# The Development of Broadband Access Platforms in Europe

## *Technologies, Services, Markets*

## Full Report

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Prepared by:

BDRC Ltd
5th Floor Kingsbourne House
229-231 High Holborn
London, UK, WC1V 7DA
Tel: +44 (0)207 400 1017
Fax: +44 (0)207 405 4778/9
mail@bdrc.co.uk
www.bdrc.co.uk

Commissioned by:

European Commission
Directorate General Information Society
200, rue de la Loi
B-1049 Brussels
Web: europa.eu.int/eeurope
Email: eeurope@cec.eu.int



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# 1. INTRODUCTION

This study describes the development of broadband access platforms across the European Union (EU). It focuses on those access platforms most suited to the residential and the small/medium enterprise (SME) market, in other words: mass-market access platforms. The following access platforms were included in the analysis[1]:

| | |
|---|---|
| **ISDN** | Integrated Services Digital Network (ISDN) used over copper, 'twisted pair,' lines as found in the local loop. Typically Basic Rate Interface (BRI) or ISDN2. |
| **Leased Lines** | Typically Primary Rate Interface (PRI) or ISDN30 used over high performance, coaxial, copper cable which is leased as a dedicated connection for exclusive use. |
| **DSL** | Digital Subscriber Line (DSL) used over copper, 'twisted pair,' lines as found in the local loop. Typically ADSL (Asymmetric DSL). |
| **DTT** | Digital Terrestrial Transmission (DTT) typically used to broadcast Digital Television (DTV). Digitised channels are transmitted over the legacy analogue infrastructure. |
| **Digital Satellite** | Wireless, radio transmission, most typically used to broadcast DTV, when it is referred to as Direct To Home (DTH). When upgraded from analogue, it is known as digital broadcast satellite (DBS). |
| **Digital Cable** | Independent networks used to supply DTV, telephony and Internet. Recent infrastructure uses fibre optic core with copper outer layer (known as hybrid cable). Legacy infrastructure uses co-axial, copper cable with two-way, digital connections. |
| **Fibre Optic** | Independent networks of solid glass pipes carrying optical signals and allowing extremely fast transmission of digital information. Described as fibre-to-the-home (FTTH) or to any other premises which is typically connected to a local area network (LAN). |
| **Fixed Wireless** | Microwave radio transmission, between a fixed, 'parent' transponder and many fixed subscribers as a 'point-to-multi-point' solution, which could be an alternative to the copper local loop. Commonly referred to as FWA (Fixed Wireless Access) and WLL (Wireless Local Loop). |
| **Mobile Wireless** | Microwave radio transmission, using a cellular network within which many mobile devices can be individually connected. Known as third generation (3G) mobile, UMTS or CDMA. |
| **Powerline** | The transmission of digital information via the electricity network, allowing simultaneous provision of two-way data access and electrical power. Known as Power Line Transmission (PLT). |

Each access platform has been analysed in terms of technical characteristics (i.e. concept, capacity, interactivity, future developments and potential lifecycle), industrial characteristics (i.e. ownership and sector overlap) and financial characteristics (i.e. business models, investment required). The report includes chapters focusing on key players, regulatory issues, and broadband content and the possible effect of digital convergence.

The study includes an assessment of the evolution of each access platform, both historically and for near term projections to 2003 (using a time line of 2000). Also included is an analysis of recent developments for each access platform within all 15 Member States, in order to benchmark the EU as a whole against the USA and Japan.

[1] Full technical description of access platforms is appended.

# 2. METHODOLOGY

The methodology employed a combination of secondary 'desk' research and primary survey research.

## 2.1 SECONDARY RESEARCH

The desk research process used as broad a range of existing information as possible. This included: many publicly available reports; attendance at selected conferences; industry media; and international business media. Throughout this report, sources of all quotations and data are given. A comprehensive list of material is appended.

## 2.2 PRIMARY RESEARCH

The primary, survey research involved designing and conducted an extensive programme of interviews with selected industry experts. The sample was constructed to ensure a representative spread of respondents from each access platform, within each country. Respondents include representatives from Government departments, regulators, manufacturers, service providers, content providers, ISPs, financial investors and consultants. Controls were also made to ensure a spread of niche players, leading edge specialists, incumbent operators, and multinationals. Furthermore, the survey was designed to ensure a representative sample of interviews were achieved across all of the Member States, as well as the USA and Japan.

The interviews themselves were implemented as a mixture of face to face and telephone interviews in such a way as to focus the research effort onto the main platforms, but also to maintain a balanced view of all Member States. 103 interviews were conducted in total (52 face-to-face and 49 via telephone). A spreadsheet describing the sample structure is appended.

# 3. BROADBAND OVERVIEW

## 3.1 INTRODUCTION

Behind the vision of a digital future and the reality of converging technology and content, lies a complex and situation specific interplay of conditions. The success of any potential broadband technology depends upon factors as diverse as: the legacy of existing technologies, current scientific boundaries, socio-economics (e.g. economic health, cultural context, political will, and education), and socio-geographics (e.g. population density, extent of anglophone communication, climate, and topography).

In order to give validity to a discussion about the past and future of 'broadband', *all* of these factors should be taken into consideration. Furthermore, the rapid nature of scientific and technical development, and a society's willingness to embrace new technology, means that there is constantly the chance of a 'wild card' scenario, in which a significant influence comes from an event of extremely low probability. In suggesting how things might evolve over the next few years, we have given some examples of 'wild card' scenarios, but have concentrated on what is currently known and so what is *most* probable in the short to medium term.

Whilst convergence of digital media, supported by a diverse range of technologies, is almost universally accepted as inevitable, it is also apparent that the process of digitisation supported by high bandwidth has only just begun. There is still a great deal of work to do in all areas from infrastructure to content and applications. And, although frequently under represented (and occasionally ignored), there are some significant behavioural changes required before the potential of a broadband era becomes a reality. Although the younger generation (under 25 years old) are now growing up familiar with digital information, older generations do not easily embrace new technologies, unless they are very sensitively developed and marketed to meet an existing need. Furthermore, the future of broadband has potential to widen any existing digital divide between those who live in a well serviced area and can afford to pay for high-speed access and content and those with little choice because they live in a poor region that is not well served.

In order better to understand the development of broadband access technologies, in the context of convergence, we have chosen to categorise each technology according to its legacy. Although we are aware that each technology has the potential to rapidly re-invent itself through a technical leap forward, unexpected popularity, or industry integration. It is also the case that the history of an access platform will determine its future.

## 3.2 THE NARROWCAST LEGACY

The telephone companies, with expertise in building and maintaining physical networks for telecommunications have evolved into data-communication companies. Traditionally these companies have sold a commodity using an established technology. Like other utility companies, they have considerable experience in billing large numbers of customers for standardised services. With rapid technical advances, increased competition and the promise of digital convergence, these companies have had to upgrade their infrastructure, broaden their product lines and, in the quest for differentiation, have begun to consider *content* as a means of attracting the customer.

The rapid increase in bandwidth demanded by a digital society has put pressure on the network. Although national networks are largely upgraded to cope with this demand, a bottleneck remains over the 'last (or first) mile' between the customer and the first node in the network. To address this problem, access to the network has evolved from the plain old telephone system (POTS), to ISDN, and now DSL. In each case, these technologies have been developed to address the problem of transmitting digital information over a network originally intended for analogue information.

In addition to developing the legacy network, telecom companies have also established a large and profitable business offering leased lines to larger, data intensive businesses. These might be secure connections directly from one site to another and so independent of the network, or a single, dedicated network connection for multiple user terminals. They have evolved to cope with the huge increase in digital information sent and received by businesses.

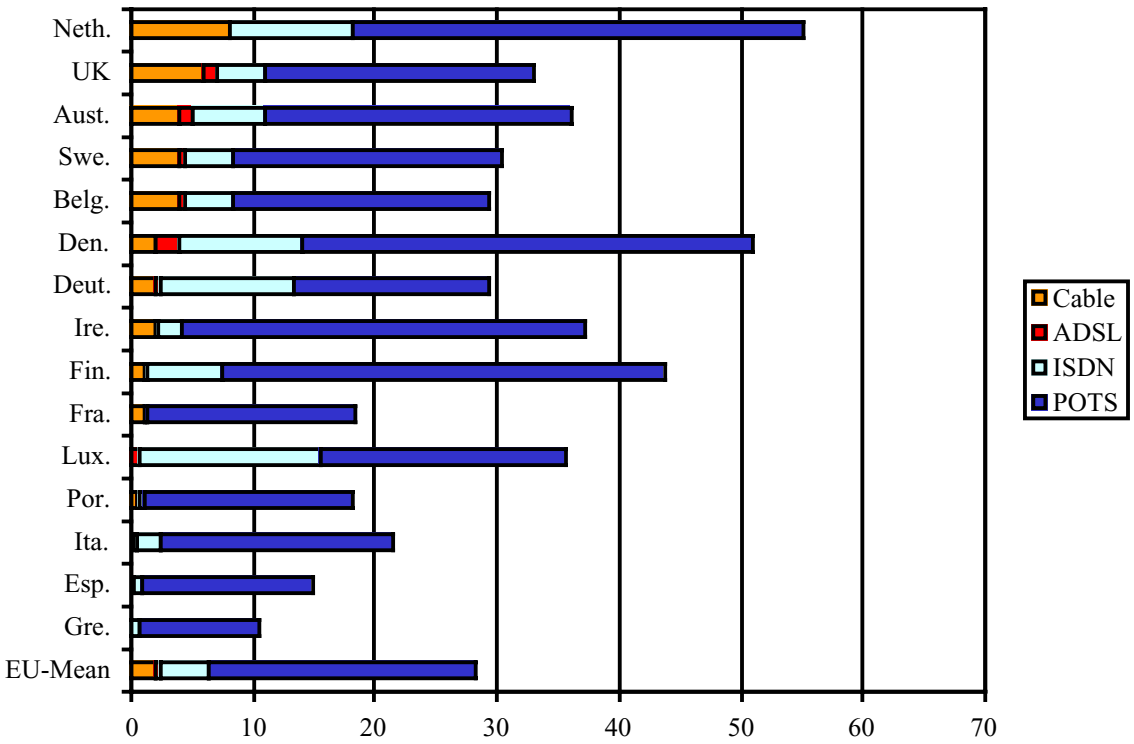
The charts on the following page (Figure 1a and 1b) demonstrate that standard dial up (or POTS) is still by far the most popular means for households to access the Internet across all Member States. Interestingly, in countries with extensive cable infrastructure, such as Benelux, Denmark and Germany, ISDN is also widespread. This suggests that as demand for faster access grows, so a variety of platforms are used, according to which best meets an individuals needs. The chart also shows that current penetration of ADSL is low. However, the technology is now present in all Member States (except Greece as at June 2001) with penetration increasing between October 2000 and June 2001. For most Member States, the current low level of ADSL penetration reflects its infancy in the market. Countries with the highest level of penetration of ADSL are Sweden (4.6%), Denmark (3.9%), Belgium (3.9%) and Austria (3.3%) - see Figure 1b.

To some extent, take up of ISDN may give some indication of the immediate demand for ADSL. Assuming that those with ISDN are likely to be among the first to take up an offer of ADSL given that it is of comparable price. In this case, it would appear that Luxembourg, Germany, Denmark, The Netherlands and Austria are all good prospects in terms of proportion of population. In terms of potential market size for an initial offer of ADSL, Germany stands out as the largest among the Member States.

ADSL currently faces most competition from cable in The Netherlands, UK, Austria, Belgium, Sweden and Ireland (and also in the USA). Competition from cable operators is likely to rise significantly as networks are upgraded.

**Figure 1a**

**EU Household Penetration of Internet Access Platforms - Ranked by Broadband Platforms**
**{EOS Gallup Europe 10/2000}**

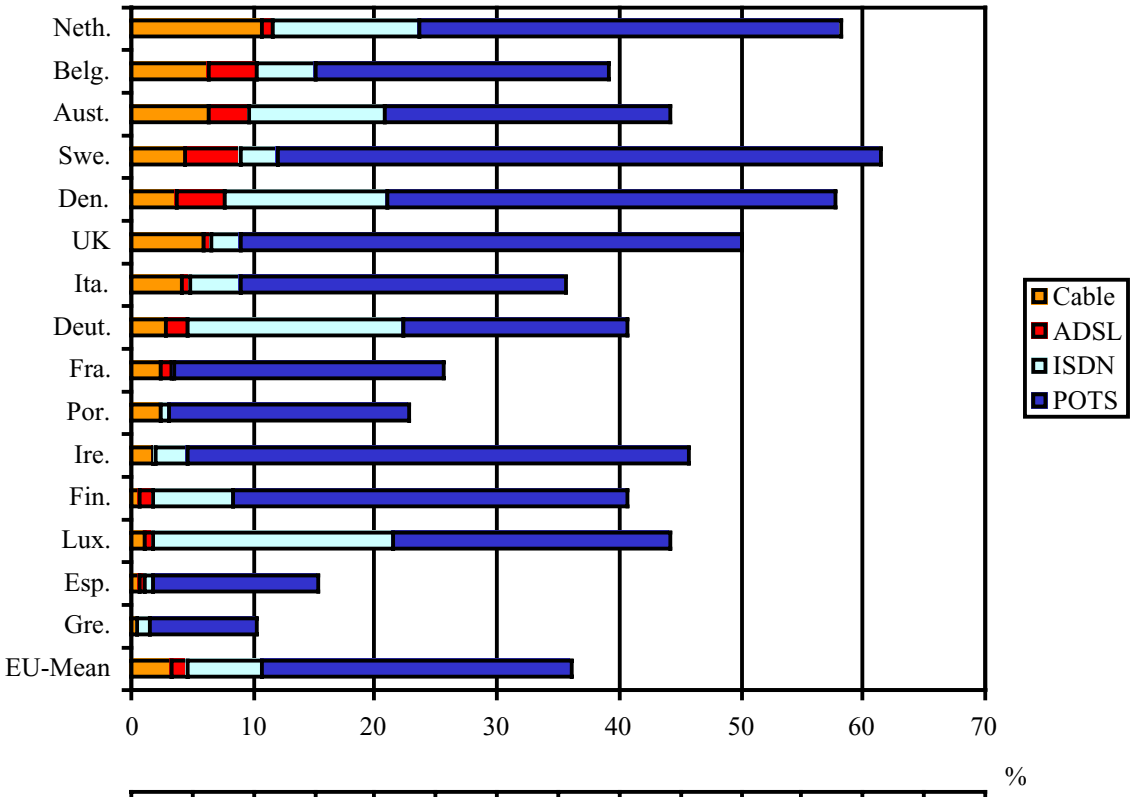



| | EU-Mean | Gre. | Esp. | Ita. | Lux. | Fra. | Fin. | Ire. | Deut. | Den. | Belg. | Aust. | UK | Neth. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| POTS | 22 | 9.7 | 14 | 19 | 20 | 17 | 36.4 | 33 | 16 | 37 | 21 | 25 | 22 | 37 |
| ISDN | 4 | 0.7 | 0.5 | 2 | 15 | 0.3 | 6 | 2 | 11 | 10 | 4 | 6 | 4 | 10 |
| ADSL | 0.3 | 0 | 0.1 | 0.1 | 0.5 | 0.1 | 0.4 | 0.1 | 0.3 | 2 | 0.3 | 1 | 1 | 0.1 |
| Cable | 2 | 0 | 0.2 | 0.3 | 0.1 | 1 | 1 | 2 | 2 | 2 | 4 | 4 | 6 | 8 |

%

**Figure 1b**

**EU Household Penetration of Internet Access Platforms - Ranked by Broadband Platforms**
**{EOS Gallup Europe 6/2001}**




| | EU-Mean | Gre. | Esp. | Lux. | Ire. | Por. | Fra. | Deut. | Ita. | UK | Den. | Aust. | Belg. | Neth. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| POTS | 25.4 | 8.7 | 13.6 | 22.7 | 41.2 | 19.6 | 22 | 18.3 | 26.7 | 41 | 36.9 | 23.5 | 24 | 34.6 |
| ISDN | 6.3 | 1.1 | 0.6 | 19.7 | 2.5 | 0.8 | 0.3 | 17.6 | 4.2 | 2.4 | 13.3 | 11 | 4.9 | 11.9 |
| ADSL | 1.2 | 0 | 0.5 | 0.6 | 0.2 | 0 | 0.9 | 1.9 | 0.6 | 0.8 | 3.9 | 3.3 | 3.9 | 0.9 |
| Cable | 3.3 | 0.4 | 0.6 | 1.2 | 1.8 | 2.3 | 2.4 | 2.8 | 4.2 | 5.8 | 3.7 | 6.4 | 6.4 | 10.8 |

As Figure 1a and 1b show, there has been an increase in penetration of Internet access platforms across all Member States, except Greece and Finland. More significantly, penetration of the principle broadband platforms, cable and ADSL, has also risen in all Member States, except the UK and Ireland which remained level between October 2000 and June 2001.

## 3.3 THE BROADCAST LEGACY

Television operators broadcast TV channels via terrestrial, satellite or cable. Terrestrial and cable have been used since the TV was invented (over 50 years ago). Satellite is a more recent development. As a consequence of this legacy, the majority of broadcast TV is transmitted and received in analogue. Digitisation of all three platforms is ongoing and by the middle of 2000 digital satellite accounted for 78% of the European DTV market, digital cable 15%, and digital terrestrial 7%[2]. Because of its more recent arrival as a broadcast technology, satellite has tended to attract customers to DTV service through exclusive access to pay-TV. Terrestrial broadcast is currently being upgraded to digital broadcast in a minority of Member States, whilst existing cable networks are in the process of being upgraded to two-way, high bandwidth transmission. However, the only one of these three technologies to offer true 'broadband' in the sense that it provides upstream as well as downstream transmission is cable.

Competition between these access platforms historically has been driven by access to content and the broadcasters are experienced at marketing exclusive access or bundled products (unlike the telecommunication operators). The concept of pay TV will lend itself well to the offer of enhanced TV with interactive channels, Internet style applications, video on demand and other new media. In terms of attracting a customer base prepared to pay for broadband services, the broadcasters have a head start over the narrowcast telecommunications providers, who have historically been focused on price of connection rather than access to content.

Broadcast broadband is not Internet led, but DTV (or content) led. With the exception of cable networks that have been upgraded, the broadcast legacy technologies will not provide full access to the Internet. Currently, they are embarking on a strategy of making the best use out of existing technologies. Through being weak on interactivity, but very strong on downstream bandwidth into the home, the strategy of operators is to concentrate on multi-cast applications (e.g. Multi-channel TV, Video/music-on-demand, and other multi-media entertainment and information services). In this way, the operator's weakness becomes their strength because it ensures a very focused and clear strategy.

The key issues facing the future of broadband broadcasting will be:

- preserving brand loyalty in an increasingly fragmenting world;
- copy protection and management of content across global networks and devices;
- the high cost of delivering personalised and on-demand services (particularly critical for publicly funded broadcasters).

The ability to market content will also be crucial in securing take up of broadband services and broadcasters have the medium and experience to do this. Furthermore, and perhaps of most significance of all, broadcasters of the future will become the providers of much more than the flat screen, real time experience of TV. Any data download will be possible at high rates, through one box, and this box will be the home console for all forms of incoming information. Behind this home console will be the financial strength and marketing ability of the whole media industry.

[2] Source: SES/Astra Satellite Monitor of Europe (mid 2000)

Of the broadcast mediums, cable appears to offer most potential as a broadband access platform. All Member States have a cable network passing at least half of all homes, except Spain, Portugal, France, Greece, and Italy[3]. In the Benelux countries, penetration is very high (over 90% of households) and in Germany (58%), Denmark (57%), Sweden (54%), and Ireland (48%) cable is very popular[4]. Notwithstanding, there is considerable variation in the nature of cable networks across Europe. In addition to the coverage and penetration of analogue service, it is also necessary to consider the condition of the cable networks and the extent of upgrading required, before making an assessment of their suitability for broadband. In some regions, the networks are very old (e.g. Benelux), and require considerable upgrading, whilst in other regions the networks are relatively new (e.g. UK and Spain) and so are already upgraded.

'Broadband' or two-way digital cable is in its infancy. Member States with the highest household penetration of cable for Internet access, in June 2001 where: The Netherlands (10.8%); Belgium (6.4%); Austria (6.4%), the UK (5.8%) and Sweden (4.4)[4]. The quality of network not only varies from country to country, but from region to region within each country (as many networks where installed by municipalities of towns and districts). The fragmentation of networks has, to some extent, inhibited the potential for consolidation through mergers and acquisitions among operators and, even where the network is new the market for telephony and DTV may drive demand, rather than Internet connection (e.g. Portugal and Spain).

Satellite broadcast is, of course, widely available and there are now around 30 million customers in the EU (over 20% of all TV households), 41% of these receive digital transmission and most (90%) of these pay for additional channels[3]. Three out of four of all customers receive DTH (Direct To Home) service, and the remainder are connected via a communal aerial (e.g. in an apartment block)[3]. In 2000 the UK had the largest number of satellite DTV subscribers (3.5 m) followed by France (2.5 m), Italy (1.5 m), Spain (1.1 m)[3]. Considering the relatively large numbers of analogue satellite subscribers in Germany and Austria, these countries have been slow to adopt digital satellite.

Two-way transmission via satellite (allowing access to the full Internet on demand) is currently only available to large businesses prepared to make the necessary investment. Although new developments in interactive systems are emerging which offer limited access to the Internet and may capture some of the SME market, they are not yet established in the market place. The only satellite 'interactivity' available to the residential market requires the use of a terrestrial link (e.g. the telephone line) for upstream transmission.

[3] Source: Eurocable Communications, ITC stats., and ITU, 1/2000
[4] Source: EOS Gallup Europe 6/2001

## 3.4 ALTERNATIVE TECHNOLOGIES

Alternative technologies have the potential to outperform technologies that rely on legacy infrastructure. They are without precedent and so tend to be of higher risk and in some cases initially more expensive than the development of existing infrastructure. However, if given sufficient financial backing to get to market, they offer great potential as they are designed specifically to meet the demands of the digital information age.

Light via fibre optic is quite simply, the optimum platform for data transmission. Fibre optic can significantly outperform any other 'broadband' access platform, and its potential is increasing faster than any other technology. Light via fibre optic does not suffer from interference and so provides an extremely reliable connection. The only drawback is the cost of installing an entirely new infrastructure. Commercial offers of fibre to the home/SME have been made in Sweden and Italy (within the EU).

Microwave radio transmission via Fixed Wireless Access (FWA) is an important alternative to the copper local loop as it can be quickly installed. This is particularly attractive in countries where the incumbent operator has been slow to unbundle the local loop. In this case, FWA could be a very competitive alternative. A drawback is that FWA is relatively untested on a large scale, although it has been used successfully for point-to-multipoint telephony service in remote towns and villages and for point-to-point, high bandwidth connections for larger businesses. Currently the business model for FWA has not been proven on a mass-market scale, but its cost will come down rapidly if the market begins to adopt the technology.

The transmission of data over electrical Powerlines (Powerline access) is interesting in theory, but there are technical barriers. This is really a legacy technology, because the first principle of the infrastructure design is to transmit power rather than data. In essence, data transmission has been grafted on to the power network. Because of this, data transmission rates are limited by the technical constraints of the infrastructure. Although Powerline may provide an alternative in some niche markets, better ways of transmitting data now exist.

Other alternative technologies, which are not covered further in this report, include wireless optical access and high altitude zeppelin or fixed wing aircraft. Wireless optical access uses lasers in much the same way as a fibre optic solution, but without the fibre. In other words, the light from the laser travels through open air. This relies on line of sight transmission and is susceptible to interference. The advantage of such a solution is that it offers the data speeds of fibre optic solutions, without the cost of installing an infrastructure. There are solutions proposed that would compete with the copper local loop, in much the same way as FWA, but without the need for a radio license. Although not yet tested in practice, this is a new and emerging technology with much potential.

Finally, the use of high altitude zeppelins or fixed wing aircraft has been proposed as an alternative to satellite. Such aircraft would fly unmanned at around 100,000ft and would probably be geo-stationary (e.g. above cities). This would offer the advantages of satellite, but would be much less expensive to install and recycle. With communication equipment onboard, such aircraft potentially could provide two-way interactive transmission without suffering the latency problems associated with two-way satellite.

## 3.5 BROADBAND DEVELOPMENT

There are many factors influencing the speed of roll out of broadband technologies. Not least is the evolution of demand for the Internet, which continues to grow across Europe. In northern European Member States, particularly the Nordic region, the Internet at home has become almost ubiquitous within the last few years and here the emphasis is increasingly placed on the speed of connection. In southern European Member States, particularly Portugal, Spain, France and Greece, demand for the Internet has grown more slowly and the emphasis is still on simply having access rather than the speed of the connection. Indeed, the success of the Internet would appear to be correlated to the extent of English speaking in each Member States, since the vast majority of the content is in (US) English. This picture is beginning to change as automatic translation software becomes more effective and European content providers begin to offer Internet content in other languages, stimulating demand.

Clearly, broadband access platforms are in their infancy across Europe. The preceding chart (Figure 1a and 1b) shows current penetration of all Internet access platforms. By far the most popular method remains standard dial up, with broadband technologies only just beginning to emerge. Of the broadband technologies available at this moment in time, digital cable has a head start, whilst DSL is not far behind. But, neither of these access platforms have been available for very long (e.g. only 18% of cable infrastructure is set up for two-way transmission, and DSL has only been commercially available since 2000 in most Member States).

In terms of business models, there are broadly two strategies for the future of broadband. There is the 'commodity' business where reliable data transmission (particularly upstream) will be charged for according to number of units of data transmitted (with many variations of tariff structure as seen in the mobile market). Such a business model will suit the price sensitive residential/SME market for data transmission. Then there will be the 'premium' business where popular applications (mostly data rich content downstream) will be marketed independently of the access platform and amount of data transmitted, but with exclusive content and bundled applications. The 'commodity' model will typically include an equipment installation charge, whilst the premium business will subsidise the equipment installation in return for a customer lock in period to multiple products.

Of course there will be increasing cross over of content between platforms (including mobile wireless platforms). But in the short term, the TV (rather than the PC) will evolve into the main digital gateway to the home for the mass market, with content accessed via broadcast technologies with some limitation on upstream capacity. Over this time, the PC will evolve into the next generation work station and communication tool eventually requiring symmetrical broadband access into and out of the home/office. In the medium to longer term, as TV and PC applications converge, large symmetric bandwidth will become the norm. The home will have a server or console for data storage, transmission and manipulation, which can be accessed by any number of different screens or keyboards depending upon the desired application. This will enable significant shared functions of the hardware (e.g. one memory source, independent access devises of any function and style, linked through an in-home wireless network).

Ultimately, the digitisation of the home will lead to the 'Home Gateway', currently being developed, by companies such as Matsushita and Sony, to connect all the digital devices in the home through a common wireless platform which in turn connects to the external broadband access network. This technology uses the IEEE 8.02 standard of microwave wireless radio transmission in products such as 'HyperLAN2' which provides broadband network within a confined area such as a home, office or airport waiting lounge. 'Bluetooth' is a precursor of the concept, but it is based on lower capacity technology and so lacks the potential of IEEE 8.02. An IEEE 8.02 product is likely to emerge in Japan and the US first (as these are the home markets of the companies involved). Indeed, demand for the wireless in-home network may be the catalyst that drives demand for broadband into and out of the home.

Outside the home, there are a number of possible directions for the future. Third generation mobile networks will allow for Internet access, and fourth generation mobile may offer sufficient bandwidth for continuous video streaming. An alternative future direction may be to build larger memories into mobile devices so that content and applications can be downloaded from a fixed location and then experienced whilst on the move. The future is likely to be a combination of these two methods.

Below are estimations for access platform development over the next 3, 5 and 10 years. The timings may be half as long or twice as long depending upon economic conditions and the speed of cultural acceptance of new technologies. In Europe, there will be very great differences in the evolution of broadband on a region by region basis.

**3 Year View (2Mbps to the home/SME)**

In the short term, ADSL and cable will compete to be first to market. ADSL is likely to capture market share fastest, by offering downstream bandwidth of 512Kbps. 2+Mbps ADSL and upgraded 2+Mbps cable penetration will grow at different rates on a region by region basis wherever demand is greatest (SMEs and early adopters). Broadband FWA has the potential to attract a small niche market by competing with ADSL and cable, however the practicalities of getting to market are still uncertain. Fibre optic and fibre/copper hybrid networks will increasingly reach closer to the home, with a growing minority switching from ‘interim’ broadband solutions to fibre. Powerline and two-way satellite may emerge, but only in niche markets. Digital broadcast will continue to replace analogue broadcast, with satellite and cable broadcast continuing to grow. Growth of ISDN will slow and go into decline. UMTS will further stimulate Internet use and interactive applications, but will not reach the 'broadband' speeds available via fixed platforms.

**5 Year View (2-10 Mbps to the home/SME)**
In the medium term, there will be a choice between at least cable and ADSL in most urban and suburban regions. Lower bandwidth ADSL will be widely available, even in more remote regions. Fibre to the basement of apartments and to SMEs will begin to replace copper access platforms in urban areas. Fixed Wireless Access will also be an alternative in urban areas and for those unable to access ADSL or Cable. Digital cable, digital satellite and DTT will share the broadcast market, but ADSL, fibre and FWA will also compete in the broadcast arena. A two-way satellite solution may emerge which is suitable for remote regions, and areas poorly served by other platforms.

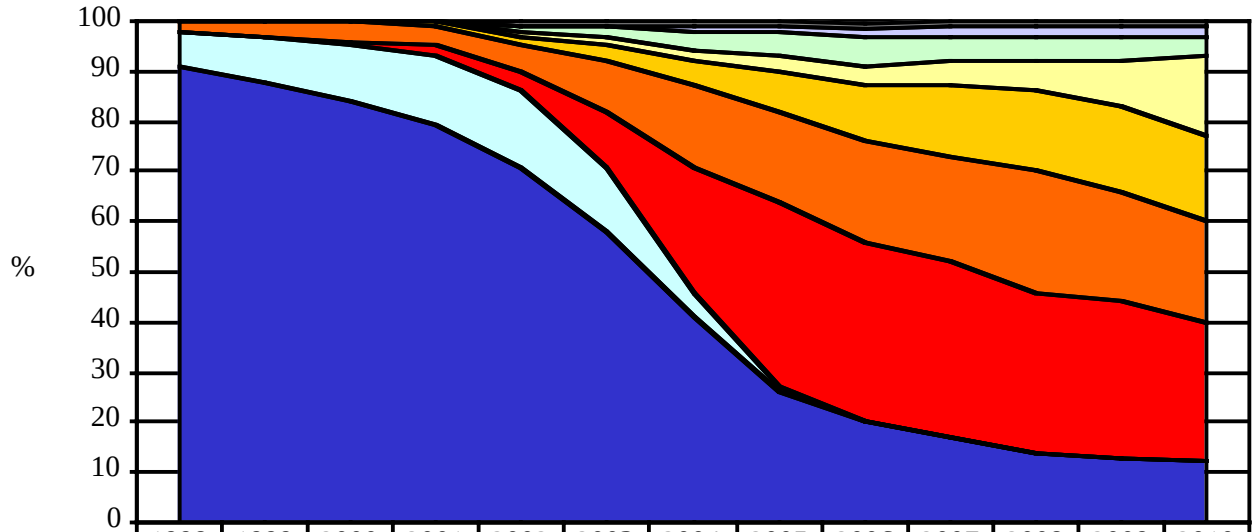
**10 Year View (10+ Mbps to the home/SME)**
Given continued exponential growth in demand for broadband, and based upon current technical possibilities, the most likely (and by far the most appropriate) technology for symmetric, unlimited bandwidth is fibre optic. The market for ADSL will begin to decline, and coaxial cable will be replaced by fibre. VDSL may exist over copper from the curb to the home/SME, but even in this case a hybrid fibre optic platform will have reached to the curb. Symmetric, high bandwidth via a wireless technology (UMTS, FWA, wireless optic, satellite, or high altitude zeppelin) may emerge.

