your neighbours all have their own wireless LANs but by then 802.11a/g access points will allow more channels.

### Other 802.11 names

The IEEE standards committee creates new committees for many different areas of interest. There are - take a deep breath - 802.11c,d,e,f,h,i,j,k and m standards. However, you don't need to know what they are, except for 802.11i which is a security spec coming later this year.

### SETTING THE STANDARD

And now for the good news: you won't need to remember all of these standards. Pretty soon 802.11g products will sweep away 802.11b and will be known as Wi-Fi g or 54g. Because all 802.11g products speak 802.11b as well, there will be no point calling them 802.11b/g.

Since products that handle both 802.11a and 802.11b/g need two radio chips, they will be more expensive for a time. They also won't be particularly useful unless there is an 802.11a network at your workplace. Eventually, however, 802.11a/g products will be the norm and these products will work in any Wi-Fi hotspot or network. Network managers will choose between the 2.4GHz and 5GHz band, according to need and what else is using the radio spectrum in that area. ☒



## Is WPA the saviour of Wi-Fi?

The IEEE set up a working group, 802.11i, to create a secure extension to the Wi-Fi standards. This will improve authentication - that is, identifying a user to the network - by using 802.1x, a standard defined for wired networks. It also specifies better encryption and more secure keys.

Standards bodies are slow, though, and 802.11i is still a draft, not a formally complete standard. With insecure products out there, the industry needed a quick patch. The Wi-Fi community decided to define an improved security standard based on the direction that IEEE would take.

Thus WPA (Wi-Fi Protected Access) was born. It uses Temporal Key Integrity Protocol, which lets Wi-Fi systems change keys but keep in step. It also improves the keys so that it would take a cracker 100 years to find a well-chosen one. WPA fixed WEP's broken integrity check, so users can be sure that messages haven't been tampered with. And like 802.11i which will eventually replace it, WPA uses the 802.1x authentication protocol. It doesn't go the whole hog with encryption because these algorithms are very computer-intensive.

WPA is a subset of 802.11i, so it will be easy to upgrade to the full standard when that arrives. The new 802.11i standard will probably be branded WPA 2 in Wi-Fi products. In fact, not all vendors have yet implemented WPA so many of us are still working with WEP.

To be honest, attacks on domestic networks are not all that likely and WEP is adequate for most purposes. Like window and door locks, it offers a strong deterrent even though an expert could get past it relatively easily.

**WPA fixed WEP's broken integrity check, so users can be sure that messages haven't been tampered with. And like 802.11i which will eventually replace it, WPA uses the 802.1x authentication protocol**

If you're short of time and are thinking of setting up a wireless LAN, we can sum up our shopping advice in two words: 'buy 802.11g'. It's that straightforward, says Peter Judge

The 802.11g products, sometimes referred to as 54g, are compatible with the more usual 802.11b devices and now only cost a fraction more (around £10 on an access point costing about £60). On the other hand, 802.11a products are only for specialist users. They are more expensive and don't work with 802.11b devices, although next year 802.11a/g products that can work with all three types will reach sensible prices.

What kit you buy will depend on what you already have and what you want to achieve. In a nutshell, you need an access point and a wireless adapter for each of the devices that are connecting to the wireless LAN (local area network).

A basic access point has an ethernet port to connect to the wired network and a radio for Wi-Fi. What sort of adapters you get and what type of access point are the next questions to answer.

### Sharing broadband

The most usual scenario is to share a broadband connection between several PCs. You can do this by plugging in your access point to the router that connects your broadband network.

Alternatively, follow the trend of bundling more and more features into one device and opt for a single box that combines the router and the access point. It may include a firewall and will probably have a four-port switch so that local devices can be plugged straight in by ethernet. Again, getting a multifunction box will represent only a small price increase and will simplify your network.

There are affordable access points and routers from several vendors. The leading ones for domestic networks are Netgear, D-Link, Buffalo and Linksys. Expect to pay something not much more than £70.

### Adapters for all

For the client systems you have to buy Wi-Fi adapters unless, like Centrino PCs and some PDAs such as the Toshiba E740 Wi-Fi, they have built-in Wi-Fi. You can use PC card adapters in any laptops, PCI cards in PCs and Secure Digital or CompactFlash cards for any PDAs that can use them.

