IN BRIEF

- There are many ways of connecting to the Internet, from the slow dial-up connection to a range of fast broadband services.
- Each type of connection has its own advantages and disadvantages.
- Use the Internet to research the best Internet service provider for your location and requirements.

Connecting to the Internet

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There are many and varied ways of connecting to the Internet. For the vast majority of the Internet's existence, most people connected using the maddeningly slow click-and-wait experience of a dial-up connection. By June 2005, the number of the newer and faster broadband connections in the UK exceeded dial-up connections for the first time (approximately 1/3 broadband cable and 2/3 broadband ADSL). By the middle of 2006, 40% of households in the UK had a broadband connection, compared to just 28% in 2005. In the last quarter of 2006, the total number of broadband subscriptions in the UK had topped the 13 million mark (one subscriber may equate to multiple users sharing one connection). Mobile Internet access via mobile phones and other devices will mark the biggest change in the way that we access the Internet and is likely to have a profound effect on our everyday lives. In this section, we look at the various ways of connecting to the Internet and compare the features, benefits and costs of each.

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Refereed Paper
© British Dental Journal 2007;
202: 317–322
DOI: 10.1038/bdj.2007.225

CHOOSING AN ISP (INTERNET SERVICE PROVIDER)

There are various websites[1-4] that list the hundreds of ISPs in the UK; some of them carry out regular tests and make recommendations on best buys.

Points to look for when assessing dial-up services include above-average download speeds and the fewest dial-up errors or dropped connections. For broadband connections, it is unlikely that you will notice vast differences in the quoted speeds from different providers, so buy on quoted speeds, cost, contract terms and customer service. Zen Internet and Waitrose have been a Which? Best Buy for broadband ISPs for two years running, although neither is a particularly cheap service. Look out for special offers of reduced or even free equipment and activation. Bear in mind that you can shop around for equipment separately[5] – you don't have to buy it from the ISP. It is also worth considering the cost of telephone support when choosing your provider. Sometimes support is free, but it can be as much as £1 per minute. Sky is the latest company to get on the convergence wagon by offering broadband Internet access alongside its satellite TV service, while mobile phone operators O_2 and Orange bought out the ISP companies Be Broadband and Wanadoo. Picking an ISP solely on cost has never been harder as companies compete by offering packages that include quadruple-play services such as TV, Internet, and both mobile and fixed voice communications. The simplyswitch[6] website provides a good way to compare the top broadband providers and find the best deal for any individual requirements.

ESTABLISHING A DIAL-UP INTERNET CONNECTION FOR THE FIRST TIME

Assuming that you have the right hardware installed on your PC, setting up your account with your chosen ISP is normally quite straightforward. Insert the CD supplied by your ISP into the computer's CD-ROM drive; the CD should start automatically. Select the product option of choice and follow the on-screen instructions. Your computer must be connected to a telephone line via the modem. You will be automatically connected to the Internet for the registration process. If prompted, select your modem and dialling location. Once you have registered, an icon will appear on the desktop; click on this icon at any time to connect to the Internet.

If you do not have access to a CD supplied

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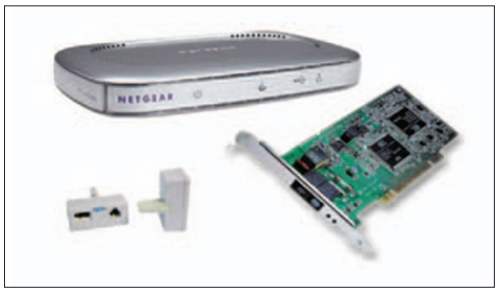

Fig. 1 To set up an ADSL Internet connection requires either an ADSL modem which plugs into the USB computer port, or an internally fitted ADSL PCI card modem. It is also necessary to use a micro-filter on each phone socket to separate voice from data

by an ISP, Windows XP has a New Connection Wizard that aids you through this process and offers you a selection of ISPs. Access this through **Start**, **Connect To**, and **Create a New Connection**.

HOW IS THE SPEED OF AN INTERNET CONNECTION MEASURED?

The capacity of an Internet connection is referred to as its bandwidth; the greater the bandwidth, the faster web pages, files and emails download. Bandwidth is measured in bits of data per second, a bit being an on or off, 1 or 0 signal. A thousand bits is a kilobit (kbit), a million bits is a megabit (Mbit), a thousand million bits is a gigabit (Gbit) etc. To work out how long data will take to download, you have to take into account that data files are measured in bytes, where one byte = eight bits.