The chart on the following page (Figure 2, Page 15) gives an indicative prediction of the future market share of each access platform among homes/SMEs. This refers to the EU as a whole, and so ignores the fact that there will be significant regional differences. It also describes 'Internet' access, as we know it today, and does not take into account changes in the consumption of content, which may arise from broadband. For example, satellite and DTT broadcasters may offer interactive TV and even Internet connection using the telephone line for upstream transmission, but we have not included this as 'broadband' (although clearly there is large bandwidth into the home suitable for fast downloads).

The chart shows that ADSL will capture market share fast, but will eventually loose market share as demand for bandwidth grows beyond the capacity of ADSL. Upgrading of coaxial copper cable networks will capture market share at a slightly slower rate to ADSL, and new hybrid copper/fibre networks will also be built. As demand for bandwidth grows, so people will be prepared to pay for the higher capacity offered from fibre to the home/SME. ISDN still has some life, and although POTS will be used less and less as an access platform, it will not completely disappear, as it is likely to become virtually free. Currently, satellite and FWA look set to be a niche alternative. However, in both cases there may be a breakthrough that increases the potential of these technologies. And of course their may be a wild card, like the rapid adoption of fibre optic which this prediction does not see happening until after 2010.

**Figure 2**

**Predicted Market Share of Access Platforms to EU Homes/SMEs**




| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Other | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Satellite | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1.5 | 2 | 2 | 2 | 2 |
| FWA | 0 | 0 | 0 | 0 | 1 | 2 | 4 | 5 | 6 | 5 | 5 | 5 | 4 |
| Pure Fibre | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 9 | 16 |
| Fibre Hybrid | 0 | 0 | 0 | 1 | 2 | 3 | 5 | 8 | 11 | 14 | 16 | 17 | 17 |
| Coaxial Cable | 2 | 3 | 4 | 4 | 5 | 10 | 16 | 18 | 20 | 21 | 24 | 22 | 20 |
| DSL | 0 | 0 | 1 | 2 | 4 | 11 | 25 | 37 | 36 | 35 | 32 | 31 | 28 |
| ISDN | 7 | 9 | 11 | 14 | 15 | 13 | 5 | 1 | 0 | 0 | 0 | 0 | 0 |
| POTS | 91 | 88 | 84 | 79 | 71 | 58 | 41 | 26 | 20 | 17 | 14 | 13 | 12 |

# 4. BROADBAND ACCESS PLATFORMS: MARKET PERSPECTIVE

## 4.1 ISDN

ISDN was developed in the early 1990s, to connect a LAN (Local Area Network) with 10 or more telephone lines to the local exchange and so avoid the expense of a leased line. This was before the widespread use of the Internet, which is typically accessed via standard dial up over POTS (plain old telephone system). Because standard dial up over POTS provides a relatively poor connection in terms of reliability of connection and speed of data transmission, ISDN has proved to be a better alternative for those prepared to pay more.

Since its emergence, ISDN has been a success in some Member States (e.g. in The Netherlands, Luxembourg, Germany and Denmark over 10% of the households use ISDN for their Internet connection). However, given that ISDN was not specifically designed to handle the data rates required for content rich web-sites (and other applications such as file transfer), its scope is limited to an improvement over standard dial up and not a broadband access platform.

ISDN penetration is likely to continue to grow over the next 1-2 years in markets where it remains the only alternative to standard dial up. However, alternative broadband technologies are likely to replace ISDN as they become available (assuming they are offered at a competitive price).

## 4.2 DSL (DIGITAL SUBSCRIBER LINE)

Increasing demand for bandwidth for Internet use, via standard dial up modem or ISDN, has put pressure on the telephone infrastructure, particularly the 'local loop'. In theory, the best possible solution would be to re-build the last (or first) mile of the network with fibre optic. In practice, this is prohibitively expensive (except in some specific circumstances). As the 'twisted pair' copper cable is already installed in the vast majority of homes and businesses, in theory, this infrastructure offers a greater immediate business opportunity as a way to meet the demand for higher bandwidth. The telephone line is also the means of Internet connection most familiar to the market.

Perhaps the most significant factor in bringing DSL (in particular ADSL: see Appendix A1 for technical description) to market is that demand for higher bandwidth Internet connection via PC exists now, and building a completely new infrastructure would take too long (to say nothing of the cost!). Hence, ADSL is well placed to become the first technology to capture the market for higher bandwidth. Incumbents and new entrants are both attempting to capitalise on this opportunity and ADSL offers are now being seen all over Europe. However, there are a number of issues hampering roll out on a wide scale.

The initial implementation of ADSL equipment is expensive. The technology is relatively new and is still evolving and economies of scale are only slowly emerging. Operational costs are also high at this stage. Indeed, operators have yet to demonstrate that it is possible to make a profit from an ADSL service alone. This is exacerbated by the falling stock value of

the telecom sector, a lack of available capital, and the realisation that considerable investment is required before the full benefits of the new technology are felt by the mass market.

In order to encourage customers to pay a premium for increased bandwidth, operators appear to be targeting niche markets (such as early adopters and small businesses) with highly differentiated offers in terms of monthly rental, installation charge, length of contract and available bandwidth. The aim is to maximise income and gain market share by offering more than just higher speed connection. For example, operators are offering features such as a personalised broadband portal with rich content bundled with a fixed voice telephony service (IP or analogue) and the potential for video streaming. Even with this business model, it is still necessary to achieve rapid deployment, unconstrained by bandwidth limits or other deployment barriers, in order to gain sufficient volume to provide a return on the investment.

**Industry View**

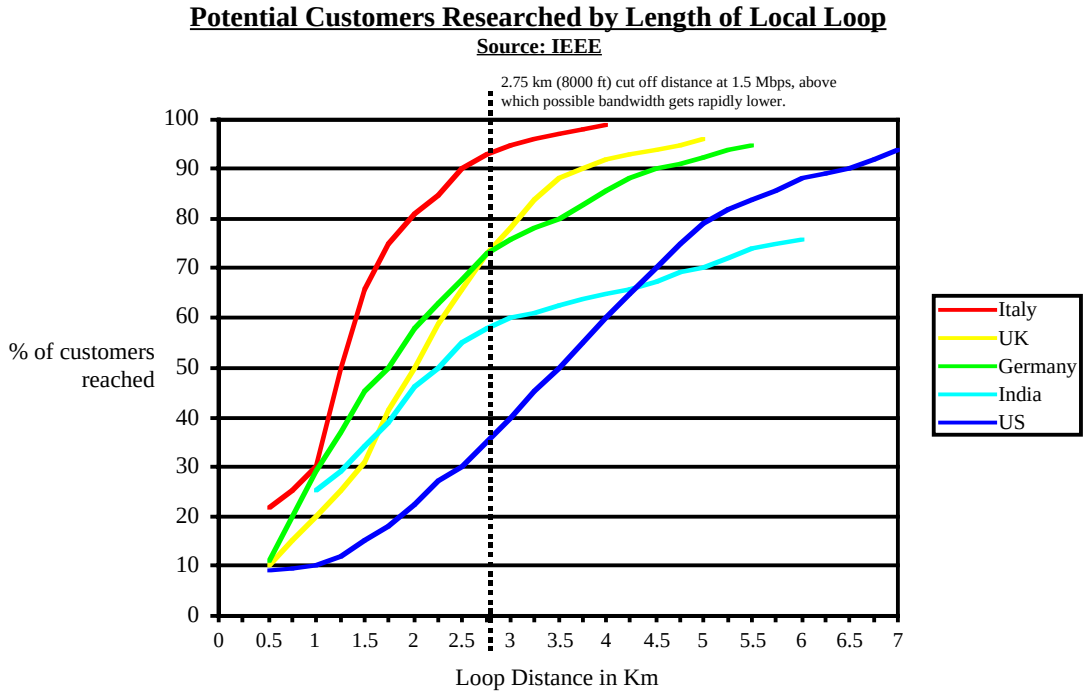
*"Companies will find it hard to get the finance for DSL. Financial companies don't like DSL companies because of the US example where DSL has been expensive and has not taken off, with usage at under 1% after 4 years! In Europe, QS Communications lost 2/3rds of its value. KPNQwest announced DSL roll out and got hammered by the market, so pulled back to focus on other things. DSL sounds great. Superficially, the business plan is clear. But in practice it is not as profitable"*

Bank

There are also significant technological considerations, which determine the achievable market share and mean that ADSL will never be a universally available access platform and may suffer from patchy availability.

The chart below (Figure 3) emphasises the great differences in potential for ADSL across different countries. For example, in the US fewer than 35% of potential users are currently capable of receiving greater than 1.5Mbps of bandwidth (irrespective of the type of DSL deployed). In this case, if only 10% of households demand higher bandwidth services, and only 35% of those households are capable of receiving high-bandwidth transmissions, then less than 3.5% of US households can take advantage of full-rate ADSL. In comparison, ADSL has much more potential in Europe as a much greater proportion of the population can benefit from high-bandwidth service. Italy has the greatest potential with over 90% currently able to receive 1.5Mbps or higher, and in the UK and Germany, the figure is just over 70%. Indeed, the length of the local loop does not correlate to population density, but reflects the incumbent's choice of network architecture at the time it was installed. India is included to demonstrate the potential for ADSL on a global scale.

**Figure 3**




In summary, these technical considerations and the high equipment and operational costs are likely to slow the roll out of ADSL. Particularly as the situation in each local exchange has to be tested. Another issue for ADSL over the local loop is that it has been developed to enhance a 'legacy' infrastructure, which was originally designed and deployed to provide analogue telephony and may now be in need of upgrading. In some Member States (e.g. Portugal, Spain, Greece) the technology is limited by the ageing infrastructure.

As the digital era comes closer, and the younger generation exploits the potential of digital convergence, it is likely that demand for bandwidth will supersede the capability of DSL over the local loop (this may take 10 years). In this scenario, DSL over the local loop has a limited life span. If the current trend toward greater individual mobility, autonomy and choice continues, with ever greater demand for entertainment in the home, then at some point in the future (say in 2020), the occupants of a 'home' will require Giga-bit access to and from the premises. Similar predictions are made for the SME market. Assuming this potential for bandwidth demand, DSL has been described as a 'Band-Aid' on a problem, and as such only a transitional solution to meet growing demand. Indeed, predictions of bandwidth demand have consistently proven to be under-estimations in retrospect. Furthermore, if demand for upstream bandwidth grows significantly, then alternatives to ADSL will be sought. Whilst SDSL and VDSL can offer high bandwidth in both directions they require a different network architecture to the local loop (e.g. fibre to the curb). If fibre to the curb, or even fibre to the home is to happen, it is likely to follow on from ADSL when demand for bandwidth has gone beyond the capabilities of the local loop.

**Industry View**

*"DSL standards were developed many years ago (5-10 years ago), without the Internet in mind. You could make a similar comparison to IRIDIUM where terrestrial mobile overtook it more rapidly. A similar thing may happen to DSL (as other technologies such as fibre optics take over) ."*

Multi-platform Operator

Despite these drawbacks, ADSL is in a strong position. It has the potential to grab market share before other technologies, particularly if it can be sold on the back of a content proposition such as 'Video on Demand'. For example, cable companies (and satellite/terrestrial broadcasters) do not sell just the connection, they sell the content and the connection is included.

In the business market, the principle alternative to DSL technologies are leased lines (specifically coaxial cables or fibre optic). As ADSL becomes increasingly available, and provided its performance proves to be of sufficiently reliable quality, then new leased line business will be eroded by ADSL as a cheaper alternative. However, ADSL will only be attractive to the smallest of businesses, as most SME business applications, such as e-commerce, will require a symmetric solution of over 2Mbps. For businesses with larger bandwidth requirements or guarantees of reliability, existing copper leased lines will be replaced by fibre optic. Of course, DSL technologies such as VDSL or SDSL may be deployed along the existing point to point leased lines in the short term.

**Industry View**

*"The local offer is very expensive, so its unattractive at the public level, it may even be 'deterrently' priced because they (the incumbent) may be able to offer it but they would rather not roll it out as it is extremely costly [and the network may not be able to support it]. The offers being made on ADSL are not what I would call broadband. It is only 128Kb per second, or 256 at the maximum. There are better offers from cable operators, but it depends whether you are in their service area.."*

Broadcaster

Currently, initial offers of ADSL have been made in all Member States of the EU except Greece (see table below). Roll-out has been fastest in Denmark and Austria with the UK, Germany, Finland, Sweden Belgium and Luxembourg all showing signs of penetration growth. There are large differences in the bandwidth offerings (up to around 2Mbps), but most initial offers are in 100s of Kbps rather than in Mbps and so are only suitable for higher speed Internet and not 'video on demand'. Furthermore, prices vary considerably and are relatively high compared to standard dial up and ISDN. These factors have led some to question the viability of the current mass market business model and new entrants and incumbents are looking increasingly likely to focus initial offers on SMEs. In doing so, emphasis will be placed on achieving a reliable high bandwidth service (2+Mbps) and symmetric solutions, as ADSL is more suited to asymmetric residential applications (i.e. downloading entertainment rather than sending large files).

The race is now on between ADSL and cable to see who can get to market first with an attractive broadband offer, with the cable industry currently undergoing some major upgrading in order that it can offer broadband to the residential market before ADSL comes along. However, cable companies have a very great task in upgrading and so will be slower to roll out than ADSL. Hence, ADSL over the 'local loop' will capture market share fast and, provided ADSL operators can compete on price and content, they may capture sufficient market share to dominate cable in the short to medium term. This argument is supported by the experience of the US, were ADSL is now catching up with cable. However, where upgraded cable networks can quickly achieve high levels of availability in a region, cable is likely to be the preferred broadband provider among consumers, whilst ADSL will be preferred by SMEs

## Summary of ADSL Offers in 2000

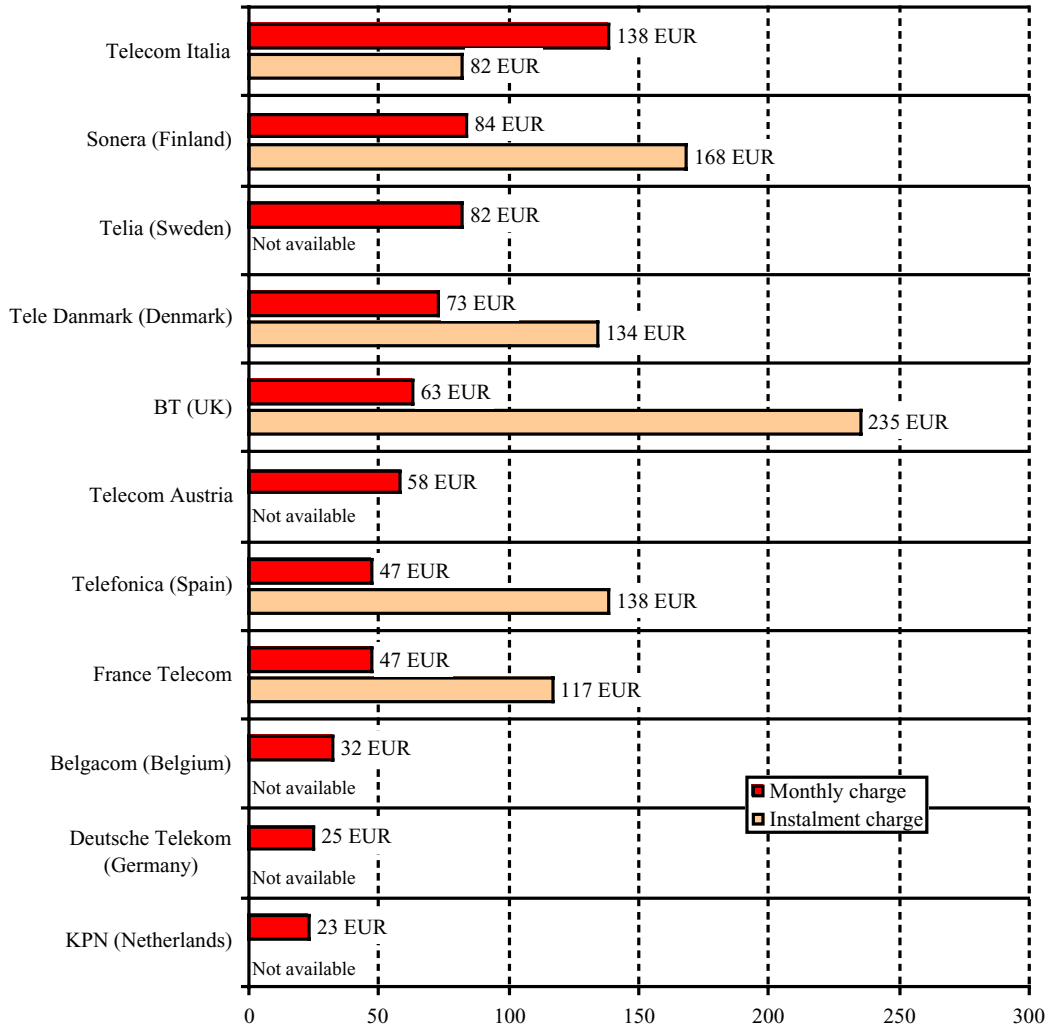
| | Examples of ADSL offers | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|---|
| **Aus.** | *Telekom Austria* (A-Online Speed)<br>Primarily residential<br>Potential to reach 100,000 subscribers (55% of households) | 64 / 512 | 58 - 68 (?) |
| | *Inode*<br>Business and residential | 64 / 512<br>(higher for busines) | 65 - 109 (?)<br>77 - 115 (?) |
| **Bel.** | *Belgacom* (coverage of over 75% of households)<br>Residential: Turboline Go (Self installation - buy modem)<br>Turboline Plus (Rent modem)<br>Business: Turboline Pro<br>Turboline Premium | <br><br>128 / 750<br>128 / 1000<br>128 / 1000<br>512 / 1000 | <br><br>32 (+ modem)<br>40 (?)<br>90 (?)<br>375 (?) |
| **Den.** | *TeleDanmark* (NetExpres)<br>October 1999 (2-4km from exchanges in Copenhagen, Århus, Odense, Aalborg.)<br>Considering symmetric DSL for business/municipalities | 128 / 256<br>128 / 512<br>256 / 1024<br>512 / 2048 | 48 (134)<br>67 (134)<br>94 (134)<br>134 (134) |
| | *Cybercity* | 128 / 348 up to<br>512 / 2000 | 66 (0)<br>133 (267) |
| | *World Online* | 256 / 256 up to<br>512 / 2000 | 53 (0)<br>133 (268) |
| **Fin.** | *Sonera* (Home ADSL)<br>*Sonera* (Business ADSL) | 256 / 256<br>512 / 2000 | 84 (168)<br>415 (?) |
| | *Elisa* (Kolumbus) | 256 / 256-512 | 66 - 134 (496) |
| **Fra.** | *France Telecom* (Netissimo) - Residential<br>*France Telecom* (Netissimo) - Business | 128 / 500<br>259 / 1000 | 47 (117)<br>107 (151) |
| | *Easynet France* | ? / 2000 | ? |
| | *KPNQwest* | ? | ? |
| | *Cegetel* - Business HDSL | +2000 / +2000 | ? (760 - 1524) |
| **Ger.** | *Deutsche Telekom* (T-DSL) - Residential<br>*Deutsche Telekom* (T-DSL) - Business | 128 / 768<br>768 / 6000 | 25 (?) or meter<br>135-1590 (650-3900) |
| | *QS Communications* - Business | 144 - 2300 | 110-456 (252-777) |
| | *KPNQwest* - Business | Up to 7500 | ? |
| | *First Telecom* (Atlantic) - Business (SDSL) | Up to 2300 | ? |
| | *KKF.net* | Up to 2300 | 289-1449 (296-890) |
| | *Riodata* | From 256 to 8192 | 262-1702 (358) |
| | *Versapoint* - Business | Up to 1500 | ISP package |
| **Ita.** | *Telecom Italia* (Tin.it ADSL) - Residential, ADSL<br>*Telecom Italia* (Ring) - Business, VDSL | 128 / 640<br>Up to 155000 | 138 (82)<br>? |
| | *Mannesmann* (Infostrada Net24) - Business, ADSL | ? | ? |
| | *KPNQwest* (ADSLink & ADSLight) - Business ADSL | 8000 | ? |
| **Neth.** | *KPN* (Mxstream Basic) - Residential<br>*KPN* (Mxstream Extra) - Residential | 64 / 512<br>256 / 1000 | 23 (?)<br>30 (?) |
| | *KPN* (Mxstream Office) - Business | 64 / 512 | 39 (?) |
| | *KPN* (Mxstream Office Extra) - Business | 256 / 1000 | 45 (?) |
| **Spa.** | *Telefonica* (Terra ADSL) - Residential<br>*Telefonica* (Terra ADSL) - Business | 128 / 256<br>128 / 512<br>300 / 2000 | 47 (138-204)<br>97 (203)<br>190 (384) |
| **Swe.** | *Telia* (Telia Flexicom) - Residential<br>*Telia* (Telia Flexicom) - Business | ?<br>400 / 2000 | c. 82 (?)<br>283 (?) |
| **UK** | *BT* (BTOpenworld) - Residential<br>*BT* (BTOpenworld) - Business | 250 / 500<br>250 / 500-2000 | 63 (235)<br>63-167 (248-435) |
| | *Kingston Communications* - Business | 256-1000 / 500-2000 | 16 - 25 (94) |

* Indicative only as prices are changing fast, and comparison with different levels of service is difficult. Prices quoted are inclusive of VAT. Flat rate pricing with Internet access is almost universal. With QS Communications and KKF.net the installation charge varies depending upon the length of contract (e.g. 1 to 3 years). Deutsche Telekom makes call charge in addition to monthly rental. There are also ISP packages emerging.

**Deutsche Telekom offer ADSL over ISDN, a relatively straightforward conversion which takes advantage of the large base of ISDN customer.

**Figure 4**

**Price Comparison of Selected ADSL Offers within the EU**
**{Source: BDRC 2001}**




The chart above (figure 4) compares the price of selected ADSL offers within the EU. These offers are broadly comparable, with downstream connection speeds of 256-750Kbps and an upstream speed of 64-250Kbps. The Deutsche Telekom offer differs from the others in that connection is metered, whereas the others include an 'always on' connection.

There is considerable variation in the price of ADSL across the EU (Monthly charges range from 138 Euro to 23 Euro). Whilst Telecom Italia make a relatively low installation charge, their monthly charge is the highest in Europe, perhaps reflecting the lack of competition from cable and other access platforms. In the Nordic Member States, where demand is high, the monthly charge reflects consumer willingness to pay for fast Internet access. At the other end of the chart, charges are relatively low in the Benelux countries where there is considerable competition in the market and a need for ADSL providers to undercut cable prices in order to capture market share. Belgacom offers particularly good value with speeds of 750Kbps downstream and 128Kbps upstream for just 32 Euro per month. BT stands out for making a relatively high installation charge.

## 4.3 LEASED LINES

The leased line industry is well established in all Member States. Originally developed as a way to interconnect multiple phone lines via one connection to the telephone network, it has now become the primary means by which larger businesses provide Internet access to employees.

The benefits of a leased line are as follows:

- Bandwidth can be bought to match demand. Also, variable bandwidth can be bought so that in effect the bandwidth is available on demand.
- High level of security
- Symmetric or asymmetric data flow as required
- Tailored service arrangement to include aspects of LAN
- Reliable connection without time delay
- Multiple, simultaneous users
- Flat fee rather than incremental call charges

For the customer, the most important issue when renting a leased line, apart from price, is the level of service guaranteed rather than the technology of the leased line itself. For example, to provide a permanent connection, redundancy needs to be built into the route. This means that if the connection fails somewhere, an alternative backup route is available. Also, it is often difficult to assess the bandwidth of a leased line until it is tested in practice. In some cases, the maximum bandwidth possible in practice may be lower than that expected, depending upon the path taken and other transient conditions.

An alternative to a leased line is to buy and maintain a private line. This requires the owner to retain a technical resource to implement and maintain such hardware and makes upgrading an expensive option. However, as fibre optic bandwidth has removed the risk of obsolescence for the time being, private lines for large businesses are an increasingly viable option.

The emerging broadband technologies, described in this report, represent a real alternative to a leased line and so threaten to erode leased line business. For example, ADSL (or other DSL variants) will offer cheaper bandwidth suitable for SMEs that might previously have had no alternative to a leased line.

There is a perceived security risk associated with using ADSL over public switched lines, which is not present with a dedicated leased line, however, this can be overcome by using secure message protocols (otherwise known as tunnelling).

The real issue with leased lines is that alternative broadband access platforms such as ADSL threaten to cannibalise existing, highly profitable, leased line business. Naturally, incumbents are be reluctant to see that happen (of course new entrants see this as an opportunity – hence the need for competition!). With increased competition from local loop unbundling, new entrants and alternative technologies, the leased line market is set to fragment. Suppliers of telecommunication access platforms will differentiate their offers to attract niche business and there will be a much wider range of alternatives.

Leased lines that use ISDN30 over coaxial copper cables (i.e. E1 cables as described in Appendix A1) will gradually be replaced by ADSL, cable, satellite, fibre optic and fixed wireless solutions as these technologies begin to offer a better bandwidth/price trade off. For the larger company, the option to lease a dedicated connection via any of these technologies will remain a popular alternative to installing and maintaining private equipment. And for the SME, the trade off will have to be made between the benefits of leasing a dedicated connection with bandwidth on demand or relying on ADSL, cable, FWA or fibre to the premises depending upon price and availability.

## 4.4 TERRESTRIAL BROADCAST (AND DTT)

Terrestrial broadcast (analogue or digital) is currently the most popular access platform for television in Finland, France, Greece, Italy, Portugal, Spain and the UK. In all other Member States, a combination of cable and satellite accounts for the vast majority, or in some cases almost all broadcast media. As digitisation progresses, it will become imperative for terrestrial broadcasters in these countries to switch from analogue to digital. The switch will be made in order: to meet demand for DTV (which will also be met by satellite and cable); to avoid having analogue as well as digital TV; and to free the transmission frequencies which could, for instance, be used for next generation wireless technologies.

In Europe, the analogue switch off date has been set by a number of countries, with the earliest being 2006 in Italy and Finland and 2010 in France, UK, and Spain. However, the UK is currently the most evolved in terms of the provision of digital terrestrial television service. The speed of progress toward analogue switch off will be determined by many factors, including the need for governments to maximise the available radio frequencies as wireless technologies grow in popularity.

It is most likely that analogue TV switch off will not occur until the vast majority of a country's population have either a digital TV set, or a digital adapter of some description. Analogue TV sets are remarkably long lasting items and are likely to remain in use for many years to come. Furthermore, it will be necessary to alter or replace every TV set in households with more than one, and VHF video recorders will also need to be upgraded for full functionality.

Despite these hurdles, the following benefits will drive uptake of digital TV equipment:

- Many more channels allowing broadcasters to target niche interest audiences (minority groups, etc) as well as the main stream channels currently available;
- Fast download allowing for TV/video, music, games or any other digital media, virtually on demand, using compression algorithms defined by MPEG-2;
- Improved picture and sound quality, including the availability of high definition DTV;
- Interactive television ('Click through TV'[5], Internet, shopping, banking, e-mail etc.)

[5] Full description in Section 6 (Page 45)

Of course, the need to provide these services is placing new demands on broadcasters, with knock-on effects throughout the industry including programme makers, advertisers, post-production facilities, transmission services and the price of such services to the customer.

Despite the hurdles, such as its limited transmission capacity, the great advantage of DTT over cable or satellite is that, in those countries with a legacy of terrestrial broadcast, most of the infrastructure is already in place, though it has to be upgraded from analogue to digital. Furthermore, and of very great significance, the TV has become a deeply ingrained cultural necessity in most homes. It is a passive medium associated with leisure time, entertainment and news (compared to the PC, which is an active medium associated with work or interactive play). The challenge for those companies promoting the extra benefits of DTV, is to overcome the cultural inertia associated with change. In this situation, DTT is in an auspicious position to introduce the possibilities of DTV with minimal disturbance to existing patterns of behaviour and cost to the consumer. Then as the benefits of DTV are experienced, customers will be more likely to upgrade to cable, satellite or other access platforms offering a greater array of applications.

The potential of DTT varies considerably from country to country in Europe. In those Member States where cable and satellite account for the vast majority of broadcast media, the roll out of DTV is most likely to be through organic growth and upgrading of these existing platforms, rather than investment in a new terrestrial infrastructure with limited potential.

DTT is currently available in the UK, Ireland, The Netherlands, Spain, Finland and Sweden, with France, Italy and Portugal all planning to launch in a year or two. In these Member States, DTT offers considerable potential as a broadcast platform, which will ease the change over from analogue to digital. However, even in these countries, the long term potential of DTT is somewhat limited, as there will be increased pressure on radio frequencies for mobile, fixed wireless and satellite.

The early introduction of DTT in these countries, even as an interim measure, will speed up the arrival of analogue switch off and encourage the benefits of digital convergence via the television. In countries quick to switch from analogue to digital, a larger proportion of the population will have upgraded their equipment and so a larger proportion will benefit from ‘broadband’ applications via the television.

## 4.5 CABLE AND CABLE MODEMS

Cable operators are in a race to grab broadband market share before ADSL. Cable offers some significant advantages over ADSL, such as potentially higher access speeds at lower cost with bundled product including access to DTV, telephony and Internet. However, cable is limited by geographical coverage of the network and the extent to which the legacy coaxial copper networks have been upgraded to bi-directional, digital transmission.

Although upgrading has been going on for some time (around a fifth of EU networks are now upgraded), it is a very expensive and time-consuming process. Although the coaxial copper itself is not necessarily replaced, upgrading to two-way transmission requires operators to build a virtually new end-to-end IP (Internet Protocol) network infrastructure which includes connecting to the Internet backbone, installing routers, switches, servers and new network management systems.

An upgraded system has to be able to cope with a huge demand for bandwidth (to avoid disappointing new customers and damaging the reputation of cable as an access platform). There have been a number of examples (e.g. Noos in France and Telewest in the UK), of operators having to stop offering service because of system overload. Although upgraded cable has the potential to provide higher bandwidth than ADSL, it is likely to be limited by the operator to ensure that the system can cope with periods of maximum demand.

Some critics of cable claim that it has an inherent weakness in the network architecture as the available bandwidth for a street or apartment block has to be shared by everyone in that community. ADSL on the other hand, connects each user independently. However, cable operators are quick to point out that their systems are 'scaleable', meaning that they can increase the available bandwidth to match increases in demand.

In some countries (e.g. UK and Spain) where there is no significant legacy of cable, it has been necessary for operators to lay entirely new networks. In these cases, the cable is likely to be a hybrid of fibre optic and coaxial cable and the network will be designed from scratch to cope with large increases in bandwidth demand in the future. The disadvantage of this approach is that operators start with a relatively small potential market, as the geographic coverage of the network is limited. In these cases, cable is made available in more densely populated areas.

In order to connect a digital signal to an analogue TV set it is necessary to have a set-top-box at the customer end. In addition to this, a cable modem is required for Internet via cable networks. Two international standards are now in place for cable modems, they are: DOCSIS, which originates from the US; and DVB/DAVIC Euromodem, which is the European standard for set-top-boxes and cable modems.