There's no need to have the same brand of cards as your access points. However, if you are buying them at the same time it is probably simplest and safest to do so. Some vendors have supercharged versions of 802.11g such as Netgear's Super-g and D-Link's g+, which will only work if you buy access points and adapters from the same vendor. These may require a small price premium (another £10 or £15) and will probably be superseded by a more standard speed boost. But if you're desperate for faster Wi-Fi then it's worth a look.

Make sure you get adapters to match your access point - probably 802.11b or g not 802.11a. An 802.11g adapter will, again, set you back £10 more than an 802.11b card. But since the latter is only £10, the price difference is harder to swallow - effectively you're paying double.

Be aware that wireless adapters will use up batteries on mobile devices more quickly. If your dream is to work in the garden you may find that you cannot do so for long without bringing out an extension cable. ☒

### Access points

**Buffalo Airstation G54** Buffalo: 01753 555 000; price: £86 inc VAT

**D-Link Airplus DWL-900AP** D-Link: 020 8731 5555; price: £75 inc VAT

**Linksys Wireless-G** Linksys: 0870 041 6624; price: £90 inc VAT

**US Robotics Accelerator** US Robotics: 01628 640 140; price: £52 inc VAT

## A word about speed and coverage

Although 802.11g products are certainly faster than 802.11b models, in our informal tests they have never hit the maximum speed of 54Mbps (megabits per second) claimed by all vendors. Typically we find 802.11g networks perform at between 10-15Mbps.

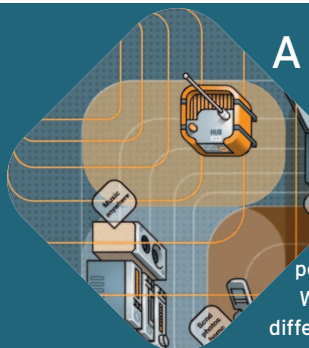
We could easily get access points and cards from different vendors to connect, but pairings never hit full 54Mbps 11g speeds. In other words, Linksys access points work fastest with Linksys PC cards and so on, although none of the leading brands had difficulty working with one another.

If you plan to use your network primarily for sharing broadband internet access, the speed limitations of your networking technology won't matter much. All of the

popular standards - a, b and g - significantly exceed the top broadband speeds (600Kbps to 2Mbps) of residential DSL or cable services.

What is more irritating are the claims made in terms of signal distance. The 100m coverage only applies if there's nothing to hamper the signal. If you live in a four-story Victorian house, with the study in the attic and the broadband access point in the basement, signal strength can vary from acceptable to extremely poor.

If the network is trying to penetrate three ceilings, for example, coverage can drop to as little as 50ft. Once signal strength drops to 'very low' you'll get kicked off the web. And if this happens on a regular basis you'll end up relocating to other floors closer to the access point but less suited to working.



## Frequently asked questions

The myth that the two devices interfere is prevalent because other interference effects are often blamed on phones and some people in the US have cordless phones that use the 2.4GHz band.

If I do have a problem, what is causing it?  
Most likely it is metallic objects such as filing cabinets, people or weather conditions. Bluetooth devices operate on the same wavelength but have low power and very few of these are in use yet. Other devices that operate in the same band are microwave ovens, although any radiation from these is accidental leakage and can be reduced by getting a new oven.

I don't get 54Mbps from my 802.11g network (or 11Mbps from my 802.11b network). Why not?  
The figure only refers to maximum throughput. This performance is shared with any other users on that access point and it fades with distance and other conditions. A good level of throughput for 802.11g is actually more likely to be around 28Mbps.

What can I do to improve my Wi-Fi performance?  
If you have a workstation that is going to stay in one place and a cable will reach it then use a cable. That gives that machine a faster link and clears the air for the rest of the devices you might use on the WLAN.

Another option is to add a second access point to your ethernet network. The two will use different channels and shouldn't interfere.

# What happens next?

We've given you the lowdown on wireless networks but what's in store for the future of Wi-Fi? Peter Judge stares into his crystal ball

In 1997 the first 802.11 standard only allowed 1Mbps (megabit per second). The speed has increased vastly since then, along with many other aspects.