So, a 1 MB (megabyte) file consists of 8,000,000 bits and, in theory, will take 200 seconds (three minutes 20 seconds) to transfer over a dial-up 40 kbit/s (40,000 bits per second) connection. The same file would take just 18 seconds to download on a broadband connection of 460 kbit/s.

Always bear in mind that your connection is constrained by the slowest component of the network and the amount of data being transmitted across it at the time. Bottlenecks *en route* will affect transmission times, and imperfect connections can lead to errors and delays.

DIFFERENT TYPES OF INTERNET ACCESS

Dial-up 56 kbit/s

A standard telephone line and a modem is the entry-level connection to the Internet. Nowadays the only reason for having a dial-up connection is if you are one of the unlucky few for whom ADSL/cable broadband is not available in your locality. The modem (**mo**dulator-**dem**odulator) translates the analogue telephone signal into a digital signal recognised by a computer, and the connection is initiated by dialling an ISP's Internet access telephone number. Many PCs are sold with an internal modem fitted as standard. Modems are also sold as an external box.

A dial-up connection is only 'live' when you are connected to your ISP ('online'), so for example, email sent to you while you are 'offline' will only be received the next time you connect to your ISP. Data flows in both directions; you 'download' a web page or email and 'upload' your responses such as sending email or clicking on a link in a web page. Download speeds approach the quoted 56 kbit/s only under perfect conditions; speeds of 40-45 kbit/s are more common. The upload speed is up to 33 kbit/s.

There is generally a local telephone call cost and/or an ISP subscription charge, although charging models are many and various. Some ISPs offer a free connection so that all you pay is the cost of a local call while you are online. Others charge a monthly subscription of around £10-15 per month; this may include the cost of all online calls or a certain number of hours online per month (see 'Choosing an ISP').

Since the dial-up connection uses your existing phone line, it is not possible to make or receive phone calls unless an additional telephone line is installed. A dial-up service can be unreliable with engaged tones, dial-up errors and spontaneously terminated sessions.

How do you define broadband?

Broadband is defined as a transmission facility having a bandwidth sufficient to carry multiple voice, video or data channels simultaneously. More bandwidth results in improved streaming of audio/video, online games, application programs, telephone calling, video conferencing and other high-bandwidth services.

In the United Kingdom 'broadband' is generally taken to mean either an ADSL, cable or satellite connection, although there has been much disagreement about what bandwidth speed actually constitutes broadband. The general consensus seems to be an 'always on' service of at least 512 kbit/s.

Broadband

Broadband has been one of the fastest growing technologies in history with more than 263 million global users towards the end of 2006.[7] Its growth has been even faster than mobile phone uptake; it took five and a half years for mobile phone uptake to go from 10 to 100 million worldwide, but it took broadband only three and a half years. There are so many variables involved in setting up a broadband connection that it is always best to discuss your individual requirements with the broadband provider. They can give you advice about the suitability of their product(s), operating system and hardware requirements and details about installation. Table 1 compares the advantages and disadvantages of the various broadband connections with dial-up and ISDN.

- Broadband ADSL (asymmetric digital subscriber line)

Broadband ADSL technology uses the existing phone line to provide 'always on' Internet access for a fixed monthly cost. ADSL

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has the added advantage of enabling you to make voice calls at the same time as accessing the Internet. Apart from a suitable telephone line, you also require either an internal PCI ADSL modem (approx. £25-40, and has to be installed into the PC) or a USB ADSL modem (approx. £25-40 and can just be plugged into a computer's USB port). It is also necessary to plug a micro-filter to separate voice from data on each phone socket (cost about £2 each) (Fig. 1). ADSL services are self-install, which means that you connect the equipment and install the necessary software yourself. It is also possible to connect multiple computers onto a single line using an Ethernet cable or wireless router (£60-£200).

All set-ups require a firewall to ensure home/work computer security; either use the firewall built into Windows XP or choose a stand alone firewall program such as the popular ZoneAlarm.[8] Many routers come with additional firewall features and some routers have the ADSL modem built-in.

Entry-level broadband services in the UK are being offered at download speeds of 512 kbit/s (in reality download speeds of about 460 kbit/s are normal, but this is still 10 times faster than the actual speeds obtained from a 56 kbit/s modem). Upload speeds are limited to 256 kbit/s, which is why the service is called 'asymmetric'.

More recently ISPs have been offering flexible bandwidth packages of two, four or eight Mbit/s (sometimes with a monthly usage allowance) for about the same price as their 512 kbit/s services. ADSL services are available through a large number of ISPs who resell products from the major network operators such as BT Group PLC and Kingston Communications. Towards the end of 2005, companies such as Easynet and Bulldog started to unbundle the local-loop by installing their own equipment in BT's exchanges. The service they provide is known as 'local loop unbundled' and promises to give a connection of up to 24 Mbit/s. Initially at least, the actual speed of such a connection is likely to be highly dependent on line quality and distance from the telephone exchange.