**Industry View**

*"The idea of 'double play' and 'triple play' is very old. It's been around for 20 years. The cable players have done this and taken only 20-25% of the market (in certain countries). The key to marketing broadband is not to compete on price by offering 'triple play' but to compete by offering a service which can't be got anywhere else (e.g. like sport) or an extra TV channel. Success will come from differentiation"*

Cable Company

Cable operators typically offer 'double play' or 'triple play' packages, in which the customer benefits from a lower overall price is they subscribe to a combination of TV, flat rate Internet access and telephone calls. In these cases, cable modems are integrated with the set-top-box and are provided as part of the subscription package. However, there is a view that this is not the best strategy for encouraging broadband access because demand for bandwidth will be driven by highly differentiated content, rather than lower prices. In some European countries (e.g. the UK), cable TV has gained its foothold on the back of exclusive access to certain content (in particular sport), but because penetration is limited, it has been hard for the cable companies to reach the audience levels expected of them.

In summary, the European cable industry is likely to be slower to grab market share than ADSL. And ADSL will probably emerge as the preferred method of accessing the Internet among SMEs and early adopters of such technology. However, cable operators are in a strong position to market an extensive choice of channels, video and broadcast on demand, new interactive programmes as well as low cost Internet and telephone, and this may be the means by which cable can catch up with ADSL, as networks are slowly upgraded.

In the course of 2000, with the collapse in share prices of many of the leading players, expectations for the market have slowed in the short term. For example, the optimistic plans of UPC's broadband portal Chello have been scaled down, and NTL are suffering from their huge investment outlay and have been forced to reduce the workforce to cut costs. Market consolidation will continue, which will strengthen those companies that survive.

## Summary of Cable Internet Offers in 2000

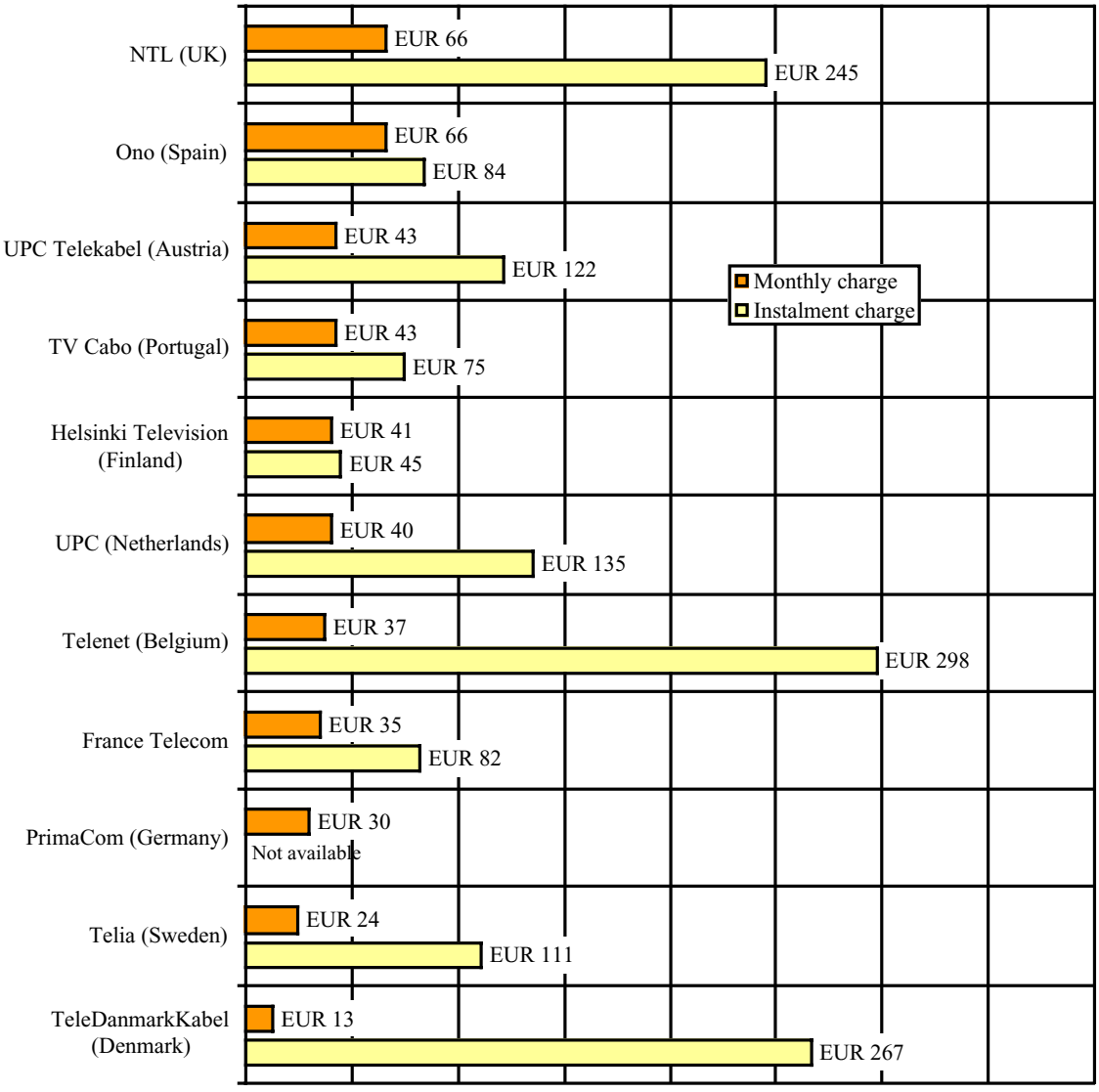
| | Examples of Cable Internet offers | Data Rate Up / Down Kbps | Price* in Rent/month (installation) |
|---|---|---|---|
| **Aus.** | *UPC Telekabel* (Chello) - Residential 60,000 subscribers | 128 / 512 | 43 (72 + 50) |
| | *Liwest* (24 Speed) - Residential - 2,500 subsc. in Linz | 64 / 300 | 42 (?) |
| **Bel.** | *Brutélé* (Residential: Brutélécom@home) | ? | 36 (520) |
| | *Brutélé* (SME: Brutélécom@turbo) | ? | ? |
| | *UPC Belgium* (Chello) | 128 / 512 | 36 (?) |
| | *Telenet* (Res.: Pandora. SME: Pro-pakket or Pro+Pakket) | 128 / 512 | 37 - 50 (298) |
| | *ALE-Télédis* (Télédisnet) | 64 / 256 | 35 - 74 (171) |
| **Den.** | *TeleDanmarkKabel* | Via telephone / 512 | 13 (267) |
| | *Telia Stofa* (500,000 homes) | 384 / 1000 | 101-335 (133:low vol.-267:high vol) |
| **Fin.** | *Helsinki Television* (HTVI) | ? | 41 (45) |
| | *Sonera* (QuickNet) | ? | ? |
| | *Starvisio - Kupio Cable TV* (Komeetta) | ? | 42 (50) |
| **Fra.** | *France Télécom* (Câble Wanadoo) - Residential | 128 / 512 | 35 (82) |
| | *France Télécom* (Multi@ccess) - Business | 128 / 768 per terminal (up to 1 Gbps total) | 111 (68) |
| | *France Télécom* (Plein@ccess) - Business | 256 / 1000 per terminal (up to 4 Gbps total) | 228 + 6 per 20Mb up |
| | *UPC* (Chello) - Residential | ? | 36 |
| | *NC Numéricâble* (AOL par NC Numéricâble) - Res. | ? / 512 | 50 (107) |
| | *NTL* (Noos) - Residential | ? | 36 (76) |
| | *NTL* (Noos) - Business | ? | 15: 1 terminal<br>29: 2-4 terminals<br>45: 5-8 terminals<br>58: 9+ terminals |
| **Ger.** | *Komro* (only in Stadtgeviet and Rosenheim) | 26-500 / 64-2058 | 20-173 (0) |
| | *PrimaCom* (only in Leipzig and Magdeburg at present) | 128 / 512 | 30 (?) |
| **Neth.** | *UPC* (Chello) - Residential | 128 / 512 | 40 (135) |
| | *ExciteAtHome* (AtHome) - Residential | ? | 40 (136) |
| | *France Telecom* (Casema) - Residential | 32-64 / 96 - 160 | 41 - 54 (82)* |
| | *Sonera* (QuickNet) - Residential | 64 / 512 | 36 - 41 (107 - 164) |
| **Por.** | *TV Cabo* (Netcabo) | ? / 640 | 43 (75) |
| | *Cabovisão* (Netvisão) | 128 / 512 | 55 (50) |
| **Spa.** | *Ono* (Ono Internet) | ? / 512 | 66 (84) |
| | *Madritel* (Internet 777) | ? / 777 | 11 (90) |
| | *Reterioja* (AVE 256) | ? / 256 | 48 (90) |
| | *Retena* (AVE 256) | ? / 256 | 48 (90) |
| | *Supercable* (Super 256) | ? / 256 | 41 (90) |
| **Swe.** | *Telia* (Internet Cable) | 128 / 512 | 24 (111) |
| | *UPC Stjärn TV* (Chello) | 128 / 512 | 22-33 (143) |
| | *Tele2* (Connect2Internet) | 128 / 512 | 24 (0-167) |
| **UK** | *NTL* (NTLWorld) - Residential | ? / 512 | 66 (245) |
| | *Telewest* (Blueyonder) - Residential | ? / 512 | 54 (82 - 124) |

* Prices are indicative only

The chart below (Figure 5) compares the price of selected cable Internet offers within the EU. All of the offers included in this chart refer to a two-way connection via cable (except TeleDanmarkKabel, which relies on the telephone for the upstream path) with a downstream speed of 512 to 640Kbps and an upstream speed of 128Kbps (except TeleDanmarkKabel, which is likely to be up to 56Kbps).

**Figure 5**

**Price Comparison of Selected Cable Modem Offers within the EU**
**{Source: BDRC 2001}**




There is considerable variation in monthly charges across the EU (from EUR 66 to EUR 13), however, there are a number of factors that need to be taken into account when making any assessment of these variations. For example, levels of service may differ depending upon the demand placed on networks and the quality of upgrade varies from region to region (e.g. networks in the UK and Spain are brand new).

In most cases Internet access via cable is sold as part of a package of services, which may include telephony and TV. This partly explains the large variations in instalment charge as different offers are based on different business models. Those with a relatively high one-off instalment charge require the customer to pay up-front for a cable modem, whilst others discount the cost of modem and set-top-box on the basis of committing customers to a number of services over a fixed period of time.

## 4.6 SATELLITE

Satellite is very successful as a broadcast medium for the mass-market, and for dedicated two-way transmission for larger businesses and network infrastructure. However, the most obvious limitation of mass-market satellite is that the data transmission is highly asymmetrical. Although up to 2Mbps per channel may be delivered into the home, most current satellite systems are not able to provide an upstream path. To achieve this it is necessary to use another access platform such as the telephone line. In terms of convergence with the Internet, such a system would allow access to TV or tailored Web-style media, but would not allow access to the whole Internet or e-mail (except via an alternative access platform). At present, this does not present a major problem for the broadcasters as most 'interaction' associated with TV does not require high return data rates, however it does limit the potential of satellite as a broadband access platform for the future.

A more likely outcome is that the symmetrical nature of broadcast satellite will become its strength, rather than its weakness. If the market continues to develop with the emphasis on a wide but restricted choice of enhanced TV and new media channels and downloads, with a separate access platform for the Internet, then the future of satellite looks secured. In this way, satellite may evolve into the 'quality' broadcast medium of the future offering high quality channels tailored to niche markets such as business communities, ethnic minorities (multiple languages), interest groups etc.

Satellite telecommunication is widely used as a backbone technology for global networks. Constellations have been designed specifically for this purpose, with the aim of competing with fibre optic. The advantages are that there are no boarders to cross physically and some such networks would immediately reach almost 100% coverage of global population. For example, Teledesic are planning such a network, which could offer point-to-point, two-way connection of 64Mbps upstream and 64Mbps downstream.

Fully interactive connections via satellite (i.e. with fast upstream as well as downstream transmission) have been available to larger organisations for some time. This service is most suitable for dedicated links within and between high tech companies (e.g. HQ and ISPs). It is particularly applicable for sites in locations with poor terrestrial infrastructure. However, when this is scaled down to the level of individual houses/SMEs interacting, there are technical limitations which cause an unavoidable delay in transmission of at least 0.5 seconds.

**Two-way Satellite Broadband - Will consumers get everything they want?**
By Peter J. Brown from the January 22, 2001 issue of *Broadband Week*

EchoStar went on record with the FCC last November as being cautionary-if not outright gloomy-about its ability to compete with cable on the data front. In comments filed in response to the FCC's inquiry concerning high-speed access to the Internet over cable and other facilities, EchoStar stated, "In contrast with the finite bandwidth available to wireless and satellite systems, the terrestrial broadband pipe technologies available to cable systems offer bandwidth that is virtually limitless for almost all current practical purposes."

"DBS (Digital Broadcast Satellite) companies are technologically disadvantaged in offering truly inter-active products. DBS services (which use the DBS downlink spectrum) do not have a return link from the home to the satellite and cannot at this point in time practically or reasonably duplicate the two-way cable pipe that is being deployed by AT&T and other cable operators. EchoStar has tried to respond to consumer demands through its participation in the StarBand joint venture with Gilat, but this service is provided through a platform that is relatively cumbersome to consumers. EchoStar's next-generation broadband solution (which involves use of the Ka-band) is likewise significantly spectrum-constrained."

A limited interactive broadband service via satellite is now being offered to smaller business and in the future may become financially and technically viable for residential Internet access for the residential customer. For example, in Europe, SES/Astra are offering a Broadband Interactive (BBI) service with up to 2Mbps upstream and 6Mbps downstream (and potentially more depending upon the size and power of the transmitter and dish). However, this two-way transmission is achieved by broadcasting (or 'Webcasting') a wide, but limited selection of Web-sites /interactive multimedia to users PCs. This 'hybrid push/pull' system relies on the recipient storing popular media on their own hard drive for later use. Such a selective access to the Internet is likely to be applicable to users who do not wish to 'surf' the Internet, but do require regular visits to specific Websites (e.g. certain businesses, educational institutions, government etc).

**A problem with two-way satellite**
FT 10/12/00

Gilat@home, now Starband, offers two way satellite access. Unfortunately early users are discovering terrible TCP/IP upload performance, perhaps worse than dialup modem speed. This lack of upload performance is going to be a characteristic of all (geo-stationary) two-way satellite systems.

Why is upload worse than modem speed? Because of the extremely high latency (delay) between the user's PC, and the destination of the uploaded data. No matter what tweaks satellite companies provide to maximise this *long fat pipe* for download, they cannot improve upload speeds since those same tweaks would be required on the server end, but servers cannot be optimized for just one class of user.

Starband users may find this an impossible problem for multiplayer games that rely on TCP/IP traffic, or indeed any other internet application that requires TCP/IP uploads.

There have been trials of a system to provide full access to the World Wide Web via satellite, aimed at the residential/SME market. But these have run into unforeseen technical difficulties with unacceptable latency and slow access speeds, as the number of users increases (e.g. Europe Online suspended further trials on this basis). These problems may be resolved in the long term (5-10 years), as a reliable solution has the potential to grab a large proportion of the market for broadband.

The burning issue with all satellite technology is the astronomical cost of getting a new system up and running. Since a constellation is required for the system to operate, and each satellite costs millions of Euro to build and launch, the total investment required for the whole system is vast. Given the rapid pace of change in technology, and so the possibility that a new satellite system may not remain up-to-date for long, investment in space is inherently risky (as the failure of the Iridium constellation to compete with the growth of GSM demonstrates). Once the constellation is in place, the technology on board cannot be adjusted or replaced, which means that any investment in space must produce guaranteed returns for many years. By comparison, terrestrial technologies (e.g. Fibre optic) benefit from the advantages associated with incremental and organic (see above) growth.

Satellite broadcasters are going in the direction of launching bigger (e.g. Astra), more powerful satellites that have a larger footprint so that the customer requires a smaller and cheaper dish to receive signals. Hence, this will allow for more rapid roll out to a wider market. In such situations, broadband access is likely to be a combination of satellite transmission into the premises and telephone connection out of the home. For some living in rural areas, this type of satellite transmission may offer one of the most effective access platform to 'broadband' access to the Internet (DTT and Fixed Wireless Access also have potential).

Furthermore, a limited form of 'interactive' service via satellite will also be available to the business market initially in the UK (by Astra), and depending upon the company's ability to enter and the size of the market, Spain, France and Germany, as well as Poland where "everything is satellite".

**European firm deals blow to Internet-by-satellite.** By Richard Baum

LONDON, Oct 13 (Reuters) - A leading provider of high-speed Internet services via satellite is relaunching as an interactive broadcaster after concluding the technology cannot be used for Web surfing.

The decision by Luxembourg-based Europe Online is a blow to hopes that satellites could bring fast Internet connections to rural communities shunned by fixed-line operators.

The two-year-old company, run by a former head of Walt Disney Television, uses the Astra satellite to beam Internet content to 15,000 customers across Europe.

Although the technology theoretically can provide fast download speeds, the service slows considerably as the number of users rises. Furthermore, data from the user's computer is sent over a normal dial-up modem.

Europe Online believes the two constraints make high-speed Web surfing impossible, despite the claims of U.S. rivals like Hughes Electronics Corp.

''High-speed Internet access simply does not work with satellite,'' Europe Online spokeswoman Simone Steinmetz told Reuters. ''It's a bad use of satellite capacity.''

There are also designs for broadband satellite networks (e.g. Skybridge, which is owned by Alcatel and Teledesic, an independently owned US company) made up of multiple, smaller, simple 'bent-pipe' satellites. 'Bent-pipe' refers to very simple satellites, which divert signals to an earth station for switching and routing of the signal. These satellite networks would allow interactive broadband via dedicated links between remote sites.

Such instant ubiquitous coverage as would come from a project like Skybridge (95% coverage of the global population) has huge potential across the globe including developing countries without the legacy infrastructure to support broadband. For projects like this, there will be more likelihood of success in the future if standardisation of coding protocols (such as Internet Protocol) can be assured over a long period of time, and as the demand for broadband becomes more clearly understood. The high frequency Ku band (which has been allocated for satellite use by the ITU) is not effected by weather. And the simplification of the technology to go into the satellite, allowing earth stations to deal with the more complex system requirements is under development.

## Summary of 'Interactive' Satellite Offers in 2000

| | Examples of Satellite Internet offers | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|---|
| **Fra.** | *EasySky* (upstream by standard dial up of ISDN) | ? | 30 (303+) |
| | *Teles* - planned service (with upstream by telephone) | ? | c. 18 (180) |
| **Ger.** | *Teles* SkyDSL (upstream by standard dial up or ISDN) | 56 - 128 / 4-8000 | 20 (153) |
| **Neth.** | *Internet Access Nederland* (upstream by standard dial up) | 34-64 / 400-800 | 16 (85) |
| | *Ision* (upstream by ISDN) | 64-128 / 256<br>64-128 / 512<br>64-128 / 1000<br>64-128 / 2000 | 406 (2,949)<br>678 (2,949)<br>951 (2,949)<br>2,176 (2,949) |

* Prices are indicative only.

## 4.7 FIBRE OPTIC

Fibre is clearly the preferred choice for digital backbone network because of its unrivalled bandwidth capacity. In general the combined cost of fibre, laser diode, connectors, installation, and all other equipment is now competitive with traditional copper solutions. Fibre solutions are also common for larger businesses as leased lines or privately owned networks. The construction of MANs (Metropolitan Area Networks) also offers cost effective possibilities for smaller businesses.

**Industry View**

*"I think, ideally, fibre to the home would be where the technology will lie. I think if bandwidth demand is going to show as aggressive a growth curve as it has, I think fibre to the home would be a good objective for the industry to have.."*

VP of Leading Global Player

If the consideration is the bandwidth/cost ratio, then fibre optic is thousands of times cheaper than copper. Fibre optic is a "future proof" infrastructure, as once laid in the ground it is the boxes, rather than the fibre, which might need upgrading (and even this will not be necessary for many years). An exception to this is the laying of fibre optic backbone under sea, since a repeater is required every 10 miles (e.g. 300 between Europe and the US) and, rather than replacing the repeaters, a new system would be laid.

**Industry View**

*"Other technologies are a Band-Aid on a problem, until fibre to the premises arrives."*

Fibre Optic Company

In addition to the unbeatable bandwidth/cost ratio (which will only improve further over time), telecommunication companies and cable network operators prefer installing fibre to copper because it is thin (takes up less space) and lightweight (cheaper to transport). What is more, fibre offers enormous bandwidth in both directions and so effectively eliminates the issue of symmetry, which is a limitation of other platforms such as DSL, cable, satellite and DTT.

Despite these advantages, fibre optic technology is not a panacea. Like every new technology, it brings its own set of problems to overcome. The most significant is the cost of components and installation. At present the physical components, which connect to the fibre, are hand made. They are extremely sophisticated pieces of machinery, which do not easily lend themselves to mass-production techniques (e.g. the laser diodes). However, as with all relatively new technologies, advances are constantly being made, so the large investment in mass-production facilities will not happen until the pace of development levels off. To give confidence to investors, it is necessary to agree industry standards of production, so that the components can be made by a variety of manufacturers in the knowledge that they will work together.

Personnel in the industry, trained to the sufficient level of technical expertise, are now in considerable demand. There are examples of projects being held up by lack of technical knowledge. However, this is being addressed, and is seen as only a short-term problem.

Undoubtedly the greatest hurdle to the realisation of fibre to the home is the physical installation of fibre optic as this requires fibre to be laid in ducts. In Europe, there is often little or no room to add new capacity in existing, cable and telecommunication ducts. The construction of new ducts is a slow and expensive operation and is restricted in some regions of Europe (e.g. historic towns and cities).

Fortunately, the problems are not without solutions. As fibre deployment increases, the economy of scale for the manufacturers is driving costs down. Also, much work is being done to by-pass problems such as:

- Trading bandwidth for easy connection by using plastic fibre optic rather than glass
- Laying fibre in the sewage system, which gets round the need for digging in urban centres
- Removal of copper from existing ducts, to make space for fibre which is thinner and reselling the copper to refiners who see it as high grade ore
- Development of Optical Wireless Access, which allows light signals to be sent through the air, without the need for glass fibre

Because of the scale of the investment required, fibre optics is only slowly, reaching out into the access network and the vision of fibre to the home (FTTH), or even to the curb (FTTC), is not yet close to realisation in most Member States.

The most advanced country in terms of FTTH is Sweden where there are more than 30,000 customers connected directly to a fibre network. A number of situation specific factors have combined to make FTTH viable (although these may be replicated in other Member States in the future). Firstly, Sweden has the highest penetration of PC of any country in the world, with correspondingly high Internet use. Secondly, like many other Member States, much of the urban population dwells in apartment blocks, which makes fibre to the basement appropriate. Companies such as Bredbandsbolaget and Thalamus have provided fibre to the basement of multi-tenant apartments by selling the idea of bundled services and high-speed connection to landlords. The landlords then use this to attract tenants to their properties. The cost of such a broadband connection is then included in as part of the rental charge and so is treated like a utility. Such a business model becomes viable when around 30% of an apartment building's tenants use the service. Furthermore, these companies have shared the cost of laying new fibre networks with the electricity/power companies who agree to lay fibre in their ducts and benefit from bundling power provision with telecommunications to the customer.

The network architecture used in Sweden and other Member States currently introducing fibre optic to the residential market (e.g. Italy and Germany), is to bring the fibre-to-the-basement from which each flat is connected via an Ethernet over coaxial copper. In Italy, in particular, there is an opportunity to bring fibre-to-the-curb as the copper local loops are relatively short and may have the potential to provide high bandwidth DSL such as VDSL. However, even in Italy, the cost of replacing the local loop with fibre is almost beyond consideration.

One of the lessons from Sweden is that fibre to the home has an enormous impact on bandwidth consumption, which pushes the bottleneck out to the nearest node or even the capacity of the network. This requires adequate provision in the network before installation in the home, otherwise connections will not reach the speed promised. Furthermore, companies rolling out FTTH have had to learn first hand that, in addition to installing the technology, there are significant costs in billing and servicing the customer. This is of course made easier by the introduction of flat fees.

As demonstrated by its rapid and extensive deployment in the network, fibre optic is by far the best medium for transmission of digital information. Apart from the benefits of low error rates and high security, the sheer potential bandwidth of fibre means that it will eventually be the access medium of choice for broadband.

Extract from Upside magazine - December 2000.
**ÒUltimately, the winner in the future will be fibre-to-the-homeÓ**

Says Steve Pusey, president of local Internet at Nortel Networks. He explains that all of the other main broadband-access technologies: wireless; DSL; and cable, are "points in history" on the migration path to pushing fibre deeper. All of these technologies will continue to exist primarily because of their installed customer bases (phone customers for DSL and cable customers for broadband cable) but the technology that can provide the most service-rich content will be the winner

However, the production and installation of fibre optic equipment is such that the industry is already at full stretch to meet the demands of global network upgrades. At present, the scale of investment required to provide FTTH or basement on a wide scale is too large to consider (although the cost to bandwidth ratio is low).

Considering that residential/SME demand for bandwidth is there now and growing constantly, it is likely that other broadband technologies such as cable and ADSL will meet existing demand and at the same time further stimulate demand. When analogue switch off gets closer, and DTV and the Internet begin to converge, then fibre optic access (to the basement or home) is likely to replace copper solutions on a wide scale. In the meantime, fibre will gradually extend out of the cable and telecommunication networks, and get closer and closer to the home.

## Summary of FTTH Offers in 2000

| | Examples of Fibre Optic (FTTH) offers** | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|---|
| **Ita.** | *FastWeb* - Businesses in Milan suburbs | 10 - 100 Mbps | 362 (516) |
| **Swe.** | *Bredbandsbolaget* - Residential and SME | 10 - 100 Mbps | 24 (?) |

* Prices are indicative only.
**Also fibre roll out or plans in Singapore, Korea, Iceland, Japan, USA, Benelux (by B2) and Germany (by B2).

## 4.8 FIXED WIRELESS ACCESS (FWA)

Fixed Wireless Access (FWA) uses radio microwave technology to transmit digital information (see Appendix B for full technical description). Although it may have a number of different applications, FWA has been developed as an alternative technology to the copper local loop and in this scenario is sometimes referred to as Wireless Local Loop (WLL) technology. As a new system, not relying on a legacy infrastructure, FWA can be designed to meet the specific needs of users. It can provide symmetrical or asymmetrical access, at varying bandwidth as required. In theory, the only constraint is a bandwidth/distance trade off (higher frequency = higher bandwidth = shorter transmission distance).

One of the principle advantages of FWA as an alternative local loop technology is that it is, in theory, a flexible and rapidly installable solution, with the potential to meet current demand for higher bandwidth before competing technologies get to market. In theory, this first-mover advantage has the potential to allow license holding operators to enter the market and rapidly attract customers away from incumbent providers currently dominating the broadband access market. Thus the early deployment of FWA has the potential to accelerate the pace of broadband development since the providers of ADSL and cable (and perhaps other access platforms) will come under increased competitive pressure to roll out their services in the race to capture market share. In addition to competing in highly populated urban areas, which hold the greatest potential demand, FWA also has potential as an access platform for small communities in rural and outlying regions.

The deployment of FWA technology involves considerably less heavy construction than does the laying of physical lines, which might be necessary for new broadband cable networks. And in certain situations, there may be considerable value in avoiding the disruption of wide-scale deployment of physical lines, especially in densely populated urban areas and historic towns and cities (e.g. particularly in Europe).

The business model follows that fast deployment leads to faster realisation of revenues and so reduced time to payback of the investment. Even with the high costs per subscriber associated with the FWA terminal and base station equipment, a fast rate of deployment could permit a significant return on investment for the operator. Also, once installed, FWA promises lower network maintenance, management, and operating costs if compared to the ageing copper networks, which are prone to failure. Another benefit, once the FWA infrastructure is in place, is lower network extension costs as each incremental subscriber can be installed at very little cost. FWA systems, which are designed to be modular and scaleable, can furthermore allow the pace of network deployment to closely match demand.

Licenses have been awarded in most Member States for transmission in a range of different frequencies, typically 3.5GHz, which is suitable for low bandwidth applications such as basic telephony, and 26GHz, suitable for higher bandwidth applications (up to 40Mbps in both directions for a single subscriber). In some Member States, the 38-40 GHz frequencies have been allocated. At this very high frequency, FWA transmission is close to the frequencies of light pulses in fibre optic.

This may lead to some synergies between these two technologies in the future in terms of hardware and efficiency of data transmission. This is currently an area of speculation, but may explain the ongoing development of FWA in research laboratories. High frequency microwave technologies have only recently emerged from military R&D (predominantly the US military) into the public sector and so remain in the early stages of development in terms of commercial applications. However, they may hold great potential for commercial applications in the future.

A drawback of FWA, particularly for broadband transmission, is the bandwidth/distance trade off mentioned above. Hence, the type of FWA deployed will be determined by local requirements. For example in developing countries, or remote regions without telephone service, Multi-channel Multi-point Distribution Service (MMDS)[6] could be used as an alternative to POTS, to provide basic voice telephony and narrowband data services over a distance of say 10-20 miles using the 3.5 GHz band. Alternatively, in economically more advanced markets, where there is demand for broadband services, Local Multi-point Distribution Services (LMDS)[6] could bypass existing telecommunication services to provide broadband connections over 1-2 miles (which have to be line of sight) using the 26GHz up to 40GHz bands. Notwithstanding that in both cases FWA does still require fairly dense populations to make installation financially viable.

The need for line of sight connections may limit success, for example in very dense urban settings or exceptionally hilly regions, and bad weather can interfere with FWA, particularly at the higher frequency/higher bandwidth end of the spectrum. Flooding can also be a problem as it introduces interference if the signal is reflected by water.

**Industry View**

*"FWA technology is still in development stage, so it will be some time in coming to market, by which time other technologies will have arrived (e.g. UMTS)"*

Financial Analyst

Another drawback, which is surmountable, is the perception that FWA is somehow less secure than a fixed line solution such as fibre optic. In fact, the technology incorporates very high levels of data security (perhaps higher than via copper), but the perception remains that a wireless signal can be intercepted more easily than transmission via copper or fibre.

**Industry View**

*"Buyers will want assurances that the technology will be reliable and secure. With FWA there is a perception that it can be interfered with, because it is not a solid cable. This means that introductory offers will have to be considerably better than the tried and trusted alternative)"*

Telecommunications Company

Currently, FWA equipment is not produced in sufficient quantities and so the hardware remains too expensive for a large-scale roll out. As with other technologies discussed in this report (e.g. fibre and satellite), a high-risk business model and the need for considerable up front investment could ultimately stop this technology from successfully getting to the wider market. For example, it has been estimated that in the case of LMDS in a high rise business district, the technology is most effective

[6] See appendix for technical explanation.

when penetration levels are low – up to 20%. But higher levels of penetration may be required to make the investment viable as an alternative to the local loop. Of course, providers argue that as demand rises additional infrastructure can be installed to increase capacity.

Furthermore, with the potentially slow roll out of ADSL and cable modem (as funding has become harder to secure with changes in the stock market outlook), so the opportunities for FWA have increased. Even when considering the technical problems of FWA, these are no more significant than the different set of technical problems facing ADSL roll out!

In conclusion, FWA looks set to remain a niche market solution (e.g. LMDS as an alternative to a leased line, and MMDS as an access platform to those in remote areas). There is a consensus within the industry that FWA will be offered to the business market first (e.g. SMEs) as there is clearly an opportunity to undercut the leased line business (with lower prices, higher bandwidth and faster deployment). The intrinsic advantages of FWA suggest that a wider roll out of FWA as a consumer solution may yet occur and already, the market consideration and acceptance of FWA technology is continually growing.

## 4.9 MOBILE WIRELESS (UMTS)

GMS has been a phenomenal success across Europe and the rest of the world (including the US now, were AT&T are switching from tri-band to GSM). This fact combined with the possibilities associated with next-generation mobile communications and convergence with the Internet, explain why companies have been prepared to offer billions of Euro for licenses (e.g. over 50bn in Germany, and over 37bn in the UK). Although it is feared that license holders no longer have sufficient capital left to fund wide scale roll-out for some years to come, the argument also applies that license holders are now unequivocally committed to making UMTS work and maximising its long term potential.