### Combined a/g networks

Dualband systems will come down in price and replace today's 802.11g systems. This will give networks more channels to play with so individual users on crowded networks will get more bandwidth.

### Secure networks

The 802.11i security spec will be published next year and Wi-Fi networks can then become more secure. However, it will still be up to the user to apply security carefully, and make sure that passwords are not guessable. Officially, though, secure Wi-Fi should make IT managers more willing to install the technology.

bundling Wi-Fi with mobile phone services makes sense.

While some companies will, I'm sure, find a reason to offer Wi-Fi free in a few places, long-term setups will aim to get revenue from you one way or another.

### Wi-Fi and mobile coverage

Phones and PDAs will eventually have radios for both GPRS (general packet radio service) and Wi-Fi networks. They will be able to hand over seamlessly from one to the other to keep the fastest and cheapest connection, according to what subscriptions you have.

Of course, if voice over Wi-Fi really happens then roaming between mobile and Wi-Fi networks could give you cheap phone calls when you are in a Wi-Fi zone. It's a couple of years before this will be viable in a commercial product though.

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### Ultra wideband

Using a different radio technology, UWB or 'pulse radio' can give data rates similar to wired networks. Indeed, 1Gbps (gigabit per second) transmission has been demonstrated. Instead of using one frequency band, UWB sends out tiny chirps that are made up of very many wavelengths. But these are so short that other systems can ignore them - UWB signals seem like interference noise.

UWB's problem is that wireless regulators are used to parcelling up the spectrum by wavelength, so it is difficult to legislate for something that cuts across several wavelengths. The US regulator, the Federal Communications Commission, has chosen to treat UWB with the same regulation as electrical noise, only allowing systems that give off less signal than that leaked by the average CD player.

Under these rules UWB can still make a 500Mbps cable replacement. Expect products to start appearing around the end of 2004. It will eventually replace the USB cable. ☒

### Hotspot wars

There are now a large number of hotspots across the country, mostly in hotels, airports and coffee shops in large cities. Others are opening up in pubs thanks to innovative service provider Cloud, who leases capacity to other service providers.

This year will see the owners of these networks attempt to make money from them. But will people pay? Or will use of the hotspot be a loss-leader for mobile phone companies thrown into the bundle to get your business? T-Mobile and BT OpenZone are already two of the leading Wi-Fi service providers so

# Bluetooth bites back

After years of false dawns promising a seamless, short-range wireless nirvana, Bluetooth is finally showing signs of making a breakthrough. *PC Advisor* forum editor and IT consultant Peter Thomas investigates

In many ways, 2003 was a run-of-the-mill kind of year in the world of IT consulting. There were lots of client queries about employee-monitoring software, everyone seemed to be moving over to broadband and the concerns about the security implications of Wi-Fi networks bordered on the paranoid. In more recent weeks, however, clients have started asking me about something else. 'What on earth is Bluetooth?' they want to know.

While we in the IT business have been watching this short-range wireless network technology stumbling around to little effect since 1998, general awareness levels have remained low. And where there is awareness, it is often misinformed. Indeed, many confuse Bluetooth with wide-range Wi-Fi networks.

On an anecdotal level I can tell you that times are definitely changing. Interestingly, questions from clients are usually prompted by personal rather than business usage. They get a Bluetooth mobile phone

and - often accompanied by an air of slight embarrassment - they want to know if this means they can now transfer contact data to their PC or notebook without attaching a cable. (The answer, by the way, is yes as long as the destination device is also Bluetooth enabled.)

Some clients ask if they can connect to their GPRS (general packet radio service) network over their Bluetooth phone. Yes you can, although it can prove somewhat fiddly. And then there's those customers that are perplexed that their new handset features the same Bluetooth logo as some of PC World's printers, PC cards, hands-free wireless headsets and even access points.

## Are you ready for Bluetooth?

If we move beyond the merely anecdotal, we can see where these questions are coming from. Bluetooth is definitely biting back. Manufacturers are selling one million Bluetooth-enabled devices (mostly

mobile phones) every week. What's more, it's here in Europe that uptake is most rapid - accounting for some 65 percent of all sales.