The thinkbroadband.com website[1] has a full listing of ISPs and lists their services and costs (Fig. 2). The yearly total cost of ownership (which includes installation and set up fees) for a one Mbit/s service is about £150-£200 (roughly £12-£17 per month), plus the normal telephone line rental. When ADSL first arrived, you had to be within 5.5 km of a BT exchange, which excluded about 15 percent of the UK population. This restriction has now been lifted for the 512 kbit/s service, and BT estimates that 99% of homes and businesses are now able to access it. The problem will become more pronounced when people want to be able to access more bandwidth-dependent services (such as Internet TV, which requires a 2-4 Mbit/s connection) as the greater bandwidth connections are still limited by people's geographical distance to the telephone exchange.

- Broadband cable

Before they merged in 2006, there were two main broadband cable providers in the UK, NTL and Telewest Blueyonder. Later that year they merged again with Virgin Mobile, and in February 2007 the services were rebranded under the Virgin Media[9] brand name to provide a 'quad play' package of television, Internet, mobile phone and fixed-line telephone services. With plans to take on BT and the

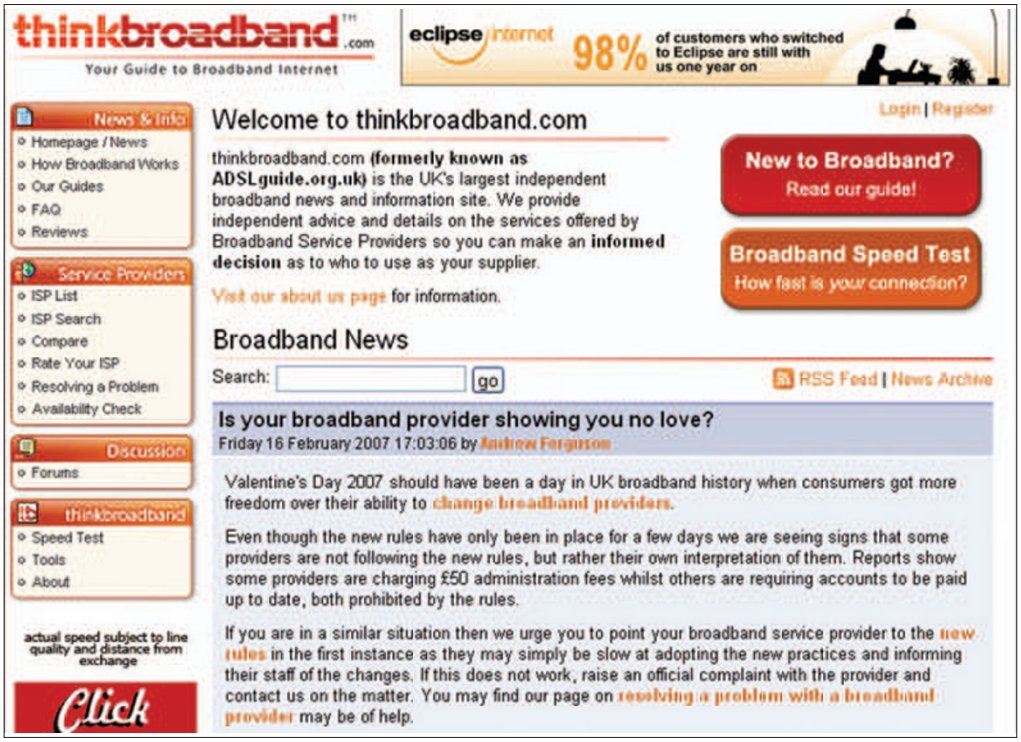

Fig. 2 The informative ThinkBroadband website is the best place to start to compare ISPs and check for ADSL broadband availability in your area

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Table 1 The relative advantages and disadvantages of the different types of Internet connection currently available in the United Kingdom

Type of Internet connection		Availability	Total cost of ownership	Speed	Portability	Reliability
Dial-up		●●●●●	●●	●	●●●	●●●
ISDN		●●●●	●●●●	●●●	●	●●●●
Broadband	ADSL	●●●●	●●●	●●●●●	●	●●●●●
	Cable	●●●	●●●	●●●●●	●	●●●●●
	Satellite	●●●●	●●●●●	●●●●●	●	●●●●
	Wireless	●●	●●●●	●●●●	●●●	●●●●

satellite TV giant Sky, Virgin Media is already the UK's largest broadband Internet company.