Once UMTS is fully implemented, a Personal Digital Assistant or PDA (such as a phone, laptop, audio/video terminal) will be permanently connected to the Internet at any location or whilst on the move anywhere on the globe (achieved through a combination of terrestrial wireless and satellite connections).

BBC Monday, 29 January, 2001, 11:41 GMT
**Gates charts Internet's future - Microsoft's Bill Gates and Sony's Nobuyuki Idei debate**
By BBC News Online's Orla Ryan in Davos

Microsoft boss Bill Gates has warned that the main threat to the growth of the wireless Internet is the cost of broadband connections. Mr. Gates was opening a debate on the future of the Internet at the World Economic Forum in Davos, Switzerland.

Mr. Gates said that the wireless Internet and the mobile phone would soon merge to become the form of communication of choice. The strengths of the internet and the ability for it to create new products and build new communities of users was demonstrated by the success of the Napster music file sharing service, he added.

Microsoft, alongside many other telecom, computer and media firms, is positioning itself to grab a slice of the action when mass market internet access via handheld devices arrives. *"When I look at the next two or three years whether it's what that P-D-A (personal digital assistance) will look like, it really will become a phone,"* said Mr Gates. *"The phone and the screen will come together. If there's anything I am at all cautionary about this picture on, it is not the hardware advances or the software things... it's whether those broadband connections will become cheap enough and popular enough to enable this for a really broad set of people,"* he said.

For media companies such as music giant Sony and German publishing company Bertelsmann, protecting their copyright is the key issue for the future.

The higher bandwidth of UMTS promises new services, such as mobile video conferencing (i.e. videotelephony). UMTS also promises to provide an alternative access platform for a virtual home environment. So that a roaming user can access the same services to which the user is accustomed when at home or in the office, either by linking to the mobile network or transparently switching to the in-home wireless network. Packet based transmission means that charges can be made for the amount of data transmitted or for the amount of time connected, enabling even more flexible tariffs such as pay-per-bit, pay-per-session, flat rate, asymmetric pricing, and others.

Despite the potential advantages, it is necessary to bear in mind that UMTS is a new technology and it will be some years before it reaches its full potential. Although service is to start being available from 2002, at this stage, it is predicted that initial offers will be aimed at the high-end business and roll out to the mass market will be slow to start with. Alternatively, UMTS operators may follow the success of GSM and offer mass market UMTS products from the outset. What is clear is that the bandwidth is unlikely to reach anywhere near 2Mbps to start with, as the scale of investment in infrastructure is enormous and the technology only allows this level of bandwidth in ideal situations.

Another crucial factor to its early success will be the consumer reaction to the rollout of services. Whilst the sheer strength of the mobile market will ensure some take-up, take up of UMTS will be driven by quality and price of content. New ways of paying for entertainment and services will be created to maximise return.

The medium and long-term potential for this technology is enormous. Mobile communications is one of the fastest growing markets in the world. Confidence in the future of mobile communications is strong, and UMTS represents a big leap forward in terms of what is possible.

However, its launch will initially be slow with relatively low penetration by 2003 (a year after launch). By comparison with current mobile comparison, the leap in bandwidth will seem great even if limited to, say 100-200kbps. But true ‘broadband’ of 2+Mbps will not be achievable for many years to come.

## 4.10 POWERLINE

The view, in 1997, was that this technology would be able to provide the service to meet customer demands ahead of the other broadband technologies. But this hope was not realised and Powerline looked set to disappear from view. However, in the last year, new trials in Germany have proved successful enough to enable the company Oneline to offer DPL to the city of Cologne in late 2001 with access speeds up to 2Mbps. The broadband community will watch with interest!

The NorWeb Story

Trials of the technology began in the UK (Manchester) in early 1999, but were cut short in September of the same year. Other trials were also carried out, in conjunction with Nortel / NorWeb, in other EU countries e.g. Italy (Milan), Sweden and Germany. NorWeb also made agreements with seven other companies: NorWeb communications (UK), Vattenfall and Sydkraft (Sweden), RWE and EnBW (Germany), Singapore Power and EDON of Netherlands. At the outset, NorWeb/Nortel believed that the potential market for Powerline was more than 35 million homes in seven European and Asian countries.

Despite great excitement about the potential of DPL in 1997/8, since then there have been criticisms of this technology. In particular: Worries concerning the noise and interference related to sending data, voice and video over Powerlines. DPL is considered noisy because electric signals from appliances can use the same frequencies as data, voice and video. Companies involved in developing the technology, e.g. NorWeb and Intellon claimed, however, that their technology has or would overcome the line noise problem in most homes. Also, during UK trials, problems were encountered in relation to emission of radio signals, which caused interference affecting radio transmission, including the emergency services, aviation authorities and amateur radio hobbyists.

Nortel/NorWeb trials were halted in September 1999 as other high-speed broadband solutions developed. ADSL began to outstrip the performance of DPL. NorWeb claimed that the technology worked, however, after widespread criticism and three years of stilted development, the companies felt that the investment costs were too great and that the market had moved along too much to warrant continuing the programme.

NorWeb claimed the decision was due to economic decisions, the product being only suited to an uneconomically viable niche with insufficient interest from other European utility companies across Europe, rather than citing technological problems.

Whilst DPL may benefit from being first to meet the demand for higher bandwidth among Internet users, it still suffers from a bandwidth limitation and so does not offer great long-term prospects.

Also, one of the advantages of DPL is that it could be developed to provide an in-home network (as it was originally intended to). The in home network is likely to become a significant technology of the future with all digital appliances linked to a home console. However, it is more likely to be the wireless network (using HyperLAN2, for example) that will capture the market and not a wired solution such as DPL.

# 5. SUMMARY PLATFORM COMPARISONS

| | Narrowcast Legacy | | | Broadcast Legacy | | |
|---|---|---|---|---|---|---|
| | **ISDN** | **DSL** | **Leased Lines** | **DTT** | **Cable** | **Satellite** |
| **Bandwidth** | ISDN2: 56-128 Kbps<br>ISDN30: 65Kbps-565Mbps | ADSL: 1.5-8 Mbps VDSL: up to 50 Mbps | ISDN30: 65 Kbps - 565 Mbps<br>DSL: Gbps | 6 Mbps | 1 – 27 Mbps | Up to 2 Mbps |
| **Interactivity** | Asymmetric | Typically asymmetric can be symmetric | Typically symmetric | Return via telephone | Only with upgraded network and modem | Symmetric possible, but typically return via telephone |
| **Special features** | - Faster plus higher bandwidth than modem<br>- Multiple applications supported simultaneously<br>- Global connectivity based on international standards<br>- Improved reliability / security over modem<br>- Relatively lower cost | - High bandwidth<br>- Uses existing infrastructure, so quick to install in theory | - Bandwidth to match demand<br>- High level of security<br>- Tailored service arrangement<br>- Reliable connection without time delay<br>- No call charges<br>- Many users can utilise the leased line at one time | - Cheap to install<br>- Widely available<br>- Perceived to be higher quality than analogue<br>- Content can arrive in any digital medium | - Higher bandwidth than twisted pair<br>- Longer distance without repeater than twisted pair<br>- Cable companies often have exclusive rights to content<br>- Continuous connection | - Wide coverage (DTH)<br>- Alternative to cable and digital TV |
| **Limitations** | - Major limitation in terms of bandwidth<br>- Needs adapter in the home | - Bandwidth/distance (max. 5km)<br>- Ideally requires gauge 24 copper wire<br>- Unbundling is unpopular with incumbents<br>- Expensive to install , slow to produce return on investment | - Can be seen as expensive if under utilised. | - Not interactive unless linked to cable or telephone<br>- Some sceptical views about quality and aerial requirements | - Existing local loop infrastructure is copper<br>- Supplied by Cable TV companies (not currently Web focused, but changing) | - Not interactive in itself, but requires a return path using an alternative technology. Systems under development can sustain high return data rates.<br>- Technical problems as an access platform to the Internet. |
| **Market Potential** | Has been very successfully implemented, but will be replaced by xDSL | Demand for bandwidth is now. xDSL will meet that demand and will compete with cable as the main access platform. Initially too expensive for residential proposition, so will target business/SMEs initially. | An large and established market among larger orgs. SME increasing market. Until recently, the alternative was to buy and maintain your own line. However, new technologies will erode leased line business. | All TV will become digital. DTT via existing television aerial will be widely used in the short term as DTV is rolled out. But will be replaced by cable/dsl/satellite. At this point it has wide market potential. | Existing local loop infrastructure is copper Supplied by Cable TV companies (not currently Web focused, but changing) | Satellites are likely to continue as an alternative to cable in terms of offering multi-cast digital TV. But they are unlikely to offer households/ SMEs the interactive capabilities of cable and telecom broadband (at least in the short term). |
| **Broadband* in 3 years?** | No – low bandwidth | Yes | Yes | No | Yes | No |

* Broadband is defined here as 2Mbps+, 2-way transmission to the residential/SME customer

| | New Technologies | | | |
|---|---|---|---|---|
| | **FTTH** | **FWA** | **UMTS** | **Powerline** |
| **Bandwidth** | Gbps | 2 – 10 Mbps | 100s of Kbps | 1Mbps |
| **Interactivity** | Symmetric | Symmetric | Symmetric | Symmetric |
| **Special features** | - No limit bandwidth once installed<br>- High level of security<br>- Same technology as network<br>- Highly reliable (very low error rates)<br>- Fibre costs match copper | - Cheaper alternative copper local loop (in theory)<br>- Fast deployment<br>- Low installation cost (relative to fibre for example)<br>- Lower network maintenance, management, and operating costs<br>- Lower network extension costs | - Enhanced mobile service through increased bandwidth.<br>- Permanent, reliable connection.<br>- Multi-mode devises tune to available service (GSM, UMTS, Satellite) | - Continuous connection<br>- Using existing infrastructure<br>- Available to almost every household |
| **Limitations** | - Existing local loop infrastructure is copper<br>- Would need optical converters for PC, phone, TV etc., and transmitters and receivers are expensive.<br>- Certain long distance fibres need costly repeaters | - Current lack of standards<br>- New technology, not widely accepted | - Slow roll out<br>- Potential high cost<br>- Bandwidth limited | - Simple in concept, and cost effective to deploy<br>DPL is probably most advanced in Europe |
| **Market Potential** | Demand for bandwidth is now. It is currently too costly to replace copper local loop term, so competing technologies will offer an interim solution. But in the future fibre is likely to enter the home in some form. | - Tentative early steps and problems are likely to be overcome.<br>- Current interest in BFWA auction indicates the perceived potential within the industry. | Huge. This offers high bandwidth while mobile. The mobile market is one of the fastest growing, UMTS will be a big leap forward in terms of what is accessible while mobile. | Threatened by other technologies. ADSL offers many of the same benefits of DPL, but faster greater bandwidth. Dogged by perceived technological problems, e.g. radio interference, noise etc. |
| **Broadband* in 3 years?** | Yes | Yes | No – low bandwidth | No – not in next 3 years (if ever), plus low bandwidth |

* Broadband is defined here as 2Mbps+, 2-way transmission to the residential/SME customer

# 6. DIGITAL CONVERGENCE AND CONTENT PROVISION

Digital convergence has only just begun. The first examples of what will be possible in the near future are beginning to emerge. For example: downloading music or video to a mobile phone; digital cameras connecting to the TV; the Personal Digital Assistant (PDA); TV via IP (Internet Protocol) or IP through a digital TV; and the in-home network allowing interaction between all enabled domestic appliances. Once in a digital format, information can be sent and stored by almost any device, provided it has the appropriate hardware and is loaded with the necessary software.

The consequences of digital convergence are woven together with the future broadband era. The future of broadband access to the home/SME is not simply about the availability of transmission platforms of high capacity (which this report is focused on). It depends upon a fine balance between transmission capacity, the processing power of devices, the memory size of devices and the content itself.

**Industry View**

*"Sony have thrown down the gauntlet and they know how to target the consumer market. The next generation Playstation will also be the computing centre of the home. The games console is the Trojan Horse into the home. Sony also have technology which allows all computers in the home to talk to each other"*

Cable Operator

As available transmission capacity rises, there will be pressure on the processing power and memory required for the content. Assuming there is demand for the content, the consumer will be encouraged to trade up their hardware in order better to experience the content. At the outset broadband access platforms will be relatively expensive (compared to standard dial up connections), and the cost of processing power and memory will further limit the market to those who can afford it. The life cycle will then evolve, step by step as new broadband content drives demand and brings the cost of broadband down and in so doing widens the market.

The key to the rate of development of broadband is, and will remain, content. If content is created that captures the imagination of the consumer then it will drive demand for bandwidth and high capacity hardware. Whilst an investigation of broadband specific content is beyond the scope of this report, some examples are as follows:

- More convenient access to all media (i.e. whatever you want whenever you want)
- New forms of content which combine the PC interface with the TV experience to create 'interactive TV' or 'click through TV'[7]
- High definition DTV, possibly leading to 3-D TV

The majority of people have not yet experienced a high-speed connection even with today's Internet content. But speeds of 512Kbps will mean no waiting for web sites to download and so a generally more satisfying experience encouraging more use of e-commerce sites (provided concerns over security are overcome). The more data intensive web sites will also be handled with ease. Although at these speeds, broadband does not offer the potential of live TV and instant video or streaming, such

[7] See glossary

broadband is likely to further stimulate Internet use leading to the next generation of broadband content.

The potential combination of the Internet and broadband access has generated some nervousness about content copyright. For example, the US company Napster had enabled anyone to share music free of charge, although a US federal court has now banned Napster from allowing material with copyright to be shared unless an agreement is reached with the copyright holder. The global issue of finding a business model for fixed access broadband content is still unresolved.

In Japan, the mobile operator NTT DoCoMo have been billing micro payments for content received by I-mode phones and then passing a share of the revenue on to the content provider.

Fixed access tends to be charged on an always on basis with a fixed monthly fee for unlimited use within a restricted bandwidth. With business products, the fee rises according to the maximum bandwidth available. The content that is currently available on the Internet is either free with income generated through advertising and e-commerce, or it is subscription based. However, e-commerce has been providing lower than expected revenues and on-line advertising has proved less effective than other established media.

Given the importance of content in driving demand, an inevitable consequence of digital convergence is that the consumer will pay for the content with little or no awareness of the access platform. This has profound significance for telecom companies that are familiar with marketing and billing telephony access regardless of content. In the future, these companies will provide portals or gateways to a range of content some of it free and others at a cost. Cable operators are already doing this and so have a more secure business for the future of broadband.

The notion of ‘a killer application’, which will drive demand for broadband, has been around for a number of years. An example of such an application might be a new computer game that allows multi-players (thousands or hundreds of thousands or players) to take part in a simultaneous game, perhaps with thousands more speculating as a virtual, on-line audience with the ability to offer support to the players. In designing such a killer application, the only limit is the imagination. As broadband access becomes widely available creative ways of using broadband technology will emerge.

An alternative view is that the ‘killer application’ will not be a single application, but will be an array of interactive applications, which offer enhanced content, tailored to an individuals lifestyle and interests. In this case, some argue that the ‘killer application’ has already arrived in the form of the Internet which will continue to evolve and will drive demand for broadband as digital convergence blurs the traditional boundaries between TV, radio, Internet, cinema, telephone and other communication/entertainment channels.

# 7. KEY PLAYERS: BROADBAND STRATEGY

The following key players have been identified as most likely to influence the course of broadband development in Europe over the coming years. Of course, the effects of full unbundling have yet to be experienced in most countries, and the telecom industry is experiencing a period of unpredictable change and readjustment. So it is likely that there will be new key players emerging, as existing key players loose their influence.

## 7.1 BREDBANDSBOLAGET (B2)

Bredbandsbolaget emerged from the Swedish IT consultancy FramFab in 1998. NTL has recently taken a 25% stake in the company, which is also owned by FramFab, Intel, Investor, BCI Investments and The Carlyle Group. The aim of the company is to provide low cost (24/month) high bandwidth connections (10+Mbps) via an independent fibre optic network. In so doing, the company has laid down a challenge to the rest of the broadband industry, which is focusing on higher cost/lower bandwidth solutions.

By the end of March 2001, B2 had 125,000 homes connected to its network, with signed agreements to supply a service to around 400,000 households. B2 are now a significant threat to the Swedish incumbent Telia, are also building networks in Norway and Denmark and are looking to apply their business model in other European countries, such as Italy (with FastWeb and MetroWeb), Benelux (B2 Benelux) and Germany. The company is also expanding into other access platforms such as 3G mobile and ADSL (when the local loop is unbundled in Sweden). Recently, B2 secured a 370 million loan from Cisco, which will help the company to reach the critical mass needed to sustain profitability, and in September 2001 annouced it had reached agreements to raise 250 million through a private placement share issue.

The B2 content strategy is based on its flexible broadband portal with which the subscriber can create their own personalised portal using building blocks or 'brikks', which relate to different subjects. Although video streaming, live TV and future broadband content such as interactive TV will all be possible, B2 will differentiate its service by offering new opportunities for on-line communities to communicate and share information such as video conferencing. The recent battle by Napster to free the sharing of MP3 files from the copyright restrictions of the music industry is very relevant to the future of B2. The more easily information can be shared via the Internet, the more demand there will be for B2's product over other access platforms.

## 7.2 BRITISH TELECOM (BT)

BT was the national telecommunication service provider in the UK until 1981 when it became a private company and in 1984, BT shares were made available to the public. Although still dominant in the UK telecommunications industry (c. 80% share of the business market and c. 64% share of the residential market), BT has faced growing

competitive pressures in the domestic market. As the telecommunication industry has moved toward a global market, so BT has expanded its interests in many countries around the world.

In an attempt to reduce its 50 billion of debt, BT has split itself into a number of separate companies, some with re-issued shares and some to be sold. The problem of mounting debt is one that all European incumbents are facing and despite having innovative products, they lack the capital to invest and so develop their market. The effect of this will be a slowdown in roll out and a re-focus on the most profitable business.

As owners of the local loop, BT have been reluctant to introduce competition and so have been slow to make progress with unbundling. However, the regulator OFTEL has now ordered BT to finish unbundling by July 2001. BT launched ADSL to the business market in July 2000 and the residential market in September 2000. Since then BT have been criticised for the slow roll out of ADSL. A possible reason for delays are the need to maximise the return on ISDN and leased lines, which will be eroded by ADSL. Furthermore, cable networks do not yet have the coverage to seriously threaten future ADSL business, although delays may give cable operators time to expand network coverage and sign up customers.

There is currently some confusion about the direction BT is taking, with some suspecting a change of focus away from residential ADSL and toward business customers because they are likely to be more profitable at least in the short to medium term. This may be reflected in recent suggestions by BT's Internet Service Provider (BTOpenworld) that it will raise ADSL subscription charges still higher. BT have also been criticised for setting the wholesale price for renting ADSL lines too high, and in so doing, limiting the scope of alternative providers to build a sustainable business, whilst getting them to fund the roll out of BT's own ADSL product.

BT has not been as active as other incumbents in developing links with content providers, but is relying more on the e-commerce opportunities provided by ADSL. However, BT has recently signed an agreement with ONdigital (the leading DTT provider in the UK), to use BTOpenworld as the ISP for ONdigital's webTV service called ONnet which was launched in September 2000 and has already attracted over 20,000 customers. BT has also reached agreements with Yes Television for video-on-demand and Videonet for broadband content via ADSL.

## 7.3 CALLAHAN ASSOCIATES INTERNATIONAL

Callahan Associates was formed in 1998 by a group of US investors who decided to take advantage of the fragmented European cable sector. Callahan Associates acquisitions began with Numericable (the French cable network formerly owned by Canal Plus) and have moved on to including the Spanish operator Ono, some regional networks in Germany (North Rhine-Westphalia and Baden-Wuerttemberg), and recently the Dutch operator Telenet. Callahan Associates has now emerged as one of the leading players in the European cable sector. Its focus is firmly placed on upgrading networks to provide two-way digital connections including Internet access and next generation content.

In addition to expanding cable interests, the company has also launched Callahan Broadband Wireless to focus on the Fixed Wireless Access markets of Switzerland, Finland and the Philippines.

The same US investors behind Callahan Associates have also formed Nupremis, a company developing broadband delivery applications to enable the provision of broadband content.

## 7.4 DEUTSCHE TELEKOM

Deutsche Telekom is the largest telecom business in Europe and the third largest in the world, after NTT and AT&T. Previously a state owned monopoly, Deutsche Telekom has maintained its dominance. In addition to controlling Germany's fixed telephone networks, Deutsche Telekom owns: T-Mobile, which is the second largest mobile telephone player in the country; T-Online, which is Europe's largest and the world's second largest ISP; and Deutsche Telekom owns and is responsible for most of the cable TV network in Germany.

Despite its powerful position, Deutsche Telekom has experienced fierce domestic competition, which has led to a decline in the market share of its core telecommunication services. To counter this, Deutsche Telekom has expanded its interests on a global level and has invested heavily in 3G mobile licenses in Germany.

Some recent activities include:

**1999:** Deutsche Telekom domestic telephony profits down 45%
**1999:** Deutsche Telekom acquired One2One for 13 billion (UK's smallest mobile operator)
**January 2000:** Deutsche Telekom sold stake in Global One (corporate network operator)
**April 2000:** T-Online goes public
**July 2000:** Deutsche Telekom sheds 1,500 administrative jobs
**Aug. 2000:** Deutsche Telekom acquired VoiceStream Wireless for 47 billion (US mobile operator)
**2000:** T-Online acquires Club Internet (France's second largest ISP)
**2001:** Deutsche Telekom retains c. 50 billion for further acquisitions

Following pressure from the EU to increase competition between its telecommunications and cable business, Deutsche Telekom is now in the process of selling off part of its cable network on a regional basis. Even after this, Deutsche Telekom will still retain a significant share of the market. In order to further its interest in the cable industry (and so balance its portfolio), Deutsche Telekom has been investing in the development of set-top boxes to enable digital TV via cable. It spent 510 million on the purchase of a 51% share of Beta Research whose next generation set-top boxes will enable Internet access via two-way cable networks.

Deutsche Telekom launched residential/SME ADSL in July 1999 and by the end of 2000 had around 400,000 subscribers to the service. Take up is set to continue as Deutsche Telekom have managed to position ADSL as an upgraded ISDN by offering ADSL to existing ISDN customers at an affordable price for the consumer. In addition to the roll-out of ADSL, Deutsche Telekom have been investing in their

national network to ensure that it has the capacity (upgraded to 30Gbps) to cope with the increased bandwidth supplied to and from the home/SME.

The German media company Bertelsmann have been developing an interactive TV product and there are reports that Deutsche Telekom are forming a joint venture with Bertelsmann to offer interactive TV, video-on-demand and other bandwidth intensive applications to cable customers. T-Online has been developing its interests in content by buying 25% of the web search engine Infoseek and a similar share in Booxtra, an on-line bookseller. T-Online is also about to launch on-line banking through Comdirect (owned by Commerzbank).

## 7.5 FRANCE TELECOM

Previously the nationally owned telecommunications provider, France Telecom was registered as a company in 1988 and went public in 1997. The French Government retains a majority stake (54%) of the company. France Telecom dominates the domestic fixed line and leased line markets and owns Itineris, a French mobile operator. The company also owns France Telecom Cable, which operates a domestic cable network and the leading ISP in France, Wanadoo (which is now the second largest ISP in Europe after having acquired Freeserve). In the corporate network and access market, France Telecom owns the market leader in France, Oleane. And the company has a share in the satellite DTV provider Television Par Satellite (TPS), it owns Globecast, a satellite communications provider targeting the Indian sub-continent, and has formed a joint venture with Europe*Star to develop two-way Internet access via satellite.

Some recent activities include:

**January 2000**: acquired full ownership of Global One (corporate network operator)
**May 2000**: acquired Orange for 40 billion (UK mobile operator)
**July 2000**: Wanadoo goes public on the Paris stock exchange
**2001:** Wanadoo acquired Freeserve (UK's largest ISP)

France Telecom owns a substantial cable network in France, which is used to provide TV. Upgrading to two-way access has been underway since 1997, and where this has occurred, subscribers can connect to the Internet via Cable Wanadoo. This service is in danger of competing with France Telecom's ADSL service and so it is expected that France Telecom will not promote Cable Wanadoo, when ADSL becomes available. Recently France Telecom sold its half of the cable operator Noos to NTL/Morgan Stanley. France Telecom also has overseas interests in cable, in particular it owns 23% of the UK-based cable company NTL.

France Telecom has been rolling out its ADSL service since 1999, and has reported huge demand. Although unbundling was due in January 2001, France Telecom still controls the local loop and has been reluctant for competition to upset its monopoly.

France Telecom is involved in e-commerce through its on-line portal Voila and its e-commerce web-site alapage.com, which is modelled on Amazon.com. Wanadoo has also been active in developing its content strategy by acquiring the production

company FIT Production, and establishing a joint venture with EMAP, a magazine group. Furthermore, France Telecom is involved with satellite content through TPS.

## 7.6 KPN

The previously state owned monopoly Koninklijke PTT Nederland became Koninklijke KPN or just KPN when it was privatised in 1989, but remained 100% owned by the Dutch government until 1994 when 30% was floated on the Amsterdam Stock Market. KPN was responsible for telecommunications and the postal service in The Netherlands, but the latter is now the responsibility of a separate company. The Dutch telecommunications market was one of the first to be liberalised and KPN has retained a dominant position despite high levels of competition in its core businesses. Following successes in the GSM mobile market, 3G mobile will be an important business area for KPN, which has formed a partnership with Japan's NTT DoCoMo and Hutchison Whampoa from Hong Kong. KPN also has international interests in the Czech Republic, Germany, Hungary and Ireland.

KPN accounts for a third of the ISP market in The Netherlands with the brands Planet Internet, Het Net, XS4All and HCCnet. It also has 20% of the Belgian market and is looking to expand further into Europe. For example KPN recently acquired a 51% controlling stake in Euroweb International.

ADSL faces strong competition from digital cable in The Netherlands. However, KPN has been rolling out ADSL since mid-2000 and had set a target of 100,000 customers by the end of 2000, with up to half a million by the end of 2001. These figures may be optimistic, given the slow roll out experienced in other European countries, but they do demonstrate KPN's commitment to the technology in the face of competitive pressure to capture market share.

KPN is actively seeking content providers for its ADSL service. It has bought half of 3rd Generation, the Internet games company which holds the exclusive license to provide the Mplayer Internet games channel, and KPN is having discussions with Disney and a number of other content providers. KPN is also developing Internet banking with ABN AMRO called Money Planet.

## 7.7 KPNQWEST

KPNQwest is a joint venture between KPN and US-based Qwest, which began in 1999. The main project of KPNQwest is to build a pan-European fibre optic network connecting over 50 cities and covering over 20,000 km. Ultimately, this European network will connect with Qwest's US and Japanese networks to become global.

The company also plans to launch DSL in 25 cities across nine European countries starting with Finland and Germany during 2000, and estimates that the European market for DSL will reach 6-8 billion by 2003. KPNQwest has been very aggressive in reaching agreements with incumbents to gain access to the local loop. It says that it is significantly ahead of schedule in the roll out of DSL offerings in

Europe, having co-located in one hundred and fifty five central offices (or local exchanges) in fourteen cities in six countries. The first offers are now being made to business customers, and include SDSL and potentially VDSL as well as ADSL. With its own European network, KPNQwest will be well placed to handle the increases in network bandwidth which will be demanded.

## 7.8 NTL

NTL is a US owned company, based in the UK. France Telecom has a 25% stake and Microsoft has 3%. In May 2000, NTL bought the residential cable business of Cable & Wireless, and in so doing became the largest cable operator in the UK. NTLWorld is also the third largest ISP in the country and is available via cable, telephone line and DTT. In addition to providing residential services, NTL operates its own fibre optic and hybrid copper/fibre network and also owns terrestrial TV and radio broadcast transmitters. In addition to this, NTL owns a substantial corporate telecommunications businesses and has signed a contract to build a new mobile network for Orange (France Telecom) over which it will run its UMTS service.

As part of its aim to become a pan-European cable player, NTL acquired Cablecom, Switzerland's largest cable operator in 1999. It also bought the French cable operator 1G Networks in the same year. This French interest may be increased as NTL have agreed to buy a 49.9% stake in Noos, France's largest cable company. NTL also owns the Irish cable operator Cablelink, and is in the process of upgrading this network to two-way digital transmission. NTL launched its broadband cable Internet product in May 2000.

NTL is very active in upgrading networks, and is looking to extend fibre to the home in its core markets. As a demonstration of its commitment, NTL bought a 25% stake in Bredbandsbolaget (B2), the Swedish fibre to the home specialist. In order to ensure that a range of access platforms can be offered, NTL are laying 'tri-mese' cable to homes which includes copper twisted pair, coaxial copper and fibre optic all in one. NTL is looking at offering ADSL to businesses over its own telephone lines, allowing speeds of 6Mbps. NTL is also very interest in gaining access to the local loop when full unbundling begins.

NTL is well placed to provide broadband content, having come to an agreement with the satellite broadcaster BskyB to have access to selected channels. The company has also run trials on video-on-demand and will offer this in the near future. NTL has also been acquiring minority stakes in football clubs but recently failed to secure a deal for pay-per-view rights to 40 English Premier League soccer games per year.

## 7.9 UPC

United Pan-Europe Communications (UPC) started in its current form in 1997. It is the largest cable operator in Europe with cable companies in fourteen European countries. It is the leading cable operator in eight of these countries. The company owns the Chello broadband ISP, has programming interests (Extreme Sports and Film

1), is involved with FWA in France, Finland, Norway, Switzerland and Spain as Priority Wireless, offers ADSL as Mundi Telecom in Spain, and has an interest in satellite in Central Europe.

The following cable operators are owned fully, or in part by UPC: Telekabel (Austria); UPC Belgium; Kabel Net and Kabel Plus (Czech Republic); UPC France; Primacom and EWT/TSS Group (Germany); UPC Magyarorszag and Monor (Hungary); Tevel (Israel); Melita Cable TV (Malta); UPC Nederland; UPC Norway and UPC Ostfold (Norway); @Entertainment (Poland); AST Romania and Eurosat (Romania); UPC Slovensko and Kabeltel and Tranavatel (Slovak Republic); IPS (Spain and Portugal); UPC Sweden; and Telewest and Tara Television (UK).

At UPC's year-end statement in 2000, the estimated consolidated total homes passed was approximately 10 million, excluding announced acquisitions, minority interests and German interests. The number of basic cable TV subscribers on this basis was 6.5 million (with 358,000 telephony subscribers, 343,000 Internet subscribers and 24,000 digital cable subscribers). In addition to this, the direct to home satellite operation in Central Europe delivers television services to 474,000 subscribers.

UPC's Internet Service Provider (ISP) is called Chello and is also offered by cable operators not owned by UPC (e.g. Telesystem Tirol in Austria, and Wolu-TV in Belgium). It uses a broadband IP (Internet Protocol) network called Aorta, which includes a caching service which uses Inktomi technology to allow information to be stored as close to the user as possible. This ensures fast delivery when requested. Chello's biggest market is The Netherlands (100,000+ subscribers), followed by Austria (66,000+ subscribers). Chello had been looking to generate capital on the stock market and was in discussions with the US ISP Excite AtHome to merge and form the largest broadband ISP in the world. However, the recent downturn in the stock market has caused this plan to collapse. Chello also intends its broadband services to be accessible via ADSL, as a 'platform-neutral' ISP.