Benson Chang, vice president of sales and marketing at Apache, says global demand for Bluetooth-enabled devices hit between 65 million and 70 million last year - that's more than twice last year's 30 million. And in 2004 sales are set to double again. In short, there are probably

## Bluetooth personal area network



## What's in a name?

Harald Blaatand 'Bluetooth' II, was king of Denmark between 940 and 981 A.D. He united Denmark and part of Norway into a single kingdom and then introduced Christianity to Denmark.

few computing situations where data exchange is involved that wouldn't benefit from some Bluetooth assistance.

I'm writing this article using a wireless Bluetooth keyboard and mouse, both of which are connected wirelessly to my PC by a Bluetooth hub that doubles as a charger for the mouse. Everything works perfectly and it took about 12 minutes to set it all up straight from the box.

That isn't to say that Bluetooth is a cure-all - it's not. But it can liberate you from much of

the drudgery involved in using more conventional methods of transmitting information and files. When teamed with a mobile phone and headset, for example, it positively excels.

## A blast from the past

This isn't the first time there's been a long engagement before the wedding day arrives. Remember the introduction of USB back in 1996? Because Windows 95 had no support for the technology there was little interest.

**I'm writing this article using a wireless Bluetooth keyboard and mouse, both of which are connected wirelessly to my PC by a Bluetooth hub that doubles as a charger for the mouse. Everything works perfectly and it took about 12 minutes to set it all up straight from the box**

## Bluetooth basics

Bluetooth allows devices such as mobile phones, headsets, PDAs and portable computers to communicate and send data to each other over short distances without the need for wires or cables to link them together. It has been specifically designed as a low-cost, low-power radio technology that is particularly suited to the PAN (personal area network) application. It's this design focus on low-cost, low-size and low-power that distinguishes it from the 802.11 wireless LAN (local area network) routers and network adapters that have swept into the limelight of late.

## Why not infrared?

There is already a perfectly good solution to the problem of how to communicate without wires. Infrared technology - the ability to transmit data from one device to another via a beam of invisible, low frequency light - is familiar to anyone who uses a TV remote control. Using a standard called IrDA, this method is used to connect some laptops with peripheral devices such as printers.

Infrared is a line-of-sight technology, however, and relies on the two devices being relatively close together - certainly in the same room. The big drawback as far as computing is concerned is that infrared data can only be sent to one device - you can't send a file to a printer and synchronise with your PDA at the same time. Bluetooth puts paid to those problems once and for all and frees you from the necessity to carry around a bundle of cables with which to attach external devices.

The various devices find one another and configure themselves without any input from you. Bluetooth is the digital 'glue' that binds them together - at least that's the theory.

## Bluetooth jargon

- **PAN** Stands for personal area network. Effectively a wireless network that operates over short distances – for instance, in a home, car or office.

- **Pairing** The process by which two Bluetooth devices bond with each other. Without an initial pairing, devices can usually not establish a communication session.

- **Discovery** Most Bluetooth devices have the ability to search for, or discover, other similarly equipped devices. When you want to use two products together you would normally perform this operation to find the devices in range.

- **Passkey** When pairing Bluetooth devices it is wise to use passkeys to authenticate incoming connections. In certain connection situations you may want additional assurance that you are connecting to a particular device or computer.

A passkey can normally be any combination of letters or numbers, but exercise caution as some devices do not map characters similarly. Passkeys are valid only for the connection and may be different for other devices or users.

**As adoption spreads, Bluetooth itself continues to improve. The latest version adds several crucial features that have up until now hindered its uptake, including faster connections between devices and adaptive frequency hopping**

A sub-release of Windows 95 (OEM Service Release 2) was issued to computer manufacturers only and it added somewhat limited support for the USB protocol. Windows 98 added additional support and fixed some problems that were in the 95 OEM release. Released in early June 99, Windows 98 SE had more robust support for USB. The teenage sales boys at Dixons got some training and suddenly it really took off.

Now every new computer has at least two – usually more – USB ports. Most of us would find it difficult to contemplate computing without it and the same could happen with Bluetooth.

### Room for improvement

And as adoption spreads, Bluetooth itself continues to improve. The latest version adds several crucial features that have up until now hindered its uptake, including faster connections between devices and adaptive frequency hopping – designed to reduce interference with other wireless devices. Devices based on this latest Bluetooth specification should be on the shelves by spring.