Broadband cable uses fibre-optic cable and is convenient for homes already wired with cable access. The current bandwidth options are for two, four and 10 Mbit/s connections (with the upload speed up to 512 kbit/s). At the time of writing, Virgin Media were charging £14.99, £25 and £35 per month for these broadband services. There are often special offers that apply when two or more of their bundled services are purchased.

The user connects their computer to a standalone cable modem or the cable modem built into a digital TV set-top box; some installations require an engineer. Broadband cable provides 'always on' access and does not tie up the existing phone line or television connection. As with ADSL, it is possible to share the Internet connection through either a wired or wireless home network.

- Broadband satellite

This service is suitable for people living in rural areas, where access to ADSL or cable is not available. An affordable satellite broadband service such as SkyDSL[10] is aimed at the residential market and uses a high-speed 'one-way' satellite link to send information from the Internet to your computer. This one-way link is 'always on' so that email is delivered to you in real time.

A traditional dial-up modem and ISP is still required for information travelling in the other direction, such as sending email and requesting web pages. The main drawback of this is that the telephone is engaged while online. The SkyDSL service offers up to four Mbit/s download for £28 per month plus any costs associated with the separate dial-up connection. Free set-up and a PCI card are included.

The bandwidth from the satellite is shared with other users and SkyDSL uses a system of three priority levels or 'gears' to give priority to those requesting a chosen download speed. The higher the gear, the faster the download, but this significantly increases the cost. As well as a dial-up modem, the system requires a professionally installed satellite dish outside the building and a receiver card to access the high-speed downstream connection.

Two-way satellite technology, aimed at businesses, is also available[11] at a monthly lease option of between £100 to £200.

- Broadband wireless networks

Wireless connections vary from Bluetooth (designed to connect devices in the same room), to WiFi (designed to connect devices in the same house or area) to wide area wireless broadband networks (designed to connect devices in the same town/city/district). They all use radio waves of different frequencies for wirelessly connecting devices.

Like broadband satellite, wireless broadband networks are seen as an alternative for homes and businesses where ADSL or cable is not yet available. Up until recently, wireless broadband coverage of the UK has been very patchy. However, UK Broadband, a subsidiary of Hong Kong-based Pacific Century Cyberworks (PCCW), has developed its Now[12] wireless broadband service in the Thames Valley. It plans to roll-out this service into other urban areas. PCCW has bought all of the regional licenses in the 3.4 GHz data band and its one Mbit/s (256 kbit/s upload) service costs £18 per month. BT is currently testing a wireless broadband service using the 5.8 GHz band.

To set up a wireless broadband connection you require an antenna and a wireless access box (which houses the signal receiver). This is normally connected via an Ethernet cable to a network card fitted into the PC. It can also be connected to a home network. You get an 'always on' connection and as it works independently of a phone line there is greater flexibility in where it can be positioned in the home.

Small WiFi 'hotspots' are springing up at selected public venues such as airports, railway stations, hotels, coffee shops etc. These local wireless network connections are available if you have a wireless-enabled laptop or PDA and a subscription to the relevant service. BT, under its Openzone[13] brand, is a member of the Wireless Broadband Alliance and therefore offers users access to about 30,000 hotspots worldwide. Most hotspots cover an area of about 70-100 m and you either pay by the hour (£6 per hour) or subscribe to a monthly service (from £10-£25 per month).

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The battle for wide area wireless networks

Over the next few years, a new system called WiMax[14] (based on 802.16 technology) will be released. WiMax networks will have a range of up to 3-10 km with data transfer speeds of up to 40 Mbit/s. WiMax is viewed as a cheaper alternative to other forms of broadband access, because the installation costs of a wireless infrastructure are minimal and setting up new subscribers should be as simple as filling in an online form. The other main advantage is that new WiMax computer chips are being developed which will include a portable 802.16e standard, enabling a totally mobile broadband connection. The mobile phone companies are developing their own high-speed access technology, but this may not be as fast as WiMax. When you consider that you can already send VoIP, (voice over the Internet, ie telephone calls and radio) at a fraction of the cost of using a conventional telephone carrier, then WiMax could have a tremendous impact on how we communicate at work, home and in between.