UPC has developed a set-to-box computer, which will handle DTV and video-on-demand initially, but is designed to be able to download software in the future so that it can be upgraded to include features such as Internet modem. And the company has made a great deal of progress in upgrading its networks (partly because it acquired those networks with most potential for upgrading). Of the 36,800km of coaxial cable owned by UPC, as much as 22,000km have been upgraded to two-way transmission. UPC is committed to offering triple play services (TV, telephony and Internet access) across the whole network (except in Eastern Europe where voice telephony is restricted). The company is also offering video services, and pay per view. Part of UPC's vision of broadband content involves the provision of thematic TV channels, marketed and distributed to niche audiences. For example, they currently offer men's and women's channels, a documentary channel and a design focused channel.

## 7.10 SES ASTRA

The Societe Europeenne des Satellites (SES) is a conglomerate of institutional investors, the largest single share belonging to Deutsche Telekom. SES operates the Astra satellite system, which broadcasts around 900 channels (both analogue and

digital) to 22 countries across Europe. These broadcasts reached 79 million homes across Europe by the middle of 2000, 29 million receiving direct-to-home transmission via their own satellite dishes, and 50 million cable subscribers (relying on a central down link). 10 million of these homes are now receiving digital transmission (up from 3 million in 1999), up from 3 million in 1999. SES is also expanding in the Far East with a 34% stake in Asia Satellite Telecommunications.

Clearly, SES ASTRA is the fastest growing digital platform in Europe, and holds considerable potential for digital broadcast in the future. The subsidiary SES Multi-media provides network services for 30 ISPs and broadcaster.

Under the name Astra-Net, SES has been providing a limited form of Internet access for a few years. However, this relies on the telephone line for the upstream connection. The company Europe Online attempted to offer a two-way Internet connection via Astra satellites. But although claiming to have 56,000 subscribers for this service, the company withdrew from the market. They claimed that satellite was technically not a good solution for Internet access as connections speeds drop significantly as more users connect and there is an unacceptable delay when it comes to interactive applications. Such an extreme turn around in strategy has dealt a very serious blow to the potential of satellite as a two-way broadband platform for the residential/SME market.

Despite this setback, SES has continued to expand its global interests, buying 20% of Embratel Satellite Division with a view to offering satellite Internet access in Latin America and 50% of Nordic Satellite Company (NSAB). Currently, any mass-market satellite Internet connection will rely on the telephone for the upstream and so cannot be considered a broadband platform. However, by offering this type of Internet connection at a competitive rate, SES has the potential to capture market share faster than any other access platform. At the same time, the company is developing the Broadband Interactive System (BBI), which uses a newly developed, small scale transponder known as a Satellite Interactive Terminal (SIT), which will allow 2Mbps upstream. The Astra 1H satellite was launched in 1999 with BBI equipment on board, making two-way broadband via satellite a little more likely. Although this system is too expensive for the residential market, Astra believes that two-way satellite access will be available for the residential market by 2002.

## 7.11 TELEFONICA

The former Spanish national telecommunications provider, Telefonica was privatised in 1987. In 1999, the company was restructured into seven independent businesses, which are as follows:

**Telefonica Móviles**: Mobile communications
**Telefonica DataCorp**: Corporate data/IP in Spain, Latin America and rest of Europe
**Telefonica B2B**: e-Commerce
**Terra**: Internet
**Telefonica Media**: Content
**Atento:** Call centre

Telefonica remains the dominant telecommunications player in Spain, and also has extensive interests across the whole of the Spanish and Portuguese speaking regions of the world, especially Latin America where it is the market leader. In addition, Telefonica is active in Europe where it is looking to expand (it recently acquired European Telecom, Austria's second largest player).

Terra Networks is the leading ISP in the Spanish and Portuguese speaking world. The company operates a number of different ISP brands including Teleline and the portal Olé in Spain, Zaz in Brazil, Infosel in Mexico, Infovia in Guatemala and Telefonica.net in Chile. The company also owns the biggest seller of Internet advertising space Double Click. Terra is currently merging with US portal Lycos with the intention of creating a leading global brand.

Telefonica holds a license to operate cable telecommunications in every region in Spain, but has agreed a 2 year moratorium with the government not to develop their interest in this area, whilst competitors are given the opportunity to build and upgrade their networks. However, these competitors only hold regional interests and so will be unable to compete with Telefonica when it does enter the market. For the time being, Telefonica has stated that it sees more potential in ADSL and so is not pressing for earlier entry into the cable market. Telefonica remains in control of the local loop in Spain (although other companies may lease Telefonica lines). ADSL, which was launched in 1999, is now installed over 7 million lines in the principle cities of Spain.

Telefonica has extensive interests in content provision. Telefonica Media already produces content for distribution via Telefonica networks and the company is in the process of buying Endemol Entertainment, a significant independent TV producer. The company also has an interest in the Spanish direct-to-home satellite operator Via Digital, which broadcasts many TV and radio channels. Telefonica also controls the national commercial TV channel Antena 3. The company is also developing its sports rights to provide broadcasting, Internet and merchandising as well as sponsorship to the European basketball league Euroleague.

Although faced with mounting debt, Telefonica is best placed to enter the broadband era of all other incumbents in Europe. It has a good portfolio of interests in all major access platforms, has extensive global interests in well defined markets (e.g. Latin America), and it has the vertical integration of content through to servicing the end customer which will be needed to ensure demand for broadband services in the future.

## 7.12 TELIA

The incumbent telecommunications operator of Sweden, Telia, recently floated 20% of shares on the Stockholm stock market, with the remaining 80% of shares owned by institutional investors. Telia provides fixed line and wireless telecommunications in Sweden and across the Nordic region and is a leading player in the Swedish cable market. It also has interests in the satellite operator Eutelsat.

Telia is also a stake holder in Scandinavia's largest Internet portal network SOL. Under the SOL umbrella, are a number of portals: sol.no and Kvasir.no in Norway; passagen.se and evreka.com in Sweden; and sirkus.com and evreka.fi in Finland. SOL

is one of the most sophisticated portal networks in the world and offers facilities such as interest group specific channels, community communication tools, games-on-demand and search and shopping which works across all four Nordic languages. In addition to this, Telia has agreements with a range of content providers such as: Avisa Centralredaktionen and Barracuda (for entertainment and news); Disney Interactive, Electronic Arts and Microsoft (for games on demand); Kamera (for sports); and Warner Music Sweden (for music).

Telia owns the main cable operator in Sweden, Com Hem, which it has been looking to divest in order to concentrate on developing ADSL. If a buyer is not found, Telia is likely to float the company. Although, virtually all cable subscribers can receive DTV, an Internet connection still requires the return link to go via the telephone line. However, the company is now building a new hybrid fibre-coax network. Telia also owns the second largest cable operator in Denmark, Telia Stofa.

Although Telia has been slow to roll out its ADSL service (which began in1999), the company is set to capture the majority of the market. It has recently signed deals with the Swedish Association of Private House Owners and the real estate company Svenska Bostäder to provide ADSL to private houses and leased residential units. In total, Telia claims to have 500,000 future customers already signed up for the service.

Telia is under some pressure from Bredbandbolaget's (also featured in this section) fibre-to-the-home offer which offers greater bandwidth for a lower price and has been very aggressive in capturing market share in Sweden.

## 7.13 TELECOM ITALIA

Societa Finanziaria Telefonica per Azioni, -STET, was the name of Italy's national telecommunications monopoly, which became privately owned by Telecom Italia. Olivetti bought a controlling share of Telecom Italia (54.99%) in 1999 and other major shareholders are the US company Capital Research & Management (6.72%), and the Italian government (3.95%). Telecom Italia remains the dominant fixed and wireless telecommunications provider in Italy. The company also owns the cable infrastructure in Italy, although it is not widely deployed, and has its own satellite subsidiary called Telespazio.

Telecom Italia's ISP, Tin.it, has experienced rapid growth in terms of subscriber numbers through 2000 and now has over 3 million customers. Tin.it is in the process of merging with Seat Pagine Gialle, which owns the countries most popular portal Virgilio.it plus other Internet related businesses. This deal will strengthen Telecom Italia's domestic Internet offer.

Telecom Italia began offering its own ADSL to Tin.it subscribers in June 2000, and is also planning to lease wholesale ADSL services to Infostrada (a subsidiary of Vodafone). Despite this partial unbundling, which will introduce limited competition, Telecom Italia retains control of the local loop.

Telecom Italia owns all of the cable infrastructure in Italy and so controls the future of this sector. Because cable is not widely deployed and terrestrial and satellite

broadcast are the preferred access platforms for TV, Telecom Italia have decided not to invest in the development of cable. This means that the future of broadband in Italy is with ADSL, unless alternative platforms emerge.

Telecom Italia is very involved in content provision. It owns Stream, the country's second most popular digital television platform (broadcast via satellite, cable and ADSL), which has been experiencing strong growth over the past two years. Telecom Italia has also announced that it will buy a controlling stake in the commercial channels TMC and TMC2 from Cecchi Gori Group. Telecom Italia is actively developing broadband content such as video on demand, video-conferencing and on-line gaming. It has also signed a deal with the newspaper Il Sole 24 Ore to develop Internet banking services and on-line trading. Clearly, Telecom Italia are deploying a balanced strategy of content and access provision.

# 8. REGULATORY ISSUES

## 8.1 ADSL

The EU has, correctly, taken the view that it is anti-competitive for a Member State's incumbent telecom operator not to unbundle the local loop. In pursuit of this policy, all incumbents in Member States were required to begin unbundling by January 2001. In most cases this has at least begun, although incumbents themselves have little or no incentive, given that the unbundling process effectively damages their monopoly and profit potential.

To facilitate unbundling, the process has been divided into partial and full-unbundling. Partial unbundling refers to a situation were the incumbent rents the local-loop to a new entrant at a fixed price. In this case the new entrant benefits from a more flexible business model while DSL technology is emerging. Indeed, some incumbents argue that partial unbundling is the only effective way to roll-out ADSL quickly and on a large scale whilst also encouraging competition. A concern of some regulators is that partial unbundling does not encourage new entrants to install their own equipment and so limits the competitive advantage of new entrants, as the incumbent has an intrinsic advantage by remaining responsible for the infrastructure.

The solution is to encourage full unbundling of the local loop, which means full access to the local exchange and local loops for hardware installation by new entrants. This would be the favoured approach for new entrants, provided they are confident of the long-term prospects and so are keen to have more technical and operational control. Clearly, full unbundling is likely to be preferred by new entrants in locations where there are high levels of demand. Some incumbents have also raised concerns over full unbundling because of a shortage of physical space in the local exchanges, making it difficult to manage the addition of new entrants.

All of these concerns with full-unbundling have lead Oftel in the UK and PTS in Sweden to delay the unbundling process. The view of new entrants in these, and other countries, is that the incumbents are playing a stalling game while they develop and roll-out their own ADSL offer and so gain huge, and unfair, competitive advantage by being first to market. On the other hand, the technical complexities of crosstalk and attenuation do necessitate strict controls when co-locating different ADSL services on the same length of network. If different operators are using adjacent cables they need to be aware of each other's system and work together to reduce factors which cause interference. This requires a close working relationship and mutual understanding, which takes time to evolve.

A further dimension to the unbundling process is the way it is managed within each country. In Germany for example, new entrants were selected by the regulator, based upon their potential to offer ADSL in a number of cities, but Deutsche Telekom have been slow to offer collocation space and have imposed high charges and strict criteria. In France, unbundling has not gone ahead yet and discussions continue about how best to ensure roll-out to the widest possible market. In the UK, the method employed has been criticised for creating huge interest in only the most profitable exchanges, but no interest in locations with less potential (e.g. there are 25 competing companies

trying to get into the Clerkenwell exchange in London). Clearly, unbundling was never going to be a simple process and incumbents are likely to seek any opportunity to slow the arrival of new entrants. An exception to this is The Netherlands where unbundling occurred in 1998 and, in the climate of increased competition, KPN has developed into a highly focused business with aspirations of expansion across Europe.

## 8.2 LEASED LINES

There have been concerns raised over the high price of leased lines. Although deregulated, there is little competition in the provision of leased lines with the incumbent dominating the market, and thus there is little pressure on prices.

In particular, the European Commission has responded to the International Telecommunications Users Group (INTUG) investigation into the pricing of inter-country leased line. This investigation found that international pricing was considerably higher than domestic prices over equivalent distances. The INTUG revealed that, although there are additional costs associated with international leased lines, a cost orientation in the tariffs for international leased lines was not evident. In response to this, pressure has been brought on national regulators by the EU.

Another regulatory issue impacting on leased lines is local loop unbundling and the introduction of DSL. The increased competition that this brings will place healthy pressure on the leased line business. As the majority of leased line business goes to the incumbents, they are likely to be reluctant to introduce ADSL where it might cannibalise lucrative leased line business among SMEs. To encourage healthy competition in this market, it is essential for new entrants to gain full access to the local loop and begin making ADSL offers to SMEs. Furthermore, at the early stages of roll-out it will be crucial for new entrants to maximise the potential market for DSL by attracting the SME market.

## 8.3 DTT/DTV

It is obviously of vital importance to government to allow free and universal access to particular, mainstream, public broadcast channels. To ensure this, without limiting the development of commercial DTV, operators are obliged to provide ‘conditional’ access in which some channels are free whilst others are not.

To encourage take up of DTV, some operators include the set-top box without charge providing the customer subscribes to certain pay channels. However, a large proportion of viewers are not willing to pay for additional channels and for these people, the set-top box (or other basic decoder) will have to be purchased in order to continue to receive free public broadcast channels after the digital switchover in broadcasting. There will undoubtedly be issues associated with the cost of basic conversion which will require some governmental intervention. Rather than subsidising the provision of basic adapters, governments are more likely to wait until the majority of households have paid to upgrade their equipment. However, in some

scenarios it may be necessary to regulate the price of basic adapters by encouraging competition, offering tax incentives, or perhaps subsidising them.

## 8.4 Cable and Cable Modems

Historically, the development of cable infrastructure was a community-orientated investment aided by governmental support and regulation. This partly explains the high penetration of cable in the Benelux countries in particular. The cable industry is now fully deregulated across Europe.

An issue still of some relevance to regulations are the standards set for cable modems. In May 1999, the European Telecommunications Standards Institute (ETSI) specified the European standard as the 'DVB/DAVIS Euromodem', which has subsequently been endorsed by the European Cable Communications Association (ECCA), which represents 13 cable operators. However, some Member States have chosen to adopt the US standard DOCSIS (e.g. the UK). There are strong arguments on both sides for keeping each standard. From one perspective, backing the Euromodem effectively builds a barrier to US entry into the cable modem market, which may not be best for economies of scale, but will generate business within Europe. However, development of the Euromodem may limit the scope of European business to expand within the US in the future (although any expansion is likely to be US companies entering Europe). Currently, it would appear that both the Euromodem and the US equivalent DOCSIS will run side by side in Europe and will divide the market for the time being.

Some governments (e.g. in The Netherlands) have suggested that cable operators (especially those with market dominance such as UPC) may have to open up their cable networks to allow competitors to gain access to the customer. In effect, they are proposing an 'unbundling' of the cable networks to stop the exclusive access to customers gained by a cable operator. The cable industry has responded to this by suggesting that this would remove the incentive for them to continue upgrading networks as if it were to happen, they would be unlikely to gain a sufficient return from their very considerable investment. The most appropriate way to ensure consumer choice would appear to be to promote alternative access platforms such as ADSL and FWA.

## 8.5 Satellite

There are no significant regulations affecting the roll-out of broadband satellite in Europe. Satellite does provide a technical solution for broadband access to remote communities, which may not benefit from the roll out of other broadband services. This is likely to be a significant market for satellite operators, but may be hampered by the high cost of equipment.

Governments of Member States with remote communities could offer some form of assistance for these communities to gain access to existing or future satellite services (e.g. subsidise or cut tax on equipment). Such action may become necessary to ensure universal service to broadband services (if this becomes an obligation in the future).

Furthermore, it is often these rural and remote areas which suffer most poverty, and so assistance with access to broadband services for businesses and SMEs may help to aid in the economic development of these remote regions by widening the market for their products and encouraging outside investment.

## 8.6 FIBRE OPTIC

The development of fibre optic networks is relatively free from regulation. However, given that fibre is a preferred broadband solution, governments may be inclined to subsidise or offer tax relief to encourage companies to roll-out fibre and customers to choose fibre over other technologies.

It is likely that the unbundling process will help to stimulate demand for broadband by making ADSL affordable through competition. However, this policy encourages considerable investment in ADSL technologies, which remain limited to access speeds of 1-2Mbps (perhaps up to 8Mbps in the minority of places where conditions are perfect). Although advanced compression technologies may improve performance to some extent, there is a physical limit to effectiveness of DSL as a transmission technology. Any broadband policy needs to take into account the likelihood that demand for bandwidth will grow beyond the possibilities of ADSL (perhaps as quickly as 2 years up to 10 years depending upon who you talk to). Of course, if DSL is widely deployed, then operators will be keen to extend the life of the technology as far into the future as possible to maximise their return on investment.

A broadband policy should take into account that when demand for bandwidth rises above 10Mbps (and almost everyone involved in the industry believes that it eventually will), then fibre optic networks will be required (with satellite filling the gaps where fibre does not reach). Fibre to the curb with VDSL over twisted pair, or coaxial cable (hybrid fibre solutions), are a step in this direction, but they do not benefit directly from ADSL technology. In this eventuality, cable companies that have invested in fibre to the curb or basement will rapidly gain market share and demand for fibre to the home will grow rapidly.

Clearly, from a regulatory perspective, the unbundling of the local loop must be part of a long-term broadband strategy, which allows for growth in demand beyond 10Mbps up to 100s of Mbps.

To encourage the roll-out of fibre, the fibre industry would benefit from assistance in getting people together to talk under an independent banner such as the EU. Such talks would be aimed at developing cross-boarder strategic alliances in which constructive progress could be made, whilst protecting the interests of those involved. At present, individual suppliers are fearful of loosing out in the race to capitalise on the new technology and so are unwilling to co-operate.

Another example of governmental assistance, which would benefit the industry, is the encouragement of training schemes in this area of technology, to help ease the current skills shortage.

## 8.7 FIXED WIRELESS ACCESS

Almost all Member States have now allocated licenses to operators of FWA. In addition to stipulating the level of service expected (e.g. start date and coverage), licenses include the allocation of radio frequency spectrum in which to operate. Although the service levels vary from country to country, radio frequencies have been issued in two spectrum categories: 24-26GHz for broadband; and 3.4-3.5GHz for narrowband services. Some countries are also licensing the 10.5GHz and 40GHz spectrum.

Apart from aiming to be fair and objective, license allocations can take any form, including: auction; beauty contest; or first come, first served. In some cases, licenses are limited to a period of time, whilst others are ongoing, but can be removed if service falls below expected levels.

**Industry View**

*"The problem with FWA regulations is that access to the frequencies comes with coverage obligations, which are unrealistic given the limitations of the technology. But it all comes back to how this is enforced and measured"*

Global Telecommunications Company

Whilst the method of allocation reflects the particular circumstances of each Member State, it is important that the lessons of the UMTS auctions are learnt, and that every effort is made to encourage rapid roll out of FWA.

## 8.8 MOBILE WIRELESS (UMTS)

The majority of Member States have now auctioned UMTS licenses. Globally, Europe, Japan and the US are all developing 3G technology, but with different alignments of the technology to protect economic and political interests.

Regulatory issues with most impact on the future of UMTS have to do with copyright law, access to information and data protection rules, especially in the European Union (as mobile operators will be keen to use 3G as a new marketing platform reaching those on the move).

# 9. COUNTRY COMPARISON OF BROADBAND ACCESS PLATFORMS

In order effectively to compare the development of high-speed access platforms between the EU, the US and Japan, it is necessary to consider the situation in each of the Member States of the EU before proceeding to an analysis of the EU as a whole. Whilst the US and Japan represent relatively homogenous markets in terms of political, economic, geographic, and cultural contexts, the principle characteristic of the European broadband market is diversity.

There are a number of large telecommunication businesses (some of which have been described in Chapter 7,) which clearly take a European, if not global view in implementing their broadband strategies. These include the incumbent telecommunication providers from the larger Member States. However, because of the fragmented nature of the EU broadband market, there are also numerous businesses with influence only on a domestic level within each Member State.

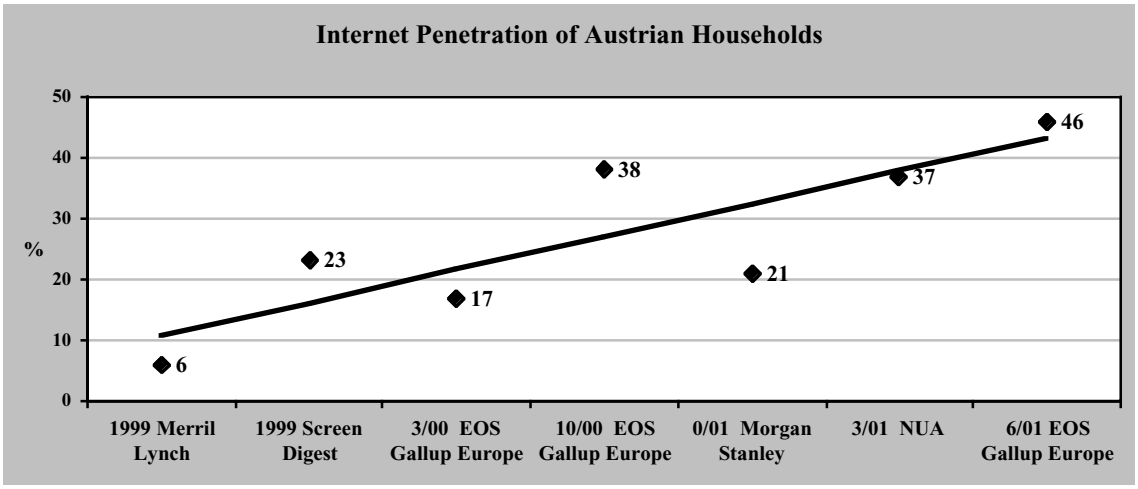
Furthermore, as emphasised in Chapter 3, the future of broadband is inextricably linked to legacy infrastructure and market conditions. As these vary considerably from one Member State to another, it is necessary to investigate the situation in each country, before coming to any conclusions about the EU as a whole.

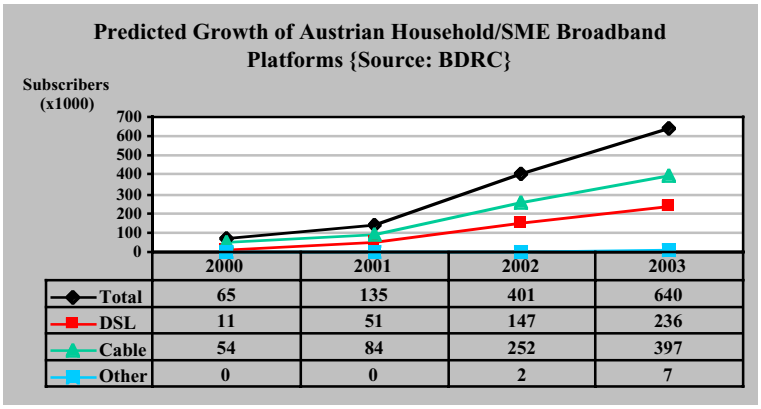
Please note that key figures for each country are from 2000. This timeline is adopted in order to allow for comparison between all reviewed countries and all analysed areas. Indeed, consolidated figures from reliable sources for all countries in all areas are only available for 2000. However, wherever available, more recent figures have been included in the analysis.

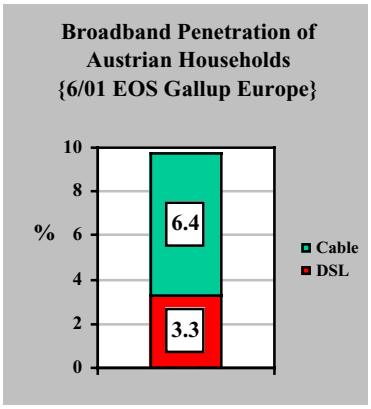
# AUSTRIA

| | |
|---|---|
| GDP[a]: | 23,484 Euro/annum/capita |
| Population[b]: | 8.2 m (64% urban)[l] |
| Households[c]: | 3.3 m |
| Main telephone lines[d]: | 3.9 m |
| Cable TV subscribers[e]: | 1.3 m |
| Satellite dish owners[f]: | 1.8 m |
| Mobile subscribers[g]: | 6.5 m |
| PC households[h]: | 1.4 m (43% of households) |
| Internet households[i]: | 1.2 m (38% of households) |
| Internet users[j]: | 2.1 m |
| Broadband subscribers[k]: | 0.07 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]Screen Digest 1999 [d]ITU 1999 [e-f]Screen Digest 1999 [g]ITU 2000 [h]Screen Digest 1999 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999



Internet usage is relatively high in Austria and other new technologies such as mobile phones have swiftly been embraced. Relative to other European countries, broadband in Austria has developed quickly in response to high levels of demand. This has been enabled by favourable conditions for private investment in cable infrastructure, as well as an early rival offer of ADSL by the incumbent telecoms operator.

Although the telecommunications industry was opened to full competition in January 1998, Telekom Austria still dominates. The TCK (Telekom Control Kommission) ordered the incumbent to unbundle the local loop in July 1999, and new entrant ADSL offers have begun to emerge. In 2000, the Austrian government attempted to float Telekom Austria on the stock exchange in Vienna and New York, however because of its poor financial performance there was only limited interest. As a result, the government retained 47%, Telecom Italia took 30% and the rest of the shares are traded freely.

The availability of cable in Austria is almost as high as in Benelux countries (70% of homes passed), and the legacy of the infrastructure is similarly based on the provision of Community Antenna TV (CATV). However, unlike Benelux countries, this situation has developed through the investment of private companies in competition with other cable companies and terrestrial and satellite broadcasters, rather than municipal funding. Apart from some local authority restrictions on pricing, it is a free market and so is attractive to larger investors. Hence, UPC (the largest pan-European cable operator) controls about 40% of the Austrian cable market through the Austrian company Telekabel. Other significant players include Liwest, Telesystem-Tirol, and Safe Kabelsignal. After this, there are over 200 other smaller CATV operators.

Although the quality of the cable infrastructure varies enormously, progress is being made in upgrading to two-way digital transmission. Provided UPC continue to dominate and maintain their commitment to upgrade networks, Austria is likely to see a rise in cable subscribers and among them a rise in 'Triple Play' subscribers who take TV, Telephony and Internet.

**ISDN:** User penetration is around 6% of households. This will fall off as people switch to ADSL.

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

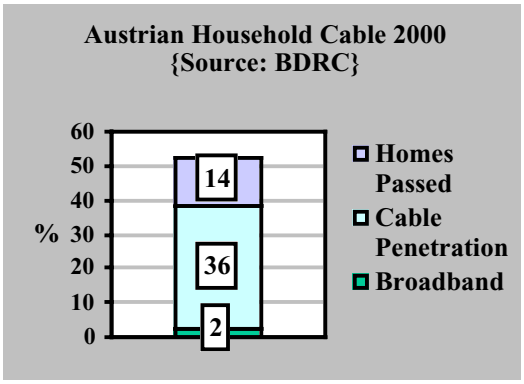
**DSL:** In response to high demand for ADSL (especially from the residential market), Telekom Austria launched ADSL in November 1999. However, early adopters of ADSL placed huge demand on the network causing it to collapse on a number of occasions, resulting in no analogue telephony service (as well as no data transmission). Telekom Austria claim these problems have now been overcome.

Although the market is deregulated, unbundling has not yet threatened the dominance of the incumbent. This is perhaps partly because of the network capacity problems experienced by Telekom Austria meaning that ISPs and competitors have preferred to lease ADSL lines from Telekom Austria for the time being, rather than installing their own equipment. Alternative ADSL packages are offered by: KPNQwest; Inode; Arges; Tempo; INS; Oonet; Teleport; Vianet; Vienna Online; Xpoint; YC net.works; Formus Communications.

| Examples of ADSL offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| *Telekom Austria* (A-Online Speed) - Primarily residential Potential to reach 100,000 subscribers (55% of households) | 64 / 512 Kbps | 58 - 68 (?) |
| *Inode* - Business and residential in Principle cities | 64 / 512 Kbps (higher for businesses) | 65 - 109 (?) 77 - 115 (?) |

**Digital Terrestrial Transmission**: Estimated launch of DTT is sometime in 2002, however, there is considerable uncertainty over actual plans, and no date set for termination of analogue transmissions.

**Digital Cable:** The chart below shows, that the cable network in Austria passes just over half of all homes, most of which subscribe to the service. However, only 2% of all homes actually subscribed to 'broadband' cable in 2000.




UPC are committed to upgrading the network infrastructure in their control, and Telekabel claim that three quarters of homes covered by their networks are now enabled for two-way, digital transmission. Chello (the UPC owned cable broadband ISP) has around 60,000 subscribers and the cable operator Liwest also offers two-way Internet access. Many of the other cable operators can offer Internet access by using the telephone line upstream.

| Examples of Cable Internet offers | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|
| *UPC Telekabel* (Chello) - Residential (60,000 subsc.) | 128/ 512 Kbps | 43 (72 + 50) |
| *Liwest (24 Speed)* - Residential (2,500 subsc. in the city of Linz ) | 64 / 300 Kbps | 42 (?) |

**Digital Satellite:** Although cable and ADSL are developing well in Austria, there has been some consideration given to offering Internet via satellite for subscribers with no alternative access platform. This potential exists because of the reasonably high penetration of satellite dishes in Austria, however any Internet service would currently rely on the telephone line for the upstream connection and so would not fall into the definition of two-way broadband transmission.

**Fibre Optic:** There are no reports of fibre optic being used as an access platform to the home or SME. However, given the current demand for ADSL and cable, in the future there may be a market for very high, two-way bandwidth which could only be met by fibre.

**Fixed Wireless:** In February 2001, the ATA (Austrian Telecommunications Authority) awarded nine licenses, all in the 24.5 - 26.5 GHz band. These went to Star 21 and Broadnet. The auction had been planned for April 2000, but after being excluded from consideration, the incumbent, Telekom Austria, went to court and forced the ATA to postpone.

There are a further 12 licenses, which are likely to be allocated toward the end of 2001/2002. Apart from Telekom Austria, there will be a number of other players keen to win these remaining licenses. RSLCom are currently running FWA trials in Austria using Netro equipment, and will be keen to win licenses. Formus will also be a primary candidate as they have a strong interest in this technology, and are currently operating as a new entrant telecommunication provider in Austria.

In the higher 'broadband' frequencies, the first test licenses were issued in the first half of 2000 for the 40GHz band, but there are no plans for commercial offers as yet.

**Mobile Wireless (UMTS):** Mobile telephones have been very popular in Austria (with over half the population subscribing to a mobile phone). WAP has been offered, GPRS is expected soon. On 15th March 2001, six UMTS licenses were allocated to the following service providers, generating a total income of 706 million:

- Connect Austria (Tele Danmark, Telenor, Viag Interkom and Orange)
- Hutchison
- Mannesmann Mobilfunk (Vodafone)
- Max.mobile (Deutsche Telekom)
- Mobilkom Austria (Telekom Austria and Telecom Italia)
- 3G Mobile Telecommunications (Telefonica)

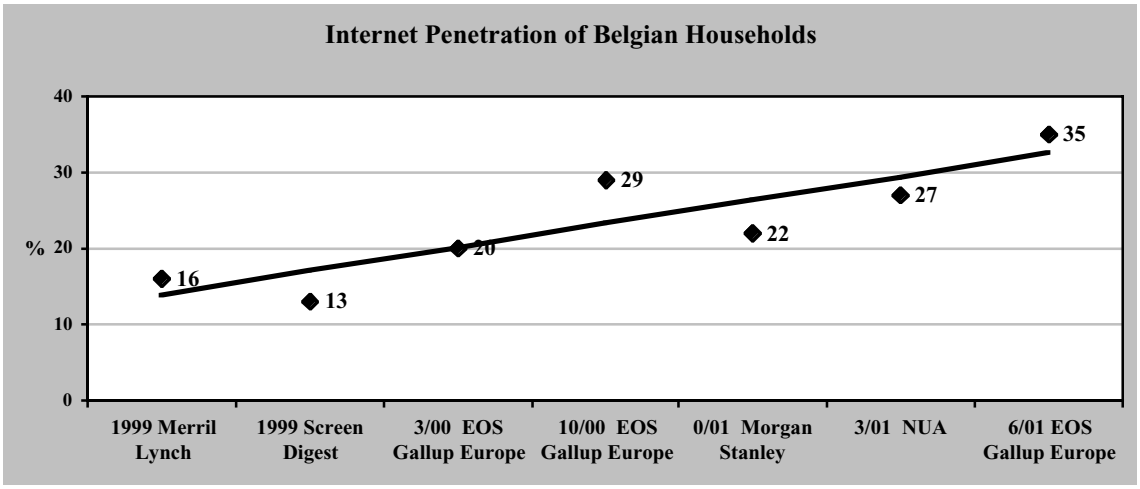
UMTS license coverage obligations are to reach 25% of the population by December 2003, then 50% of the population by December 2005.