Encouragingly the major hardware heavyweights are joining the fray. Apple Computer and IBM are among a number of companies that have begun selling notebook computers with built-in Bluetooth connectivity as standard.

However, its biggest challenge surrounds the complexity of the

technology. The Bluetooth spec defines basic connectivity. In other words, it's easy for one Bluetooth product to recognise a fellow Bluetooth product. But specific uses require separate profiles. Not all Bluetooth-enabled devices support all the profiles and this can lead to confusion for buyers who may expect a Bluetooth PC adapter, for example, to do things it isn't set up for. And there are other problems as well.

### Big issues

Bluetooth's growing pains go beyond confusion over usage profiles. The user interfaces for software and even the terms used in product manuals vary between different vendors. In due course they will simply have to make the user experience more consistent. It'll take a lot of calls to the customer-service department but finally the penny will drop.

Put simply, it's relatively easy to get two Bluetooth products from the same vendor to talk to each other, as well as perform some basic functions such as getting a headset to work with a phone. But a more difficult application such as synchronising a phone or handheld device with a PC can still prove too complicated for the average consumer.

There is also an issue of value for money here, which often makes it difficult to push products beyond what marketing folks call the 'early adopter' to the so-called 'early majority'. For example, Logitech's recently launched MX Bluetooth cordless keyboard, mouse and Bluetooth hub (see *The five-minute Bluetooth challenge* over the page) is a beautiful piece of hardware. But at a recommended price of £149.99 for the keyboard and £89.99 for the mouse/hub, it's not obvious what you're getting for the extra investment.

If, however, you could show the prospective punter what the kit does, this might prick up his ears. The hub's software, for example, can send a notification to a PC screen when there's a new text message sent to a



Nokia  
imageviewer

Bluetooth-enabled mobile phone. If you then showed the prospective customer how to start exchanging text messages with the sender using the PC keyboard instead of the phone keypad, you'll have him reaching for his flexible friend.

### Ultimate weakness

If Bluetooth has an Achilles heel, it's speed of transfer. While the technology stands every chance of overcoming some of the complexity and usage issues that have held back adoption, Bluetooth's long-term prospects could be restrained by its limited bandwidth of around 500Kbps (kilobits per second). If you want to load high-resolution images from your

camera to your PC, for example, it can prove extremely slow.

This is where Bluetooth faces a challenge from emerging short-range wireless networking technologies such as Ultra Wideband. UWB technology was first developed in the 1980s and is used in some types of radar. More recently, the technology has been considered for high-speed, short-range wireless communications. Intel, for one, is hinting strongly that it sees UWB's 500Mbps ultimately winning out.

But that day is some way off and as John Maynard Keynes famously said: "In the long run we are all dead". In the meantime I'll have no hesitation recommending Bluetooth products to my clients. ☒



## A lovely pair

When Bluetooth wireless technology connects devices to each other, they become 'paired'. So, for example, your wireless headset connects to the mobile phone in your briefcase, allowing you to make and receive calls without touching the handset. Alternatively, your PDA automatically synchronises with your office PC or your home computer after a busy day. Your mobile phone, PDA and computer all share the same address book, calendar and tasklist. You can also print from your PC or laptop to a printer in the next room or send music from your system to your MP3 player.

## PAN or WLAN: what's the difference?

A personal area network, or PAN, is created when you use one or more Bluetooth devices to form a small communications network. For example, you might have a PC, laptop and PDA – all Bluetooth equipped and all communicating with each other over a limited range. Bluetooth radio signals are extremely weak and will normally only be effective up to a maximum of 10m, although some devices may have a greater range. Bluetooth does not support TCP/IP and transfers files using the FTP (file transfer protocol). One of the main advantages of a Bluetooth PAN is that it's easy to connect – Bluetooth devices self-configure without user intervention.

A WLAN (wireless local area network), on the other hand, has a much wider range – up to 100ft for the 802.11b standard. A WLAN may have dozens of PCs connected to it. These networks are springing up all over the place, from airports to cafes. The idea is to offer public access to the internet via laptops and handheld devices, although connecting to one is not always as simple as it's made out to be and bandwidth issues can arise as the number of connected machines increases. There are also security issues. Anyone with a laptop and a wireless network adapter could in theory gain access to an unsecured WLAN.