Connecting to the Internet without a PC

Connecting to the Internet is increasingly viable using many different household items, such as:

- Via a mobile phone – many mobile phones offer Internet access on the move using WAP (wireless application protocol) and GPRS (general packet radio service), while the latest '3' technology now offers a third generation of connection over a growing network. Unfortunately connections rarely exceed 300 kbit/s, give a limited number of 'walled-off' pay-per-view web pages, the service is relatively expensive and coverage in the UK is limited. Vodafone has partnered with Sky to offer a mobile TV service called Vodafone Live
- Via a PDA (personal digital assistant) – connect the PDA to an Internet-enabled mobile phone for web browsing and email on the move. The majority of makes are based on either the Palm or Microsoft Pocket PC operating systems
- Via a smartphone – increasingly, a number of PDAs have their own built-in wireless connection, so that data can be sent and received over mobile phone networks. Known as smartphones, they also offer voice services and using them is similar to using a mobile phone. Many of the smartphones produced by the mobile phone companies are based on the Symbian operating system
- via broadband Internet TV – BT Vision was launched at the end of 2006 and offers on-demand films, music and TV via a wireless broadband router, a set-top box/hard drive recorder and TV set
- Via a games console – Nintendo's GameCube, Microsoft's Xbox and Sony's PlayStation all allow you to hook up to a broadband connection for online gaming
- Via household appliances – wired, WAP or 'Bluetooth' local wireless technology in conjunction with a PC and an always on connection can make any device Internet-enabled, such as the home security system, microwave – and even your fridge
- Via a dedicated static email phone, eg Amstrad's E3 emailer/video phone.[15]

CONTENTION RATIOS

All ADSL lines are subject to contention, meaning that the network bandwidth available is shared between a number of subscribers. The ratio to which the available bandwidth is shared between users is called the 'contention ratio'. Services targeted at home users are frequently cheaper, but have a higher contention ratio (50:1). What this means in the 'worst case' scenario is that you could be sharing a 500 kbit/s connection with up to 49 other users, but in reality it is unlikely that all the users would be downloading data at exactly the same moment. Business services have a lower contention ratio (normally 20:1), which should provide a more consistent level of performance.

HOME OR PRACTICE CONNECTION; WHAT IS THE DIFFERENCE?

Dial-up and ADSL broadband operate in the same manner whether you use them at home or from work; they should cost the same amount to set-up and run. Some companies charge slightly more for a business ADSL connection because they provide a better contention ratio of 20:1, instead of the normal 50:1 for home users (see 'Contention ratios'). Check with the telephone company first that it is possible to install ADSL, since there are compatibility issues with some internal phone systems.

Additional packages are available for businesses but these are aimed more at bigger companies who are working on collaborative projects and need to share large volumes of data amongst members or teams spread across multiple locations. You pay extra for these services, and they include such things as an uncontended service, 24 x 7 support, extra security features, web space hosting, file storage with document searching, email management, SMS text messaging and the management of contacts, diaries and meetings. There is also a symmetric DSL service (SDSL), so called because it allows information to be both sent and received at the same broadband speeds.

CHANGING YOUR ADSL BROADBAND PROVIDER

If you decide to change your ISP, either because of poor service, or you see a better offer elsewhere, then this can be a straightforward process. Since 2004, many ISPs signed up to a voluntary code designed to make switching easier; check to make sure your ISP has

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signed up to this code.[16] Contact your existing provider and ask for your migration authorisation code (Mac); this enables your new provider to make the switch for you. Your ISP has five working days to provide you with your Mac and it is valid for 30 days. Switching away from a 'local loop unbundled' service can take longer, as the provider has to manually switch equipment at the exchange. This code only applies to ADSL providers; to switch to or from cable broadband, you'll need to cancel your old service and then sign up to your new one.

1. thinkbroadband.com. http://www.thinkbroadband.com/
2. Consumers' Association. http://www.which.co.uk/ (members only, or join for a 30 day free trial).
3. UK ISP directory. http://www.uk-isp-directory.co.uk/
4. The UK Internet Industry Awards. http://www.ispaawards.org.uk/prevwinners.htm
5. The Broadband Buyer website. http://www.broadbandbuyer.co.uk/
6. Simplyswitch. http://www.simplyswitch.com/
7. Point-topic world broadband statistics, Q3 2006. http://www.point-topic.com/content/dslanalysis/World+Broadband+Statistics+Q3+2006.pdf (requires free registration)
8. ZoneAlarm firewall software. http://www.zonelabs.com/
9. Virgin Media. http://allyours.virginmedia.com/
10. SkyDSL one-way satellite broadband Internet service. http://www.teles-skydsl.co.uk/
11. Avonline two-way satellite broadband service. http://www.avonlinebroadband.co.uk
12. Now wireless broadband. http://www.mynow.co.uk/
13. BT Openzone. http://www.btopenzone.com/
14. WiMAX Forum. http://www.wimaxforum.org/about
15. Amstrad emailer phone. http://www.amstrad.com/
16. Ofcom code for ADSL broadband migration. http://www.ofcom.org.uk/advice/codes/bbm_cop/

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