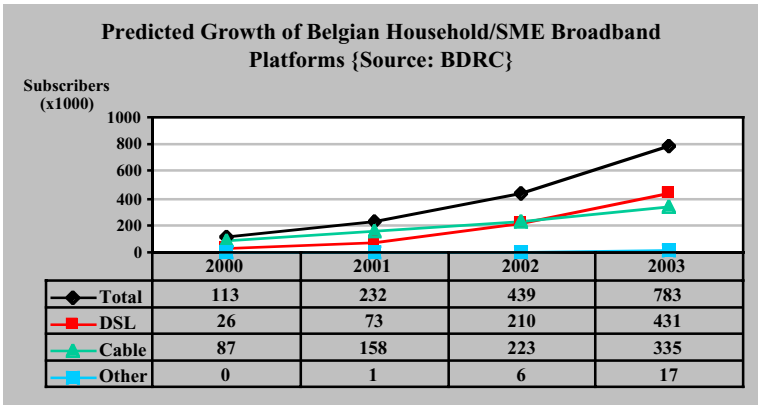
**Powerline**: There are no reports of Powerline projects in Austria.

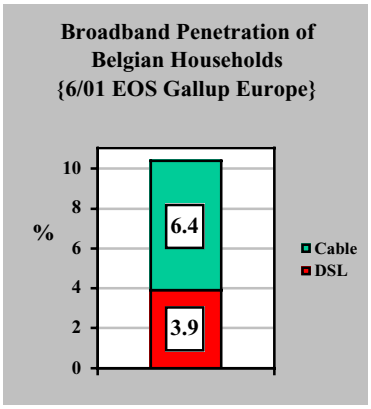
# BELGIUM

| | |
|---|---|
| GDP[a]: | 23,446 Euro/annum/capita |
| Population[b]: | 10.2 m (97% urban)[l] |
| Households[c]: | 4.2 m |
| Main telephone lines[d]: | 5.1 m |
| Cable TV subscribers[e]: | 3.7 m |
| Satellite dish owners[f]: | 0.1 m |
| Mobile subscribers[g]: | 5.6 m |
| PC households[h]: | 1.6 m (37% of households) |
| Internet households[i]: | 1.2 m (29% of households) |
| Internet users[j]: | 2 m |
| Broadband subscribers[k]: | 0.11 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]Screen Digest 1999 [d]ITU 1999 [e-f]Screen Digest 1999 [g]ITU 2000 [h]Screen Digest 1999 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999



Compared to other northern European Member States, Belgium has been relatively slow to adopt the Internet, and so demand for broadband has been relatively low until recently. However recent figures indicate that there has been a huge leap in Internet connections, including broadband connections.

Cable infrastructure is widely deployed in Belgium, and has considerable potential as a broadband access platform. However, market fragmentation and old infrastructure has slowed the process of updating networks to two-way digital transmission. Notwithstanding, cable remains the most popular broadband access platform in Belgium at present. The clear leaders in the market, and those with most potential as broadband access providers are UPC (Chello) and Telenet. Other smaller cable operators will also offer broadband access in the future, but not on the same scale as UPC and Telenet.

Unbundling of the local loop has not yet occurred in Belgium, and the incumbent Belgacom enjoys a monopoly on local access telecommunications infrastructure. New entrants and ISPs can lease Belgacom ADSL lines on a wholesale basis.

Belgacom has been proactive in developing its ADSL offer (unlike some other incumbents in Europe). This is perhaps a response to the direct competition from cable operators as in Belgium ADSL is largely offered as an alternative to a cable Internet subscription. The race to capture market share resulted in Belgacom becoming one of the first Member States to introduce ADSL and since then it has been proactive in developing the market by offering a choice of ADSL products and finding ways to lower the price of ADSL.

**ISDN:** Although ISDN is available in Belgium, penetration is only 4%. This reflects the relatively slow adoption of the Internet amongst Belgians.

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** The incumbent, Belgacom, began ADSL trials back in 1998 and made a first offer to the business market in April 1999. Since then, Belgacom have developed a number of different ADSL products for the residential market including a lower cost, self installation product, and higher bandwidth products for the business market.

Belgian society has been slow to adopt the Internet and so take up of ADSL has been slow, despite the range of offers from Belgacom. Although full unbundling has not yet occurred in Belgium, there is competition from the cable operators and Belgacom has proved very keen on developing competitive offers. Belgacom's strategy is to drive the price down and so encourage more people to take ADSL.

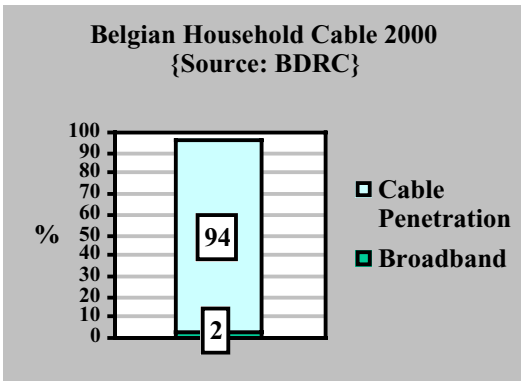
| Examples of ADSL offers | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|
| *Belgacom* (coverage of over 75% of households) | | |
| Residential: Turboline Go (Self instalation - buy modem) | 128 / 750 Kbps | 32 (+ modem) |
| Turboline Plus (Rent modem) | 128 Kbps / 1 Mbps | 40 (?) |
| Business: Turboline Pro | 128 Kbps / 1 Mbps | 90 (?) |
| Turboline Premium | 512 Kbps / 1 Mbps | 375 (?) |

When unbundling does occur in Belgium, there are a number of ADSL providers with a keen interest. For example, KPNQwest has a DSL product ready to roll out as have Easynet and VersaPoint (Versatel and NorthPoint joint ventrue). However, until full unbundling occurs, new entrants can only lease ADSL lines from Belgacom and attempt to make a competitive offer by including attractive ISP services. Wanadoo has made such an offer.

**Digital Terrestrial Transmission:** DTT is hardly used in Belgium because of the exceptionally high cable penetration. In exceptional cases, local difficulties in access to the cable market may prompt the launch of DTT services by Canal+, but satellite is more likely. In any event, DTT is unlikely to offer two-way transmission without the use of the telephone line for the upstream.

**Digital Cable:** Belgium, like the other Benelux Member States, makes extensive use of cable, reaching to almost all homes (96%). Despite this, only 2% of households where subscribing to a 'broadband' service in 2000. The reasons for this low figure are:

- The local networks are a legacy infrastructure built to provide CATV and so the national network is actually a large collection of small local network (with each hub linked to national broadcasters via satellite, cable or fibre optic).
- Belgium society is divided into French, Germany and Flemish communities, each with its own communications regulator and content providers.
- Local operators are often funded by the municipality to provide a public service, thus limiting the scope of the free market and the benefits of competition.




Before networks can be upgraded to two-way digital transmission, with low cost broadband access, there needs to be considerable consolidation in the Belgian cable industry. This has been underway in some areas, for example Electrobel, the Belgian energy, telecom and cable television company organised joint ventures with intermunicipalities in the Bologna (Italy) and Flanders (Belgium) regions. In the Flanders region they set up the company Telenet with US West Media 1, the network was coaxial, but is in the process of being upgraded to fibre optic, enabling two-way digital transmission. In 2000, this network had around 1.5 million out of the 2.2 million Flemish households

ready for the service. Following this consolidation, the US cable company Callahan bought a 55% stake in Telenet and a 55% stake in each of the individual companies operating the local networks. This investment will result in faster cable upgrading and so earlier roll out of broadband.

Other broadband developments in Belgium include The Netherlands based UPC (the largest cable operator in Europe) which is offering its Chello service in the Brussels and Leuven areas. ALE-Télédis is offering broadband cable Internet access in the Walloon region and the Belgium cable operator Brutélé is offering residential and business Internet access on its networks in Brussels, Charleroi and Wavre.

| **Examples of Cable Internet offers** | **Data Rate Up/Down Kbps** | **Price* in Rent/month (installation)** |
|---|---|---|
| *Brutélé* (Residential: BruTelecom@home)<br>(SME: BruTelecom@turbo) | ? | 36 (520) |
| *UPC Belgium* (Chello) | 128 / 512 Kbps | 36 (?) |
| *Telenet* (Residential: Pandora)<br>(SME: Pro-pakket or Pro+Pakket) | 128 / 512 Kbps | 37 - 50 (298) |
| *ALE-Télédis* (Télédisnet) | 64 / 256 Kbps | 35 - 74 (171) |

**Digital Satellite:** Currently, only a small minority of Belgians own satellite dishes. There has been some promotion of Internet via satellite, for example Europe Online attempted to offer such a service but withdrew because of technical problems. Belgacom, in partnership with Eutelsat, also offer Internet via satellite, but this is targeted at larger, data intensive businesses such as ISPs.

**Fibre Optic:** There are no live fibre optic projects. However, the Swedish fibre optic access provider Bredbandsbolaget (B2) has shown some interest in the Benelux countries, but any future project has yet to secure funding.

**Fixed Wireless:** On 15 February 2001, four FWA providers were issued with licenses by The Belgian Minister for Telecommunications for use as a Wireless Local Loop in public telecommunication networks (point to multi-point). The allocations were as follows:

| | |
|---|---|
| 3.4 - 3.6 GHz: | Formus Com., Winstar Com. |
| 10.15 - 10.65 GHz: | Landtel Belgium; Winstar Com. |
| 24.5 - 26.5 GHz: | Belgacom; Formus Com.; LandTel Belgium; Winstar Com. |

The allocations where made on the basis of a beauty contest. Taking Winstar Communications as an example, its licenses cover Brussels, Antwerp, Gent and Liege, which means a population of more than 3.2 million. Winstar Communications was awarded the entire spectrum grant at a nominal fee of 17,000.

Initially FWA is likely to be marketed to the business community, including SMEs. But providers are likely to be keen to offer telephony and broadband access to compete with Belgacom and the cable operators. Currently there are no plans to develop services in the 40 GHz 'broadband' spectrum.

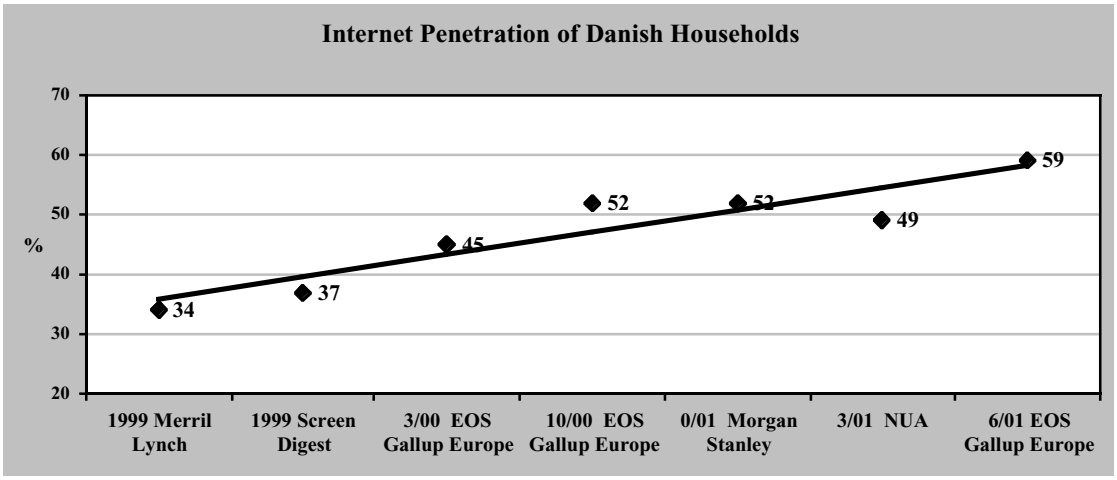
**Mobile Wireless (UMTS):** Three licences were awarded on Friday 4th May 2001 to Mobistar, KPN Orange and Proximus. A total of 480m was raised. A service is expected by 2002, with coverage obligations of 30% of the population within 3 years, growing to 85% of the population after 6 years.

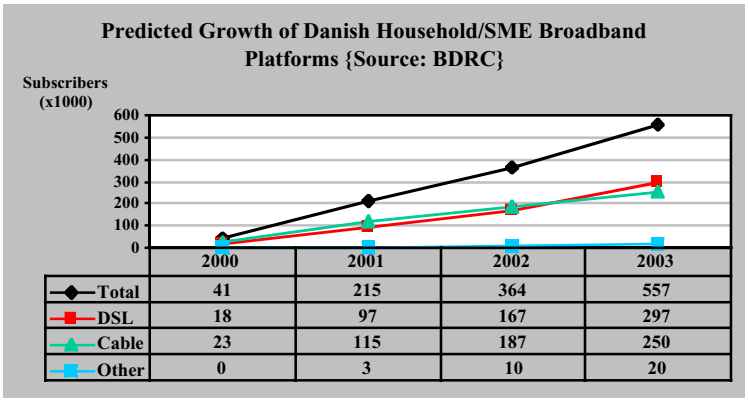
**Powerline:** There are no reports of Powerline projects in Belgium.

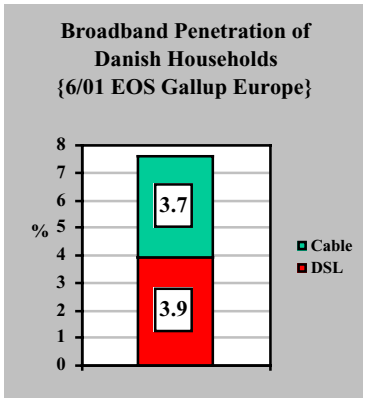
## DENMARK

| | |
|---|---|
| GDP[a]: | 25,026 Euro/annum/capita |
| Population[b]: | 5.3 m (85% urban)[l] |
| Households[c]: | 2.4 m |
| Main telephone lines[d]: | 4 m |
| Cable TV subscribers[e]: | 1.3 m |
| Satellite dish owners[f]: | 0.1 m |
| Mobile subscribers[g]: | 3.3 m |
| PC households[h]: | 1.4 m (59% of households) |
| Internet households[i]: | 1.2 m (52% of households) |
| Internet users[j]: | 2 m |
| Broadband subscribers[k]: | 0.04 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]EOS Gallup Europe 2000 [d]ITU 1999 [e-f]Screen Digest 1999 [g]ITU 2000 [h]Screen Digest 1999 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999



Denmark could been viewed as a world leader in terms of preparation for digital convergence. The Danes have embraced the Internet, with over 37% of households now on-line, and demand for broadband is high.

Government has been very involved in the recent split of incumbent TeleDanmark into a separate telecom business and cable business and has been proactive in encouraging the development of broadband through competition. Partial unbundling has been in place since the middle of 1999 with restrictions on the price that the incumbent can lease DSL for, with the aim to make broadband affordable to the largest market. Full unbundling is now underway.

Although over half of all households subscribe to cable TV, in most areas this network has yet to be digitally enabled. There are no signs that this situation will change rapidly enough to compete with ADSL. Despite this, TeleDanmark Kable were one of the first cable operators to launch digital cable in 1998. Since then the company has undergone privatisation and separation from the telecommunications arm of TeleDanmark. Hence, ADSL has greater potential in the short to medium term.

It is also worth noting that Denmark is characterised by high population density in its main towns and so, in addition to ADSL and cable, the country is well suited to fibre optic access networks and fixed wireless access.

**ISDN:** TeleDanmark has been very active in upgrading its telecommunication network, which is now fully digitised. As a consequence, user penetration of ISDN had reached 10% of the population in 2000 and was the principal means of faster speed connection to the Internet. This relatively high penetrations suggests that there is potential for ADSL to quickly capture 10+% penetration if priced competitively and rolled out quickly.

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** Unbundling of the local loop was initiated by the Danish government in 1998. The incumbent, TeleDanmark, was forced to lease the local loop at cost price to new entrants. This partial unbundling process has attracted ISPs such as CyberCity, World Online, Tele2, Mobilix and Dansk Internet Adgang to offer ADSL. As a consequence, penetration of ADSL among households reached 2% in 2000, the highest in Europe at the time.

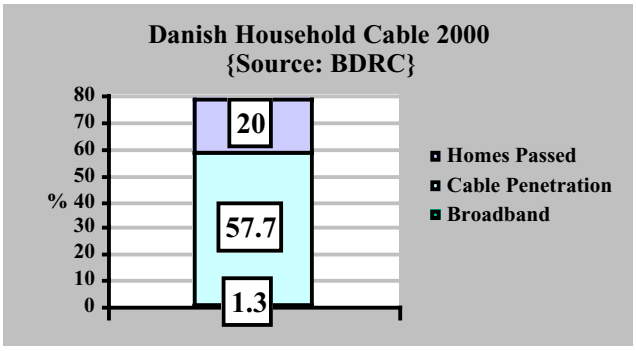
The new entrant Telia Danmark has been planning to offer its own ADSL service, but at the time of writing had not yet reached an agreement on how to gain access to the local exchanges.

| Examples of ADSL offers | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|
| *TeleDanmark* (NetExpres)<br>October 1999 (2-4km from exchanges in Copenhagen, Århus, Odense, Aalborg.)<br>Considering symmetric DSL for business/municipalities | 128/256<br>128/512<br>256/1024<br>512/2048 | 48 (394)<br>67 (394)<br>94 (394)<br>134 (394) |
| *Cybercity* | 128/348 up to 512/2000 | 66 (0)<br>133 (267) |
| *World Online* | 256/256 up to 512/2000 | 53 (0)<br>133 (268) |

TeleDanmark's ADSL consumer offer has come down in price since first introduced, and as a direct result of this price cut, take up increased. However, this ADSL offer remains slightly more expensive than cable Internet at present. TeleDanmark has experienced some problems in rolling out ADSL beyond the major cities of Denmark (reportedly because of delays in modem delivery from the manufacturer and because of a shortage of technically skilled engineers limiting the rate of roll out).

**Digital Terrestrial Transmission:** DTT was piloted in November 1999, and was planned for launch in 2000 but is not yet available. Given the preference for cable TV in Denmark and the fast adoption of ADSL, it is unlikely that DTT will be developed as a two-way broadband access platform.

**Digital Cable:** The Danish cable industry has been deregulated since the beginning of 1999. The only rules apply to 'must carry' channels and the possibility for users to influence which channels are broadcast.




Cable is the most popular means of receiving TV. 79% of homes are passed by cable, and 58% of the population subscribe to cable. Despite extensive infrastructure, only a relatively small proportion of households use cable for Internet access (1.3% penetration in 2000). Although cable has potential as a broadband access platform, the majority of the network has not been yet been upgraded for two-way transmission and requires considerable investment before this is achieved. Telia Stofa currently offers two-way, low and high volume packages based upon Mb/month, with a price per Mb.

| Examples of Cable Internet offers | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|
| *TeleDanmarkKabel* | Via telephone/512 | 13 (267) |
| *Telia Stofa* (500,000 homes) | 384/1000 | 101-335 (133:low vol.-267:high vol) |

**Digital Satellite:** Satellite penetration is relatively low, as the legacy of cable TV (especially in rural communities) has favoured cable over satellite broadcast. Europe Online had targeted Denmark as a market for its satellite Internet service, but this was withdrawn due to technical difficulties with Internet traffic via satellite.

**Fibre Optic:** Given the geographical proximity to Sweden and the similar culture in terms of Internet use, Denmark may be seen as an attractive market for the fibre optic providers of Sweden. However, there are no offers of fibre to the home in Denmark at the moment. Sweden's Bredbandsbolaget has dark fibre in place, but offers no service as yet as considerable investment is required to light up the fibre.

The Danish cable companies are in the process of upgrading their networks and may be able to offer a fibre/copper hybrid solution within the next five years.

**Fixed Wireless:** In December 2000, Telestyrelsen (the National Telecom Agency) awarded licenses for nationwide transmission to the following operators:

| | |
|---|---|
| 3.4-3.6 GHz: | Formus Communciations; Sonofon; Tele2 |
| 24.5-26.5 GHz: | Formus Communications; Sonofon; Global Connect; Mediascape |

Currently, there are no plans to develop a service in the 40 GHz 'broadband' spectrum. However, Denmark is likely to be one of the first Member States to have Fixed Wireless Access systems working on a commercial bases. Global Connect has already began offering FWA to the larger business market, and Sonofon which is majority owned by Norway's Telenor, is claimed to have signed Siemens of Germany and Spike Broadband Systems, a US-based company, to supply US$400 million of equipment for wireless internet access. The deal means that Sonofon will be in a position to offer Danish consumers a wider range of broadband services including Internet telephony, with the intention of deploying enough equipment over the next five years to reach 95% of Denmark's population

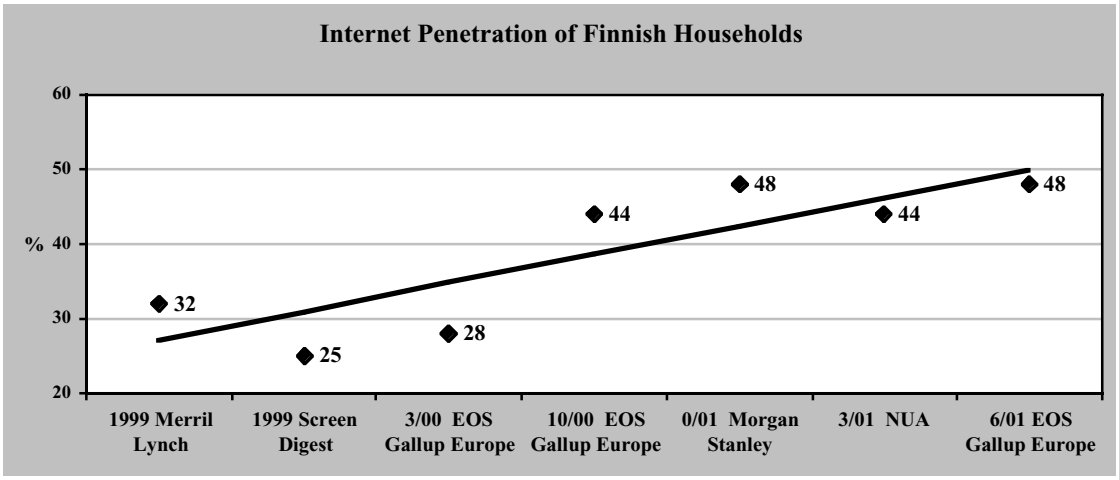
**Mobile Wireless (UMTS):** 2G mobile penetration is very high in Denmark (as across Europe). 3G licenses will be awarded following a sealed bid on 5th September 2001, and the winners will all pay the lowest of the winning bids. 3G roll-out in Denmark is likely to follow the pattern which emerges across the rest of Europe.

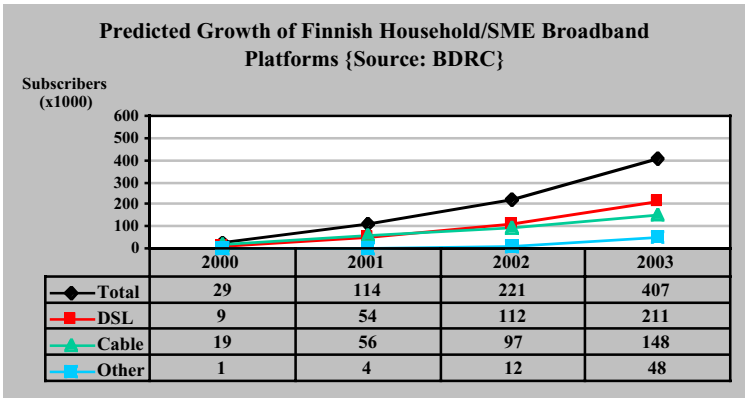
**Powerline:** There are no Powerline projects proposed in Denmark. Other access platforms are likely to get to market before Powerline.

## FINLAND

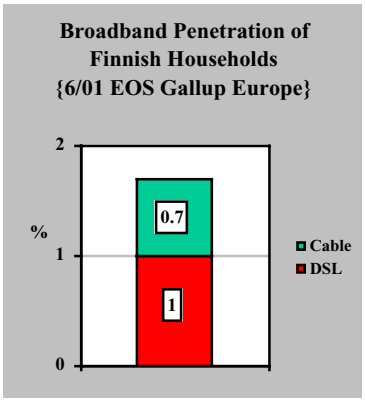
| | |
|---|---|
| GDP[a]: | 21,442 Euro/annum/capita |
| Population[b]: | 5.2 m (64% urban)[l] |
| Households[c]: | 2.4 m |
| Main telephone lines[d]: | 2.8 m |
| Cable TV subscribers[e]: | 1 m |
| Satellite dish owners[f]: | 0.3 m |
| Mobile subscribers[g]: | 3.8 m |
| PC households[h]: | 1.1 m (46% of households) |
| Internet households[i]: | 1 m (44% of households) |
| Internet users[j]: | 1.9 m |
| Broadband subscribers[k]: | 0.03 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]Screen Digest 1999 [d]ITU 1999 [e-f]Screen Digest 1999 [g]ITU 2000 [h]Screen Digest 1999 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999




| | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|
| Total | 29 | 114 | 221 | 407 |
| DSL | 9 | 54 | 112 | 211 |
| Cable | 19 | 56 | 97 | 148 |
| Other | 1 | 4 | 12 | 48 |



Finland has a reputation as one of the most innovative countries in Europe, in terms of the development and implementation of new technologies. The country is characterised by very high mobile phone penetration and like the other Nordic counties, Finland has embraced the Internet, with almost half of all households now on-line.

Cable TV is popular, with 42% of households subscribing, but the network is highly fragmented and digital upgrading is moving slowly. The telephone line is likely to be the main point of access to digital interaction via ASDL in the short to medium term, although Fixed Wireless Access may also compete.

**ISDN:** Households penetration was at 6% in 2000. This is a slightly lower figure than might be expected for Finland and may reflect the low cost of standard dial up resulting in reluctance among consumers to pay for faster Internet access.

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** The Finnish government has been proactive in encouraging competition in the telecommunications market. The incumbent, Sonera, began facing competition in 1994 when Finnet Group and Telia Finland began offering telephony services.

Access to the local loop was granted in 1997 and Elisa Communications began offering ADSL over its own Helsinki network in October 1999 and had 300 business subscribers by mid-2000. In March 2000, KPNQwest launched a DSL service to businesses in Helsinki, closely followed in May 2000 by the incumbent Sonera, which offers a service to consumers and businesses. Other ISPs are also offering packages by leasing ADSL lines from Sonera.

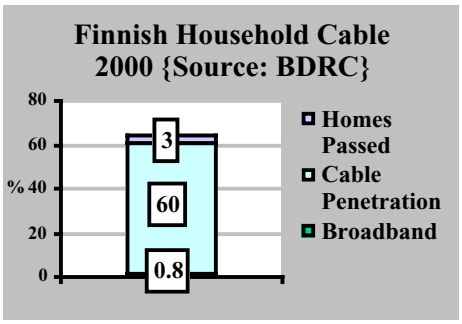
Despite this activity, currently only 0.4% of the population access the Internet using ADSL. This may be a consequence of low cost standard dial up combined with a lack of 'broadband' content.

| Examples of ADSL offers | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|
| *Sonera* (Home ADSL) | 256 / 256 Kbps | 84 (168) |
| *Sonera* (Business ADSL) | 512 Kbps / 2 Mbps | 415 (?) |
| *Elisa* (Kolumbus) | 256 / 256 - 512 Kbps | 66 - 134 (496) |

**Digital Terrestrial Transmission:** Over half of all households rely on analogue terrestrial broadcast for TV. Cable and satellite remain a minority access platform. Initial offers of DTT have been available since 2000, but take up has been slow.

**Digital Cable:** In Finland there are around 40 CATV companies, each serving a local community (c. 20,000 homes on average). The largest operators, Helsinki Television and Sonera (also the incumbent telecommunications provider), have been most proactive in developing Internet access via cable, which has been available since 1996. Other larger operators such as Tampereen Tietoverkko Oy, Turun

Kaapelitelevision Oy and Oulu TV Oy have not yet announced details of an Internet service.




CATV is popular with around 61% of all households subscribing. But, despite the high levels of Internet use across the country, only 1% of households used cable for Internet access in 2000. This is because of the fragmentation of the network operators, the old network infrastructure and competition from alternative access platforms.

Although network upgrading work is currently underway, with predictions that two thirds will be finished by the end of 2001, other access platforms such as ADSL are likely to get to market first.

Helsinki Television first offered high-speed cable modem connections in December 2000, with the intention of building a consumer brand in which the customer can experience their broadband content via a number of different access platforms including ADSL. Similarly, Sonera is offering ADSL in addition to its cable Internet offer. Ultimately, consumers may not even be aware which access platform they are connected via as the focus will be on the experience and not the technology.

| Examples of Cable Internet offers | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|
| *Helsinki* Television (HTVI) | ? | 41 (45) |
| *Sonera* (QuickNet) | ? | ? |
| *Starvisio* - Kupio Cable TV (Komeetta) | ? | 42 (50) |

**Digital Satellite:** Satellite penetration is relatively low, with 8% of households having a satellite dish. This is likely to be a result of the legacy of CATV (especially in rural communities) which has favoured cable over satellite. Europe Online had targeted Finland as a market for its satellite Internet service, but this was withdrawn due to technical difficulties.

**Fibre Optic:** Finland has a number of fibre optic projects underway as municipalities have been keen to build their own fibre optic networks. None of these are operational yet. However, an example of what may be achieved was put forward by the town of Ylöjärvi, at their recent Housing Fair. With the help of TPO, Omnitele, Nokia and ICL, Ylöjärvi built a Broadband Village in which houses where connected to a multimedia communications system via an ATM network with Ethernet connections to each house. The residents of the Broadband Village take part in trials of the service and multimedia content.

**Fixed Wireless:** Finland are one of the most advanced Member States in terms of the development of Fixed Wireless Access. The Telecommunications Administration Centre allocated licenses as follows:

| | |
|---|---|
| 3.4 - 3.6 GHz: | Sonera Entrum; Formus Com.; Callahan Broadband: Oy Interloop Ab; Priority Wireless (UPC); Riihimäen Puhelin ; Oy KD-Soft Ab |
| 10.15 - 10.65 GHz: | Formus Com.; Facilicom Finland; FirstMark Com. |
| 24.5 - 26.5 GHz: | Advanced Radio Telecomm Nordic; Formus Com; FirstMark Com.; Priority Wireless (UPC); Callahan Broadband; Oy Finland Tele 2; KPNQwest; Sonera Entrum |
| 37.0 - 39.5 GHz: | Advanced Radio Telecomm Nordic |

Although spectrum allocations include the 'broadband' frequencies of 37.0 - 39.5 GHz, this is to be developed as a point-to-point system rather than point to multi-point and so will not be a local access platform at this stage, but will be an alternative to a fixed leased line.