**One of the main advantages of a Bluetooth PAN is that it's easy to connect – Bluetooth devices self-configure without user intervention**

# The five-minute Bluetooth challenge

Rewind 12 months and the world's leading manufacturers of Bluetooth devices concluded that for the technology to be a surefire winner, products need to be up and running within five minutes of leaving the box. To what extent have they achieved this, asks Peter Thomas, as he plucks a selection of Bluetooth products from our review shelves



Logitech Mx Bluetooth cordless keyboard, mouse and Bluetooth hub

**Novice user**  
Sandie Thomas thought that the Logitech keyboard looked very high-tech in its graphite livery and had no difficulties in pairing it and the mouse by following the onscreen prompts. Setup time: 12 minutes.

**Intermediate user**  
Jamie Goumal uses a computer at work and is reasonably familiar with software and hardware installation. He had no problems with the Logitech equipment and had the whole lot up and running in less time than it took to make a coffee. Setup time: nine minutes.

**Expert user**  
IT consultant Peter Thomas encountered no problems at all - the Bluetooth technology functioned flawlessly. It seems that the interconnectivity standard really does work regardless of who makes the devices. Setup time: five minutes.

**Comments**  
Used in conjunction with a bluetooth phone, the Logitech ensemble allows you to view incoming text messages on your monitor and respond using the keyboard. This would prove extremely useful to anyone answering more than a couple of text messages a day. But at a recommended price of almost £240 this is an expensive piece of kit.  
• **Recommended price** Keyboard: £149.99; mouse/hub: £89.99



Belkin USB Bluetooth adapter

**Novice user**  
It took no time at all to configure using the onscreen prompts. File transfer between a PC and a laptop based in another room was an easy matter once Sandie realised that she needed to pair the laptop to the Logitech hub on the PC. Setup time: seven minutes.

**Intermediate user**  
Jamie installed the USB adapter on a second PC in his office and encountered no problems. He quickly paired the adapter with the hub on the first PC and was soon transferring files between the two machines. Setup time: five minutes.

**Expert user**  
Peter used the adapter on his laptop and transferred files to and from his main machine with no difficulty whatsoever. If all Bluetooth devices are this easy there'll be no need for a wireless network at home. Total setup time: five minutes.

**Comments**  
Belkin's adapter is easy to install, simple to use and is very handy for anyone who wants to dial up from a laptop via a mobile phone. An excellent device at a reasonable price.  
• **Recommended price** £49.99



Logitech Bluetooth headset

**Novice user**  
Sandie found this device somewhat confusing and needed some assistance with the phone's menu options. Once over this hurdle, however, she had little difficulty with the headset and found it easy to make and receive calls. Setup time: 20 minutes.

**Intermediate user**  
Jamie took a few moments to work out how to access the Bluetooth menu options on the Sony Ericsson T610, but once that was done he had no problems. The Logitech headset paired with the phone in seconds and Jamie was able to make and receive calls using it anywhere in the house. Setup time: 12 minutes

**Expert user**  
Peter found the phone a dream to use and set up the Logitech headset with no problems. It worked perfectly with excellent reception. Setup time: 10 minutes

**Comments**  
This device scored heavily in the good looks department and reception was as good as when using the phone itself.  
• **Recommended price** £79.99



Belkin Bluetooth hands-free headset

**Novice user**  
Having previously set up the Logitech headset, Sandie had no difficulty with the Belkin offering. She found the reception less clear than when using the Logitech model, although the range was about the same. She preferred the Logitech model as it's more comfortable to wear. Setup time: five minutes.

**Intermediate user**  
Jamie set up this headset very quickly. He said it wasn't as comfortable as the Logitech model and reception wasn't as good. Setup time: four minutes.

**Expert user**  
This headset gave Peter no trouble. The reception issues mentioned by the other testers weren't apparent to Peter, although he shared Sandie's view about wearability - the Logitech was more comfortable. Setup time: five minutes.

**Comments**  
The Belkin headset was a dream to set up, although everyone thought the Logitech model scored higher on looks and comfort. There was nothing to choose between them when it came to range and the price of both models is identical.  
• **Recommended price** £79.99