The ISP Saunalahti and the network operator Elisa Communications have both expressed an interest in offering broadband Internet services via fixed wireless access. Future developments in Finland will be of interest to the rest of the European Union.

**Mobile Wireless (UMTS):** Penetration of mobile phones is very high. Almost all Finns between 15 and 40 years of age have at least one mobile phone. And mobile phones have begun to replace the wired telephone in the home (almost a quarter of homes no longer have a wired connection for telephony).

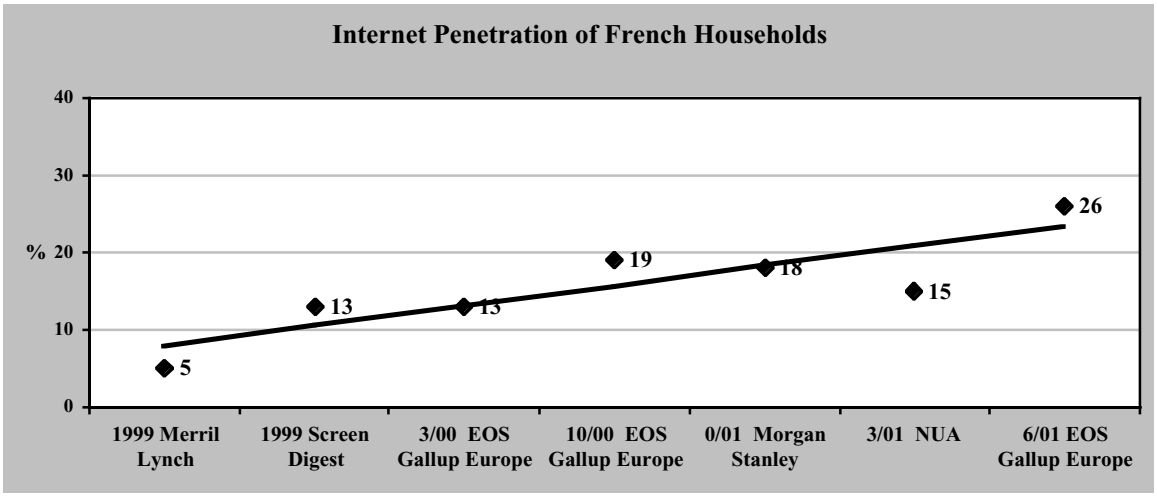
Finland was the first country in the world to issue 3G licenses in March 2000. A 'beauty contest' resulted in four licenses for: Sonera, Telia, Suomen 3G and Radiolinja. There was no charge made for the licenses.

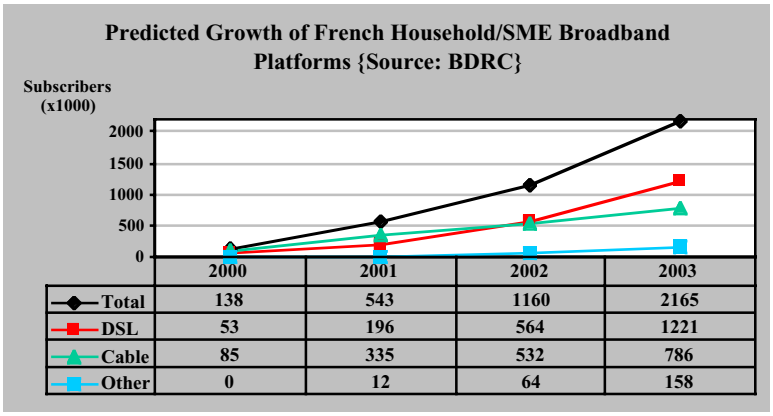
**Powerline:** Sonera has shown some interest in this technology and, in partnership with the local electricity provider Jyvaskyla Energy and the German Powerline specialist Oneline, is conducting field trials. However, there have been no reports of success (or failure).

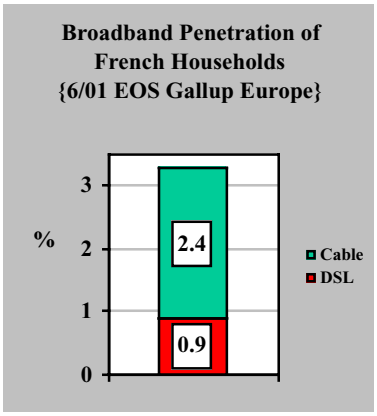
## FRANCE

| | |
|---|---|
| GDP[a]: | 20,861 Euro/annum/capita |
| Population[b]: | 58.8 m (75% urban)[l] |
| Households[c]: | 24 m |
| Main telephone lines[d]: | 34.1 m |
| Cable TV subscribers[e]: | 2.8 m |
| Satellite dish owners[f]: | 2.7 m |
| Mobile subscribers[g]: | 29.1 m |
| PC households[h]: | 6 m (25% of households) |
| Internet households[i]: | 4.6 m (19% of households) |
| Internet users[j]: | 8.5 m |
| Broadband subscribers[k]: | 0.14 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]Screen Digest 1999 [d]ITU 1999 [e-f]Screen Digest 1999 [g]ITU 2000 [h]Screen Digest 1999 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999



French Internet penetration was relatively low in 2000 (c. 15% of households on-line). However, there have been reports of recent fast growth in take up, and the future prospects for Internet and broadband access look good. A cause of the initially slow adoption is likely to be related to the amount of French content available. As this continues to grow, so will the popularity of the Internet. As one of the larger markets of the EU, France does have considerable potential for broadband access in the future.

The cable network reaches only a minority of households in France, mostly in Paris and other major cities. The incumbent, France Telecom, still controls the majority of the cable network, although they are looking to divest this business and many multi-national operators are keen to enter the French cable market. Although, cable has potential, there is likely to be some further consolidation in the market before Internet via cable becomes widely available.

France Telecom has been slow to unbundle the local loop. When this finally occurs, the prospects for broadband in France will grow. In the meantime, the slow roll out of ADSL may increase the potential for alternative access platforms such as Fixed Wireless Access as they become available. If, or when, a satellite solution for high speed, two-way, interactive transmission becomes viable for residential/SME, France will be a key market.

**ISDN:** France has a very low penetration of ISDN (0.3% of Internet users use ISDN at home).

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** France Telecom has faced competition in the telecommunications market since 1998 and there are now a number of alternative providers such as Cegetel, Siris and 9 Telecom, not to mention the direct competition from cable operators. Despite this, France Telecom has been reluctant to allow access to the local loop for competitors to provide ADSL.

To avoid unbundling, France Telecom made an appeal to the French government, making a case for keeping full control of the local loop within France Telecom, but this was rejected. Following this the regulator ART increased the pressure on France Telecom to begin unbundling by the end of 2000. However, this has been followed by claims of unfair treatment of competitors trying to gain access to the local loop. These new entrants claim that France Telecom has been charging them for the maps necessary in gaining access. Because a different map is required for each exchange, the cost to the new entrant could rise to over 4 million just to gain the basic coverage information necessary to plan an ADSL service. In other Member States, this information has been freely available.

France Telecom first offered ADSL in November 1999 to businesses and residential customers in Paris. By December 2000 they had 46,000 subscribers in Paris and other major cities. Despite the stalling of local loop unbundling by France Telecom, the first rival offer over the copper local loop was recently announced by Easynet France. By connecting the local exchange directly to their own backbone network, Easynet

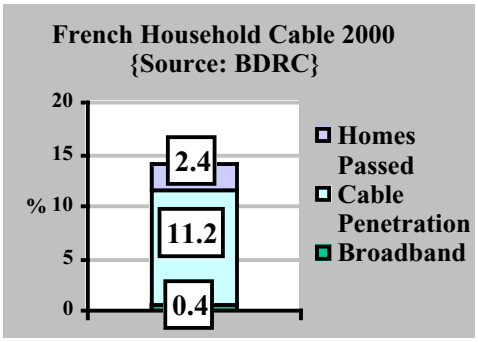
claim to have reached speeds of 8Mbps (although they guarantee only 2Mbps on their commercial service). KPNQwest is also running trials of ADSL in France and Cegetel is planning an HDSL (High Bit-rate DSL) service for businesses in Lille, Nantes and Lyon.

Partial unbundling has also been occurring, with ISPs leasing ADSL lines from France Telecom and bundling them with other services to make a broadband offer. These include: Free (no ISP charge with ADSL from France Telecom); Club Internet; World Online; Easynet (operating as ISP to gain market share); Infonie; Isdnet; Magic Online; Nerim; and Worldnet.

| **Examples of ADSL offers** | **Data Rate Up/Down Kbps** | **Price* in Rent/month (installation)** |
|---|---|---|
| *France Telecom* (Netissimo) - Residential | 128 / 500 Kbps | 47 (117) |
| *France Telecom* (Netissimo) - Business | 259 Kbps / 1Mbps | 107 (151) |
| *Easynet France* | ? / 2Mbps | ? |
| *KPNQwest* | ? | ? |
| *Cegetel* - Business HDSL | +2 / +2 Mbps | ? (760 - 1524) |

**Digital Terrestrial Transmission:** Terrestrial transmission is currently analogue, although DTT is being considered as a means to increase the number of TV channels broadcast and so compete with the satellite and cable broadcasters.

**Digital Cable:** From 1980, the then state owned France Telecom built a publicly owned national cable network, which was leased by regional CATV operators. Following its change of status to a quoted business, France Telecom was forced to negotiate a change of ownership of the network infrastructure which gave it a stake in the regional operators, whilst the regional operators each gained full ownership of their local cable network.




The cable networks pass around 14% of homes and over 10% of all homes subscribe to cable. What is particularly notable in France is that most of the cable infrastructure is relatively new and upgraded so cable has great potential as an access platform in those areas with availability (major cities). Hence, the larger cable operators have been offering Internet access for some time (in the case of France Telecom Cable since 1997).

Proof of the significance of cable as a broadband access platform in France is provided by the amount of international interest in the market. NTL and UPC have both taken significant interests in the French market, NTL purchasing the largest cable operator Cybercable (now renaimed Noos) from Lyonnaise Câble as well as five France Telecom networks in the Paris suburbs, and UPC purchasing Time Warner Cable France, Reseaux Cables de France and Videopole

In the rush to offer broadband Internet access, some cable companies have experienced network capacity problems. Most notably, Noos had to limit the number of subscribers until the system was upgraded to cope with the increased demand. In particular, the problem was with demand for upstream bandwidth (a major limitation of ADSL as well). To help limit upstream demand, Noos now charges a per Mb rate after an initial free amount of data.

| Examples of Cable Internet offers | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|
| *France Telecom* (Câble Wanadoo)<br>Residential offer:<br>Business offer (Multi@ccess):<br><br>Business offer (Plein@ccess): | <br>128/512 Kbps<br>128/768 Kbps per terminal up to 1 Gbps<br>256 Kbps/1Mbps per terminal up to 4 Gbps | <br>35 (82)<br><br>111 (68)<br><br>228 + 6 per 20Mb up |
| *UPC* (Chello) - residential | ? | 36 |
| *NC Numericable* (AOL par NC Numéricâble)<br>Residential | <br>?/512 Kbps | <br>50 (107) |
| *NTL* (Noos) - residential<br>Business | ?<br>? | 36 (76)<br>15 for 1 terminal<br>29 for 2-4 terminals<br>45 for 5-8 terminals<br>58 for 9+ terminals |

**Digital Satellite:** Compared to other Member States, France has a very active satellite market. CanalSatellite Numérique and Télévision Par Satellite (TPS) compete for subscribers to their broadcast platforms. Penetration of satellite dishes among French households now stands at 16%.

There has been much talk of two-way satellite access platforms in France. For example, France Telecom and Europe*Star have set up the joint venture Stellat which aims to position a new geo-stationary satellite over France which is specifically designed to provide two-way Internet access. The planned launch date is April 2002.

However, as in other Member States, the Europe Online two-way satellite venture has stopped operations due to technical problems and in so doing has sent a warning signal that satellite links do suffer from a time lag which may limit the scope of this access platform.

Other satellite solutions are coming to market that combine satellite for the downstream path and DSL for the upstream path. For example the German company Teles is planning to offer SkyDSL and Easynet is offering EasySky. These products are suited toward video streaming large amounts of data, whilst still having the instant interactivity demanded by Internet users (and potentially interactive TV users). There is also the possibility of maximising the upstream DSL bandwidth if necessary.

| Examples of Satellite Internet offers | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|
| *EasySky* | ? | 30 (303+) |
| *Teles* - planned service | ? | c. 18 (180) |

**Fibre Optic:** The cable operators make extensive use of fibre optic in their networks and so there is a lot of Fibre To the Curb (FTTC) in those areas with cable. It is likely that, as demand for bandwidth grows, fibre will reach into the home for those prepared to pay. However, this is still some way off.

**Fixed Wireless:** The French government awarded licenses in August 2000 when the following allocations were made:

| | |
|---|---|
| 3.4 - 3.6 GHz: | FirstMark Com., Fortel, Cegetel Caraibes; Cegetel La Reunion; XTS Network Caraibes; XTS Network Ocean Indien |
| 24.5 - 26.5 GHz: | Altitude; Belgacom France; BLR Services; Broadnet France; LandTel France |

Of these, FirstMark Com and Fortel were awarded nationwide licenses and are backed by large consortia prepared to invest substantial sums (e.g. 1 billion over 3 years in the case of Fortel). The other licenses were awarded for regional coverage only. Currently, there are no plans to develop a service in the 40 GHz 'broadband' spectrum.

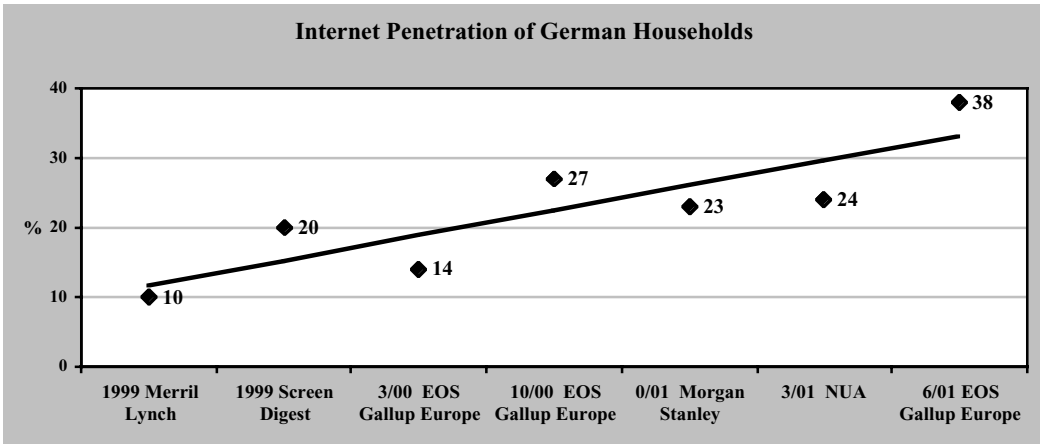
**Mobile Wireless (UMTS):** Based on a 'beauty contest' with a fixed fee of 5.1 billion, the French government issued two licenses to France Telecom and SFR in May 2001. As only these two companies applied for the four licenses on offer, the government plan to offer the remaining two in 2002. Arrangements have been made to pay the license fee in annual instalments, allowing for a lower final fee to be paid if the remaining two licenses are sold for less. Service is expected to begin in mid 2002, and the coverage obligation is to reach 80% of the population within 8 years.

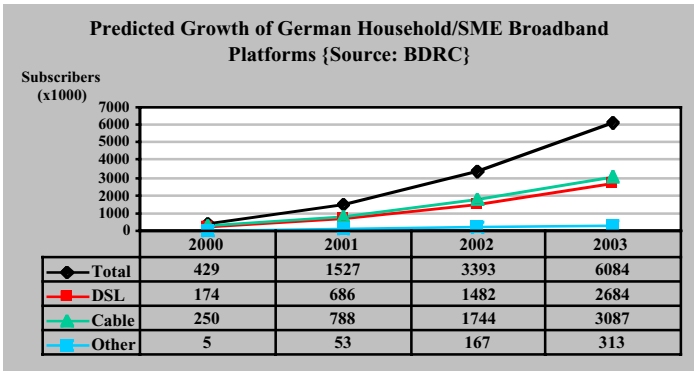
**Powerline:** There are no reports of Powerline projects in France.

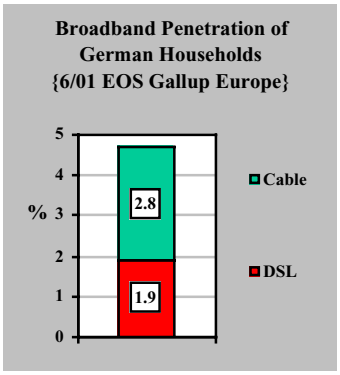
# GERMANY

| | |
|---|---|
| GDP[a]: | 22,712 Euro/annum/capita |
| Population[b]: | 82.2 m (87% urban)[l] |
| Households[c]: | 39.2 m |
| Main telephone lines[d]: | 49.4 m |
| Cable TV subscribers[e]: | 20.6 m |
| Satellite dish owners[f]: | 12.8 m |
| Mobile subscribers[g]: | 48.1 m |
| PC households[h]: | 14.9 m (38% of households) |
| Internet households[i]: | 10.6 m (27% of households) |
| Internet users[j]: | 24 m |
| Broadband subscribers[k]: | 0.43 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]EOS Gallup Europe 2000 [d]ITU 1999 [e-f]Screen Digest 1999 [g]ITU 2000 [h]Screen Digest 1999 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999



Germany will have one of the largest broadband markets of the European Union. Although Deutsche Telekom still dominate the telecommunications and cable TV infrastructures, they are open to competition and this has forced them to be proactive in offering broadband access.

ADSL will be the predominant broadband access platform. Although there are trials of alternative technologies such as Powerline and FWA, the choice of broadband platforms for the mass market is likely to be limited to ADSL where it is available. Although cable is widely deployed, it is a highly fragmented market with mostly ageing infrastructure.

The content provider Bertelsmann is a key player in the German broadband market. They have been working on broadband interactive content such as 'click through' television (a combination of the Internet and TV) and trials of broadband services began in April 2000. The proposed services would be available via cable or ADSL and would be offered for around 5 per month with additional charges to the customer for pay-per-view channels. The business model includes revenue from advertising (hence the majority of programmes are made available for free).

The content providers may force developments, but there is still considerable investment required in the infrastructure.

**ISDN:** User penetration is among the highest in Europe (12% of the households). This reflects Deutsche Telekom's pro-activity in marketing this technology for Internet access.

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** Germany is the most advanced country in Europe in terms of ADSL roll out. This is partly because there is a strong business case for ADSL, given the situation in the cable market, and partly because Germany began to introduce competition into the local loop as early as 1998.

Space in the local exchange was awarded selectively to the most viable businesses in each situation. New entrants then rent the copper line from Deutsche Telekom. There are now over 50 companies with access to the local exchanges in Germany. In addition to this, some of the largest DSL operators have chosen to build their own fibre optic networks between cities allowing them to offer high bandwidth business solutions via DSL linked to their own new backbone networks.

Deutsche Telekom first launched a DSL product for businesses in 1998 and has successfully continued to roll out the service to residential and business customers since then. In addition to a standard ADSL product, the company also offers ADSL over ISDN, a relatively straightforward conversion taking advantage of the large base of ISDN customers. Deutsche Telekom has two pricing structures, either a nominal monthly charge plus call charges or a fixed monthly charge only which they have recently lowered to 25. Such options and lowering prices should further encourage take up, particularly among the residential mass market.

KPNQwest has installed a 225 million fibre optic ring linking 16 German cities on to KPNQwest's European backbone network (EuroRing), which connects to 46 key European business centres. With this network in place, KPNQwest is now planning a European DSL service for businesses, with the first offers being made in Dusseldorf in July 2000. Although expensive to install, this network architecture has the advantage of independence from Member State's incumbent operators, and it allows upstream and downstream bandwidth capacity to grow with demand.

QS Communications have also built their own network connecting 40 German cities from which they are offering DSL over the existing copper local loops, initially to businesses. QS Communications have also been expanding their network by linking it to the network of Level3 Communications and have agreed to offer their DSL service from Worldcom's network. Furthermore, QS Communications have expanded their opportunities by providing a DSL solution to the cable operator PrimaCom, enabling cable customers in Leipzig and Halle to benefit from a Symmetric DSL connection with rates up to 2.3 Mbps.

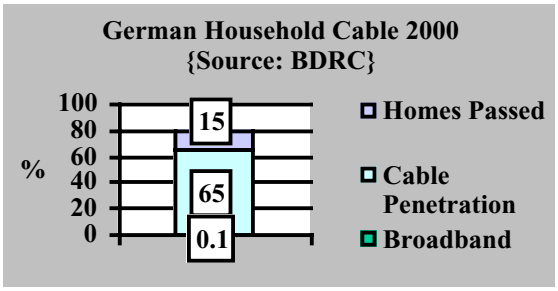
Another business DSL offer comes from VersaPoint and is available in Dusseldorf, Frankfurt, Hamburg, Cologne, Munich and Stuttgart. VersaPoint plans to offer ADSL to residential customers in the future.

| **Examples of DSL offers *** | **Data Rate Up/Down Kbps** | **Price* in Rent/month (installation)** |
|---|---|---|
| *Deutsche Telekom* (T-DSL) - Residential | 128 / 768 Kbps | 25 (?) or metered service |
| Business | 768 Kbps / 6 Mbps | 135-1590 (650-3900) |
| *QS Communications* - Business | 144 Kbps to 2.3 Mbps | 110-456 (252-777) |
| *KPNQwest* - Business | Up to 7.5 Mbps | ? |
| *First Telecom* (Atlantic) - Business (SDSL) | Up to 2.3 Mbps | ? |
| *KKF.net* | Up to 2300 | 289-1449 (296-890) |
| *Riodata* | From 256 to 8192 | 262-1702 (358) |
| *Versapoint* - Business | Up to 1500 | ISP package |

* Other players include Colt, and FirstMark

**Digital Terrestrial Transmission:** There is an ongoing debate about the need for DTT, given the high penetration of satellite and cable. DTT is unlikely to become a platform for Internet access in Germany, and the frequencies are more likely to be used for mobile or fixed wireless access in the future.

**Digital Cable:** With over 20 million subscribers, Germany is the largest cable market in Europe by a considerable margin. Cable is the principal TV broadcast medium: the vast majority of homes are passed by cable (around 80%) and the majority of homes subscribe to cable (c. 65%). Despite this, cable Internet penetration of homes is under 1% and is not likely to rise fast given the extent of network upgrading necessary.



Most of the cable networks in Germany need upgrading for two way transmission, but this process is currently being held back by Deutsche Telekom who control the 'trunk' network which lies between the centralised hubs (or 'head ends') and the link from the trunk to the customer. It is this complicated ownership, with operators owning the connection between the trunk and the customer, and other operators owning the principle distribution of content via satellite to the head ends, that has held up development. Deutsche Telekom is aiming to hand over responsibility for the trunk network in return for a 25.1% stake in the operating companies that sell the service to the end customer. Under German law a stake of over 25% gives a shareholder the power of veto on key decisions such as mergers and acquisitions. In this way, Deutsche Telekom will keep an interest in cable broadband as well as ADSL.

The largest regional network deal has been agreed between Deutsche Telekom and Callahan Associates, giving the later a 55% stake in the North Rhine-Westphalia network. Callahan Associates are planning a rapid upgrade of the 4.2 million homes, with the aim of offering Internet, video on demand, telephone and TV. Callahan Associates has also taken a 55% share in the Baden-Wuerttemberg network, which reaches 2.2 million homes.

UPC has also been acquisitive in Germany, buying EWT/TSS from Deutsche Telecom giving it the potential to offer broadband services to 1.1 million subscribers when the network is upgraded. UPC also has a minority share in PrimaCom, which has been offering broadband Internet access to the city of Leipzig since 1999 and will now expand to the whole of its network.

There also are a number of private cable companies such as TeleColumbus, Bosch Cable and Primacom which own their own 'head ends' and cable networks with no link to the Deutsche Telekom trunk network. Together these companies control around 22% of subscribers (4.4. million subscribers).

| **Examples of Cable Internet offers** | **Data Rate Up/Down Kbps** | **Price* in Rent/month (installation)** |
|---|---|---|
| *Komro* (only in Stadtgeviet and Rosenheim) | 26-500 / 64-2058 Kbps | 20-173 (0) |
| *PrimaCom* (only in Leipzig and Magdeburg at present) | 128 / 512 Kbps | 30 (?) |

**Digital Satellite:** Germany has the second highest household penetration of satellite dishes in the EU (38%), and is the largest market in Europe for satellite. This is despite the popularity of cable for broadcast TV. The reason for this is Premiere World, a pay TV product from Kirch Group, which offers a wider range of channels and access to exclusive programmes. Also, satellite offers a faster route to high quality digital TV than cable.

European Online had attempted to offer its two-way satellite connection in Germany, but withdrew because of technical difficulties. Current developments to provide Internet, or 'interactivity' via satellite, involve a fixed line for the return path. The German company Teles is offering a product called SkyDSL which can provide downstream speeds of up to 8Mbps, however this relies on a standard dial up or ISDN

connection for the upstream commands. The idea is that the satellite downstream is a supplement to the normal Internet connection for use when large amounts of data are to be received, but when fast interaction is not essential. There is no information on the success of this product, but suggestions that the company is targeting SMEs and larger businesses.

| Examples of Satellite Internet offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| Teles (SkyDSL) | 56 - 128Kbps / 4-8Mbps | 20 (153) |

**Fibre Optic:** Although there has been extensive laying of fibre optic backbone networks in Germany, there are currently no projects underway to offer fibre to the home. The company e-Biscom which is, through its subsidiaries FastWeb and Metroweb, offering fibre optic connections to businesses in Italy, also now owns the German telecommunications company HanseNet, which operates in Hamburg. There are plans to develop the HanseNet network into a FTTH product, but considerable investment is required.

As demand for bandwidth grows in the future, the cable companies may begin to extend the reach of their upgraded copper/fibre hybrid networks to the home and companies such as Sweden's Bredbandsbolaget may develop their interests in the German market.

**Fixed Wireless:** Implementation of FWA is developing well in Germany, and the first offers are now coming to market.

The Regulatory Authority for Telecommunications and Posts (RegTP) allocated licenses for specific geographical regions rather than for national coverage. Furthermore, in Germany the 10.15 - 10.65 GHz band is reserved for other applications and so was not included. A beauty contest was held in 1999, with a second round in 2000, and 662 spectrum blocks across 262 regions were awarded in the 3.5GHz and 26GHz on a cost based fee.

Details of the FWA licenses awarded are given in the table below:

| License winners | No. of licenses | Frequency Allocations |
|---|---|---|
| Viag Interkom* | 213 (Majority of households and SMEs) | 24-26 GHz and 3.4-3.5 GHz |
| Broadnet | 41 | 24-26 GHz |
| StarOne | 158 (73% of households, 85% of SMEs) | 24-26 GHz and 3.4-3.5 GHz |
| Associated Com. | 36 | 24-26 GHz |
| Callino (Formus) | 27 | 24-26 GHz |
| Deutsche LandTel | 10 | 24-26 GHz |
| First Mark | 114 | 24-26 GHz and 3.4-3.5 GHz |
| K-net | 52 | 24-26 GHz and 3.4-3.5 GHz |
| Tesion | 18 | 24-26 GHz and 3.4-3.5 GHz |
| Viatel | 2 | 24-26 GHz |
| Mannesmann Arcor | 198 | 24-26 GHz and 3.4-3.5 GHz |
| WinStar | 2 | 24-26 GHz |

The first to market with a wireless access platform are likely to be Firstmark who are building a network in the Hamburg area. The first offers are likely to be targeted at business customers. Callino is also planning to offer FWA in Munich. Currently, there are no reported plans to develop a service in the 40 GHz 'broadband' spectrum.

**Mobile Wireless (UMTS):** The German government raised 50.5 billion through the auction of six nationwide licenses in 2000. Each of the following consortia or companies paying around 8.4 Billion:

- E-Plus Huchison (KPN Mobile, NTT DoCoMo and Hutchison)
- Group 3G (Sonera and Telefónica)
- Mannesmann Mobilfunk (Vodafone)
- Mobilecom Multimedia (Mobilecom and France Telecom)
- T-Mobile (Deutsche Telekom)
- Viag Interkom (BT)

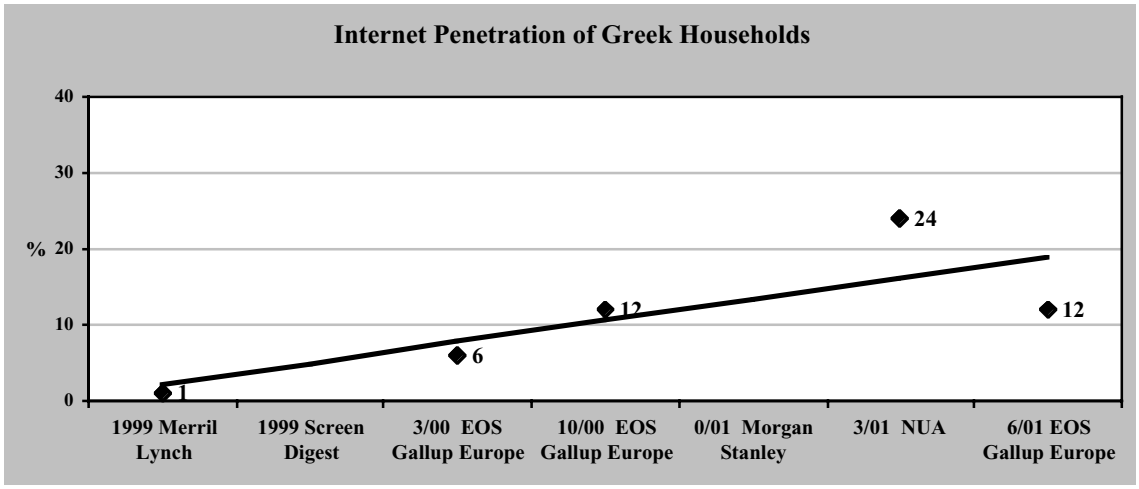
3G technology in Germany is likely to be up and running in the first quarter of 2002, but at connections speeds in the 100s of kbps rather than true 'broadband' speed as defined earlier in this report.

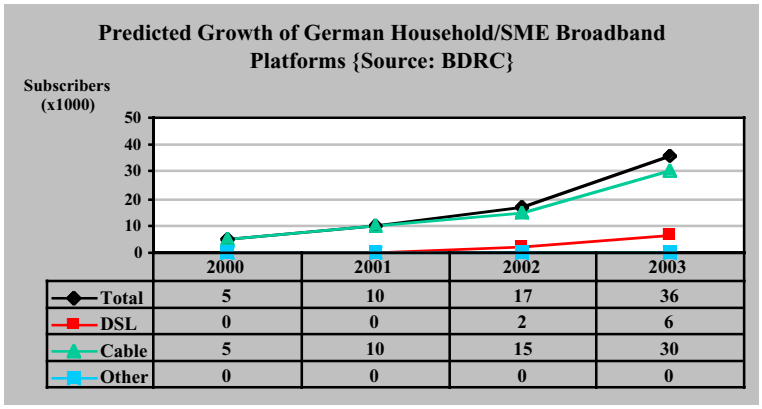
**Powerline:** Germany has been relatively active in developing and trialing Powerline technology. Oneline is currently offering high speed Internet access via Avacon's power network. Online is looking to expand its operations through partnership with electrical companies and has agreed a partnership with Sonera in Finland. The city of Cologne has been identified as suitable for Powerline technology by GEW/Siemens and NetCologne. And the German utilities companies Veba (through a company called Online) and RWE have also announced plans to offer a Powerline service.

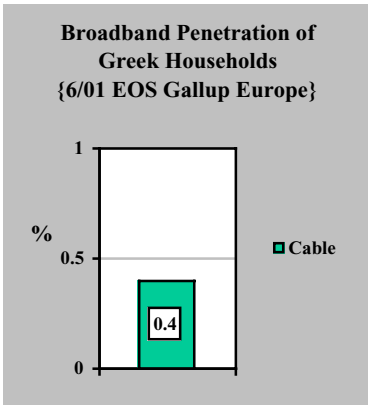
## GREECE

| | |
|---|---|
| GDP[a]: | 14,198 Euro/annum/capita |
| Population[b]: | 10.7 m (59% urban)[l] |
| Households[c]: | 3.8 m |
| Main telephone lines[d]: | 5.7 m |
| Cable TV subscribers[e]: | 0.8 m |
| Satellite dish owners[f]: | 0.1 m |
| Mobile subscribers[g]: | 6 m |
| PC households[h]: | 0.6 m (16% of households) |
| Internet households[i]: | 0.5 m (12% of households) |
| Internet users[j]: | 1 m |
| Broadband subscribers[k]: | 0.005 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]EOS Gallup Europe 2000 [d]ITU 1999 [e-f]EOS Gallup Europe 2000 [g]ITU 2000 [h]EOS Gallup Europe 2000 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999



Greece is the least developed of the Member States in terms of broadband access. Demand is relatively low compared to other Member States, and the fixed access market in Greece has been slow in adopting new technologies.

The geography of Greece, with much of its population spread across many small islands, makes it more suitable to wireless solutions such as terrestrial and satellite transmission.

**ISDN**: Only 1% of households access the Internet via ISDN.

**Leased Lines:** The Greek incumbent, OTE offer leased lines to SME businesses with large data transmission requirements.

**DSL:** There are no offers of DSL yet and OTE has not yet begun to unbundle the local loop.

**Digital Terrestrial Transmission**: Despite extensive analogue broadcast, there is currently little declared interest in DTT from broadcasters and no planned dates for introduction.

**Digital Cable**: According to EOS Gallup Europe, 8% of households subscribed to a cable service in 2000. And at 6/2001 0.4% of households accessed the Internet via cable. Currently, cable is the only broadband access platform emerging in Greece.

**Digital Satellite:** According to EOS Gallup Europe only 1% of households receive direct to home satellite transmission.

**Fibre Optic:** There are no reported plans to extend fibre to the home.

**Fixed Wireless:** Greece was the last Member State to offer licenses. The Hellenic Republic National Telecommunications and Post Commission, invited interested parties to tender by December 2000. The frequencies for which licenses will be allocated are 3.4 - 3.6 GHz and 24.5 - 26.5 GHz.

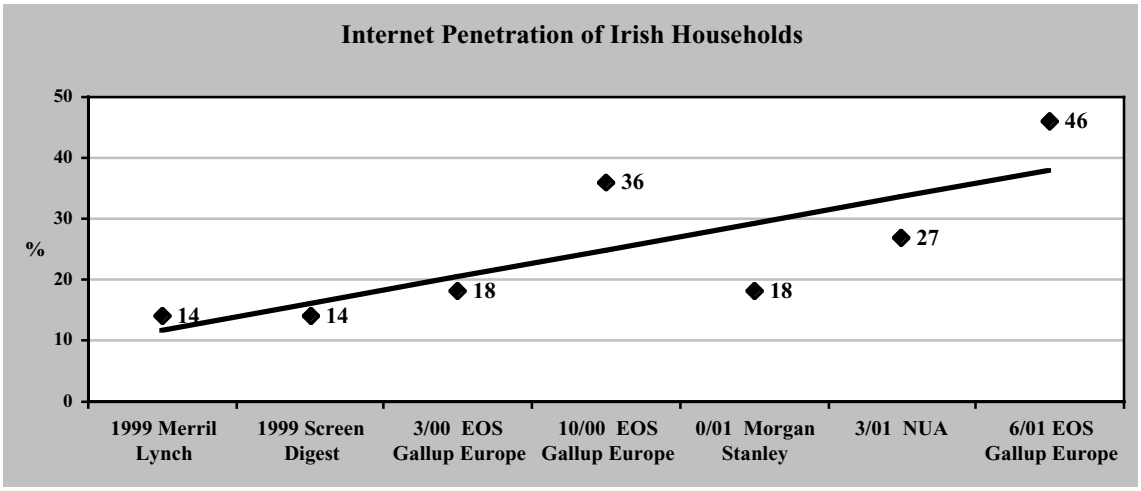
**Mobile Wireless (UMTS):** GSM mobile phones have been popular in Greece, as in other Member States, and 3G technology may become popular as an access platform to the Internet as well as a means of telephony. Although four licenses were available, only three companies actually took part in the auction, which was concluded on 11th July 2001. CosmOTE (OTE and Telenor), STET Hellas (Telecom Italia) and Panafon Vodafone each paid 143m.

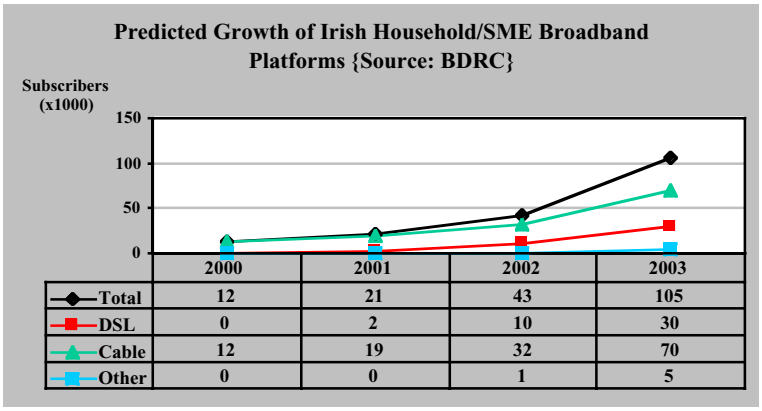
**Powerline:** There are no Powerline projects reported in Greece.

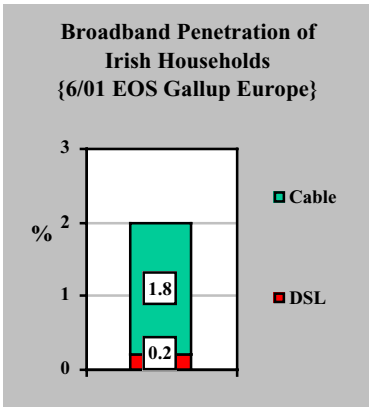
## IRELAND

| | |
|---|---|
| GDP[a]: | 24,133 Euro/annum/capita |
| Population[b]: | 3.7 m (58% urban)[l] |
| Households[c]: | 1.2 m |
| Main telephone lines[d]: | 1.6 m |
| Cable TV subscribers[e]: | 0.5 m |
| Satellite dish owners[f]: | 0.1 m |
| Mobile subscribers[g]: | 2.5 m |
| PC households[h]: | 0.3 m (23% of households) |
| Internet households[i]: | 0.2 m (20% of households) |
| Internet users[j]: | 0.8 m |
| Broadband subscribers[k]: | 0.01 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]Screen Digest 1999 [d]ITU 1999 [e-f]Screen Digest 1999 [g]ITU 2000 [h]Screen Digest 1999 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999



Ireland has been described as a hot prospect for the future of IT and broadband services, based on relatively high PC penetration in homes and relatively high levels of Internet usage. However, the incumbent Eircom has only just begun to offer ADSL, local loop unbundling has not yet occurred and the cable infrastructure is in need of extensive upgrading. All of these factors are likely to slow Ireland's arrival in the broadband era. Ireland was early to issue FWA licenses and this technology may be well suited to be the first to market with high-speed connections for the SME/residential market.

Despite the slow progress in developing the broadband infrastructure, companies such as Future TV have been active in developing video on demand products, which can run over cable or DSL networks when they become available.

**ISDN:** User penetration is relatively low with 2% of all households accessing the Internet via ISDN.

**Leased Lines:** There is a lack of high speed leased lines in Ireland, with most offers limited to under 2Mbps. Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** The telecommunication market was deregulated in 1999, and the incumbent, Eircom now faces competition from Esat Telecom (owned by British Telecom). Despite this, the development of DSL services has not yet begun in Ireland and the Irish telecoms regulator ODTR has scheduled local loop unbundling for April 2001.

Eircom began ADSL trials in Ennis in 1999, but considerable investment in infrastructure is required for a roll out of the service. However, Eircom may yet benefit from the experience of its part owners, Telia and KPN, who are now familiar with introducing ADSL services in Sweden and The Netherlands respectively.

**Digital Terrestrial Transmission:** Domestic DTT is available since 2000, and some parts of Ireland also receive OnDigital transmissions from the UK. The Irish radio and TV broadcaster, RTE, has been fairly actively involved in promoting the idea of using digital terrestrial broadcasting in bands 3, 4 and 5, not just for broadcasting but also for providing broadband Internet services as well as the normal broadcasting services.

**Digital Cable:** Cable is available in most urban areas of Ireland and passes over 75% of homes. Where it is available, it is very popular, and almost half (46%) of all homes subscribe. There are two principle operators, Cablelink (owned by NTL) and Irish Multichannel (backed by Independent Newspapers and AT&T), and these companies are in the process of upgrading their networks for two-way transmission. The first offers of Internet access via cable are about to be launched.

**Digital Satellite:** Only around 13% of households have a satellite dish, with most people preferring to gain access to DTV via a cable connection. There are no plans for two-way satellite in Ireland.

**Fibre Optic:** There are no reports of fibre to the home/curb projects in Ireland at present.

**Fixed Wireless:** Licenses were awarded in June and July 2000 by The Office of the Director of Telecommunications Regulation (ODTR). They require national coverage, and initially the distribution of programme services is not allowed. License holders are as follows:

| | |
|---|---|
| 20.029 - 2.281 GHz: | Eircom; Princes Holdings |
| 3.4 - 3.6 GHz: | Eircom; Princes Holdings |
| 24.5 - 26.5 GHz: | Eircom; Princes Holdings; Formus Com.; ESAT |

Currently, there are no reported plans to develop a service in the 40 GHz 'broadband' spectrum.

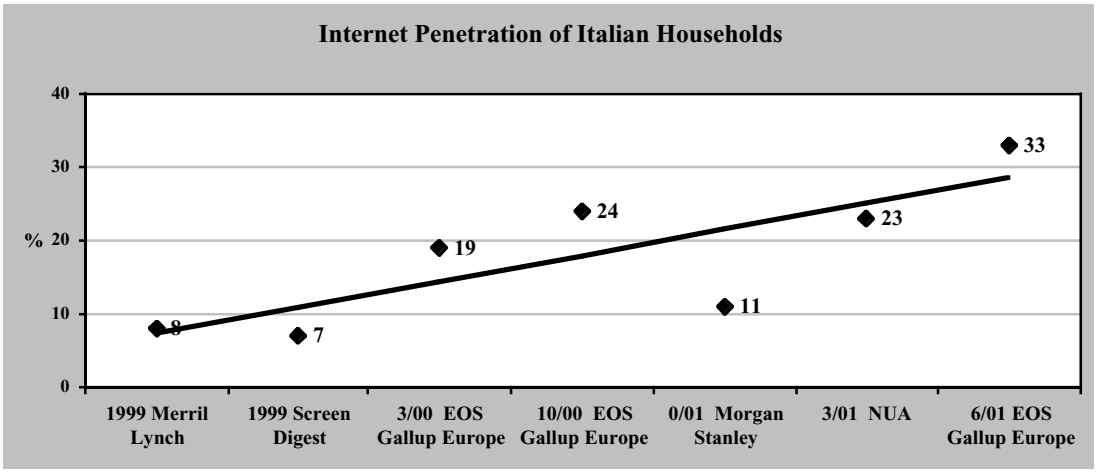
**Mobile Wireless (UMTS):** GSM mobile phones have been popular in Ireland, as in other Member States. The regulator ODTR will issue four 3G licenses this year (2001) and the two main GSM operators Eircell (Eircom) and Digiphone (Esat) are likely to do well in the beauty contest.

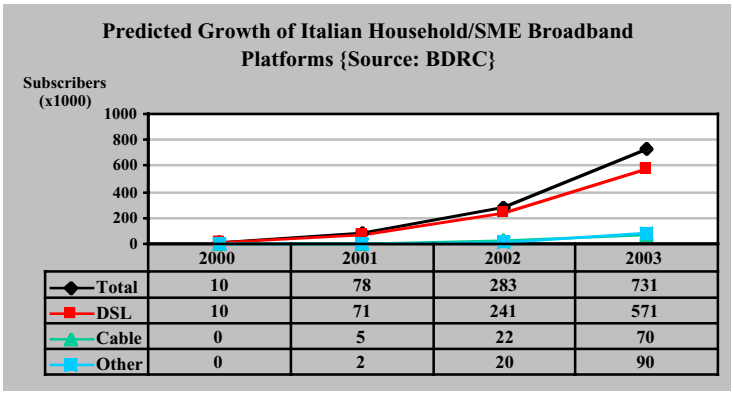
**Powerline:** There are no reports of Powerline projects in Ireland.

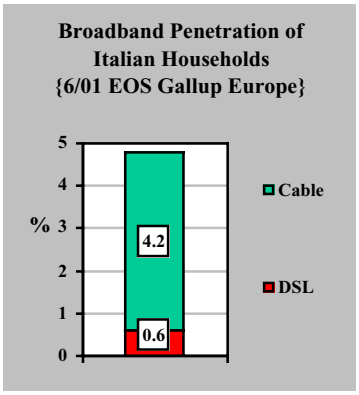
# ITALY

| | |
|---|---|
| GDP[a]: | 21,158 Euro/annum/capita |
| Population[b]: | 57.3 m (67% urban)[l] |
| Households[c]: | 19.4 m |
| Main telephone lines[d]: | 27.2 m |
| Cable TV subscribers[e]: | 0.1 m |
| Satellite dish owners[f]: | 1.2 m |
| Mobile subscribers[g]: | 42.2 m |
| PC households[h]: | 3.7 m (19% of households) |
| Internet households[i]: | 3.5 m (18% of households) |
| Internet users[j]: | 6 m |
| Broadband subscribers[k]: | 0.01 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]Screen Digest 1999 [d]ITU 1999 [e-f]Screen Digest 1999 [g]ITU 2000 [h]Screen Digest 1999 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999




NB: The 6/01EOS Gallup Europe figure for household cable penetration appears high. This may due to an interpretation error in which survey respondents with FTTH answered cable. Other industry analysis suggests that there have been no cable Internet offers in Italy to date.

Initially, Italy was slow to adopt the Internet, compared to some other Member States. However this situation has been changing rapidly in the last year, as Italian banks and big businesses have announced aggressive Internet strategies. In this environment, future demand for broadband is likely to be high, particularly in the North of the country. Mobile phones have been especially popular in Italy, and so Italy is likely to be a key market for 3G.

The incumbent, Telecom Italia, controls the legacy telecommunications infrastructure (full access to the local loop has not happened) and the DTV infrastructure. This dominance is slowly being eroded as competitors build new independent networks.

There is virtually no competition from cable in Italy, and so DSL solutions are well placed to capture the broadband market. Because of the lack of competition from cable, Italy is seen as having potential for alternative technologies such as FTTH, two-way satellite, Powerline, and FWA.

Italy has a unique legacy network architecture, which affects the way DSL technologies are implemented. The distance from the local exchange to the home/business is relatively short. This means that DSL operators can achieve higher speeds in Italy than in other Member States, and there is the possibility to offer VDSL or SDSL as well as ADSL. However, this network architecture also means that there are many more local exchanges and each of them is physically smaller as it contains fewer connections to customers. Rather than attempting to gain access to many relatively small local exchanges, new entrants have preferred to build their own networks from scratch. Initially, these network builders have focused on high bandwidth solutions for the business market.

The medium term prospects for the residential market look promising. Italy has numerous ISPs which are now offering ADSL products. They are offered over a choice of networks, and content developers such as Stream will generate demand for broadband connections in the future.

**ISDN:** Although 11% of fixed lines use IDSN, most of them are for business use. Household penetration of ISDN as an Internet access platform is relatively low at just 2% (in 2000).

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** The deregulation of the telecommunications industry in 1998 involved the issuing of licenses to around 50 new entrant companies to construct and operate their own networks and, in so doing, provide competition to the incumbent, Telecom Italia.

Telecom Italia was the first to offer ADSL in September 1999. Their product, Turbolinea ADSL was initially made available to a trial group of 300 Tin.it subscribers across 25 cities (tin.it is the name of Telecom Italia's ISP).

Full local loop unbundling has not yet occurred in Italy and the operation of the copper local loop remains the responsibility of Telecom Italia. Following a ruling by

the Italian Competition and Market Antitrust Authority in December 1999, Telecom Italia was allowed to offer its own retail ADSL product, but was also required to offer its ADSL lines on a wholesale basis to ISPs and other operators wishing to offer ADSL. Following this partial unbundling of the local loop, the ISP Infrostrada (then owned by the German company Mannesmann) began to offer ADSL over Telecom Italia equipment in 11 cities. Other ISPs also offering ADSL over Telecom Italia's equipment are Dada, Galactica, Informatica Commerciale, Internet Village, Nextra, Pro.Net, Telvia, Unidata and Unisource.

| **Examples of ADSL offers** | **Data Rate Up/Down Kbps** | **Price* in Rent/month (installation)** |
|---|---|---|
| *Telecom Italia* (Tin.it ADSL) - Residential, ADSL | 128 / 640 kbps | 138 (82) |
| *Telecom Italia* (Ring) - Business, VDSL | 155 Mbps | ? |
| *Mannesmann* (Infostrada Net24) - Business, ADSL | ? | ? |
| *KPNQwest* (ADSLink & ADSLight) - Business ADSL | 8 Mbps | ? |

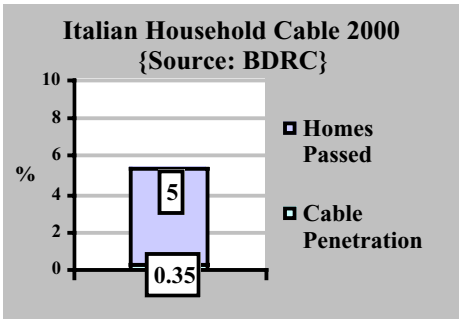
In 1999 KPNQwest entered the Italian ADSL market by buying the independent ADSL operator Comm2000. This gave KPNQwest access to the business broadband market via Comm2000's own high-speed ADSL network. Following this, KPNQwest have negotiated access to Telecom Italia's local exchange in order to install their own equipment which would allow them to offer an ADSL product with speeds up to 8 Mbps.

Cable & Wireless have recently bought the company Unidata, owner of the brand Smart. Under Smart there are two ADSL offers: Basic and Plus, which are available over Unidata's own network.

Another new entrant to the ADSL market is the company Albacom (owned by BT, Banca Nazionale del Lavoro, energy group ENI and media group Mediaset). They will offer ADSL via their own local networks which will be linked to ENI's 3,000 km national fibre optic network, which in turn will be linked to BT's 45,000 km pan-European fibre optic network (known as Farland). Albacom will market its ADSL offer via Italian ISPs such as Kataweb, Jumpy and Infinito.

**Digital Terrestrial Transmission:** DTT transmissions are currently planned for 2002, with analogue switch off in 2006. However, it is likely that the transition to digital will take longer than anticipated.

**Digital Cable:** Cable penetration in Italy is very low, with only 5% of homes passed and just a fraction of a percentage point of households subscribing to cable TV.




Cable was introduced to Italy by Telecom Italia in 1996 under a subsidiary company called Stream. Although relatively small in scale, it was the first fully digital network in Europe at the time. Telecom Italia subsequently decided that the investment required to roll out cable to a wider market would be too high, and that direct to home satellite would be a more cost effective platform for DTV in Italy.

Stream, which is also owned by News Corporation and Microsoft's Web TV, have developed from cable operator to broadband content provider and have developed a broadband DTV product which can be transmitted via cable, ADSL or fibre optic.

**Digital Satellite:** Although satellite penetration is currently fairly low (13% in 2000), it is growing rapidly and is expected to reach 50% by 2003. This is partly because of Telecom Italia's decision to promote satellite DTV though its company Stream. Competition from Canal Plus has further intensified the need to capture market share.

Since 1999, satellite has become a preferred medium in Italy as Telecom Italia (via their satellite company Telespazio) invested some 440 million into a 3,960 million global broadband Internet and intranet project managed by Lockhead Martin and TRW in the US. Although this project is for an international communication backbone, and is not a direct to home solution, there are spin-offs for Telespazio in terms of developing satellite technologies for information transmission.

If and when the technology is developed to a sufficient level, Italy will be a prime market for a direct to home, two-way satellite connection. Indeed Astra (operated by SES) is currently targeting the Italian market with a product offering high speed downstream via satellite and upstream via the telephone line. It is also developing a two-way system, which will initially be offered to businesses.

**Fibre Optic:** There has been extensive fibre optic network construction in Italy, and a number of fibre to the home projects are being proposed. E-Biscom owns the companies Fastweb and Metroweb, both of which are involved in developing FTTH in Italy. FastWeb is now offering a FTTH service to businesses in the suburbs of Milan. Their plan is to roll out a similar service to 12 other Italian cities by 2003 and they have drawn up a business plan based on residential fibre to the home throughout Italy for a subscriber fee of just 50 per month.

| Examples of Fibre-to-the-Home offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| FastWeb - businesses in Milan suburbs | 10 - 100 Mbps | 362 (516) |

The Italian public broadcaster RAI is collaborating with FastWeb in developing broadband content including video on demand, and the Swedish FTTH provider

Bredbandsbolaget (B2) is also collaborating with FastWeb in developing the infrastructure and regulatory framework to make FTTH possible.

**Fixed Wireless:** Italy is likely to be one of the last Member States to allocate FWA licenses. This is despite significant interest from industry in developing a FWA solution to compete with Telecom Italia's dominance of the local loop.

The Communications Regulatory Authority is planning to allocate licenses in the summer of 2001 in the 24.5 - 26.5 GHz band and the 27.5 - 29.5 GHz band. There are also plans to offer the 40.5-43.5GHz band. So the 24.5 - 26.5 GHz and the 27.5 - 29.5 GHz bands are likely to be developed first for point-to-multipoint services marketed at SMEs. In the future, operators may move up to 40GHz as services evolve towards broadband and extra bandwidth is required.

Given that FWA and satellite are both wireless, microwave, data transmission technologies, there could be some synergies between the two.

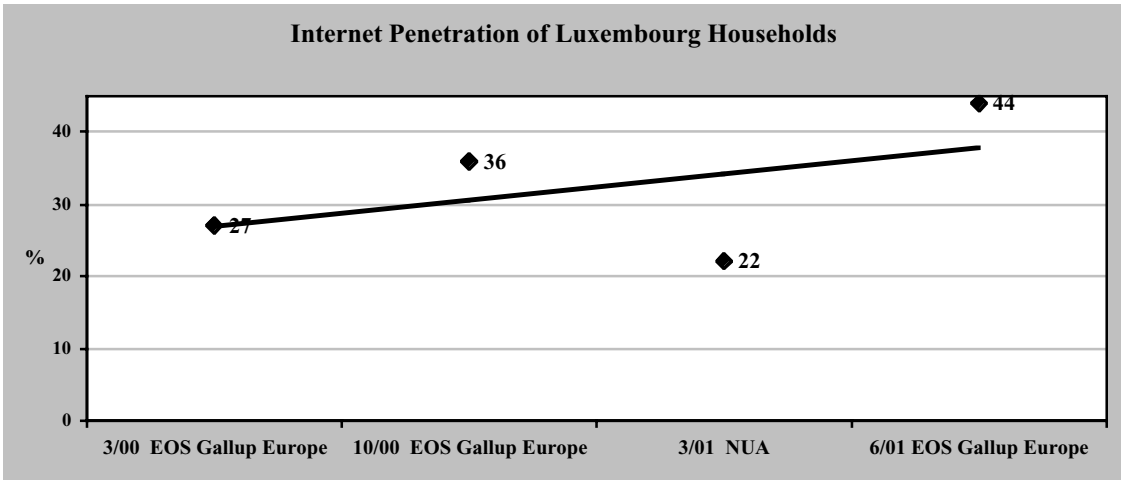
**Mobile Wireless (UMTS):** GSM mobile phones have been hugely popular in Italy and so there is great potential for 3G. The auction of licenses was highly controversial, following the last minute withdrawal of the Blu consortium and the subsequent acceptance of the five remaining applicants despite their lower than expected bids. However, licenses were awarded in October 2000 and service is likely to begin in the first quarter of 2002. The holders are: H3G (Hutchinson consortium); Ipse (Telefonica and Sonera); Wind (Enel and France Telecom); Omnitel (Vodafone); and Telecom Italia Mobile. The coverage obligations are regional capitals within 30 months, and provincial cities within 60 months.

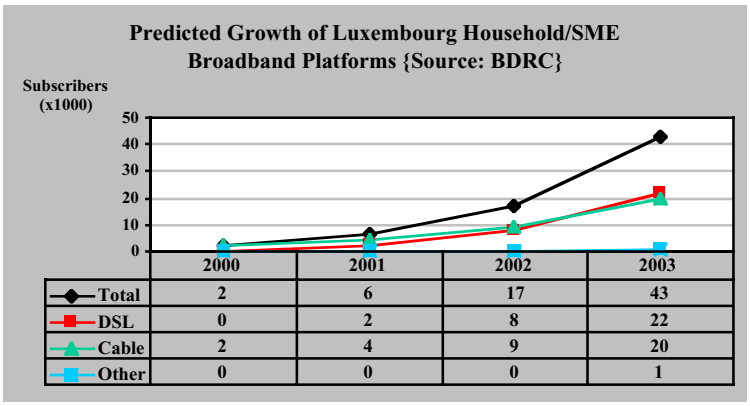
**Powerline:** The Italian utility companies AEM and Enel have both successfully tested data transmission over Powerlines in Italy. AEM, using Nortel equipment, has estimated that around 10% of its customers (45,000 people) would be interested in receiving the service. Despite these tests, there have been no commercial offers of Powerline as yet.

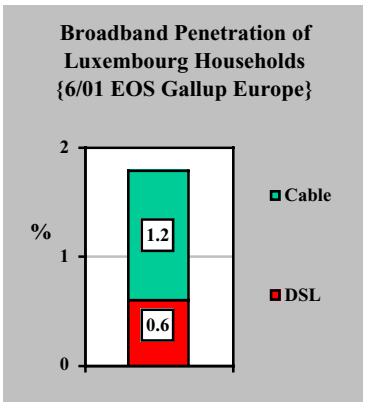
# LUXEMBOURG

| | |
|---|---|
| GDP[a]: | 38,773 Euro/annum/capita |
| Population[b]: | 0.4 m (89% urban)[l] |
| Households[c]: | 0.3 m |
| Main telephone lines[d]: | 0.3 m |
| Cable TV subscribers[e]: | 0.3 m |
| Satellite dish owners[f]: | 0.05 m |
| Mobile subscribers[g]: | 0.3 m |
| PC households[h]: | 0.17 m (57% of households) |
| Internet households[i]: | 0.1 m (36% of households) |
| Internet users[j]: | 0.1 m |
| Broadband subscribers[k]: | 0.002 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c] EOS Gallup Europe 2000 [d]ITU 1999 [e-f]EOS Gallup Europe 2000 [g]ITU 2000 [h]EOS Gallup Europe 2000 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999



PC penetration is high, and around a third of all households are connected to the Internet. The most likely high-speed access platform currently offered is ISDN. Although the cable access is universal, very few connections have been upgraded for Internet connection and DSL roll-out is only just beginning. However, Luxembourg is a very small country, both geographically and in terms of population with a high GDP, so it would be possible to install an access platform fairly rapidly. This makes the installation of Fibre to the home more possible in Luxembourg than in some other Member States.

**ISDN:** Luxembourg has the highest penetration of ISDN lines in Europe (15%).

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** The incumbent EPT Luxembourg has begun to roll out ADSL in some parts of the City of Luxembourg. Speeds of up to 1Mbps downstream and 128Kbps upstream are available for 74.4/month plus 3/hour (peak rate).

**Digital Terrestrial Transmission:** There are no reported plans for DTT.

**Digital Cable:** Analogue cable transmission is the principle means by which people in Luxembourg receive TV and almost all homes have a cable connection. However, only a small minority of homes have been digitally. There is considerable investment required to upgrade the ageing cable network.

**Digital Satellite:** Satellite is the most likely DTV platform. And satellite penetration is currently at around 16% of all households.

**Fibre Optic:** There are no reported plans for fibre to the home.

**Fixed Wireless:** Licenses are being awarded on a 'first come, first serve' basis. However, license holders are restricted to telecommunication services and so FWA is not planned to become a broadband access platform in the near future.

3.4 - 3.6 GHz: BCE, First Mark
24.5 - 26.5 GHz: BCE, First Mark

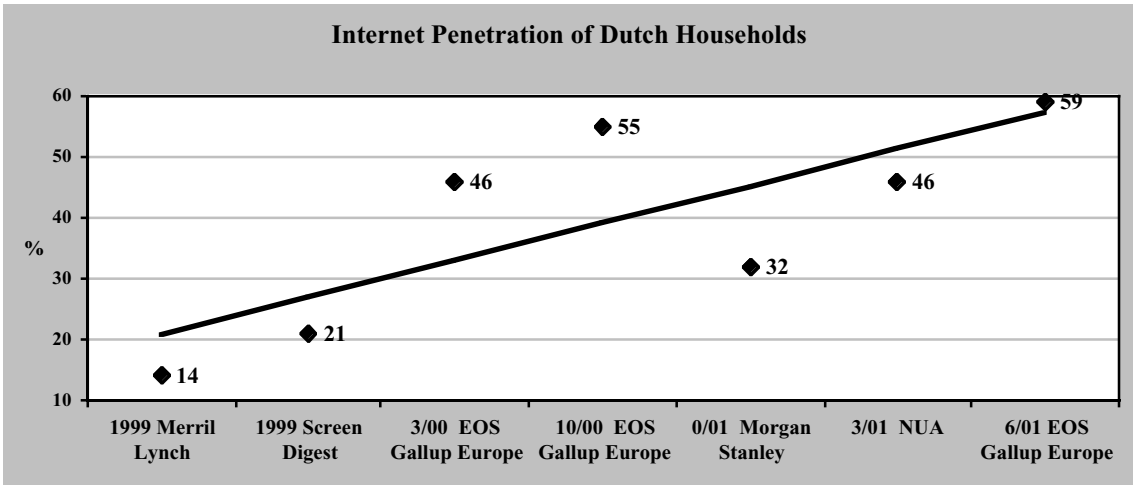
**Mobile Wireless (UMTS):** A beauty contest is planned in the last quarter of 2001, at which four licenses will be offered. Winners will pay an annual fee of 0.2% of turnover.

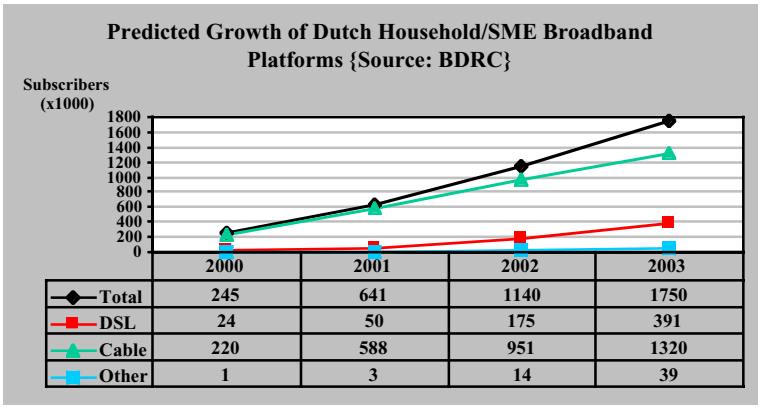
**Powerline:** There are no reported plans for Powerline transmission.

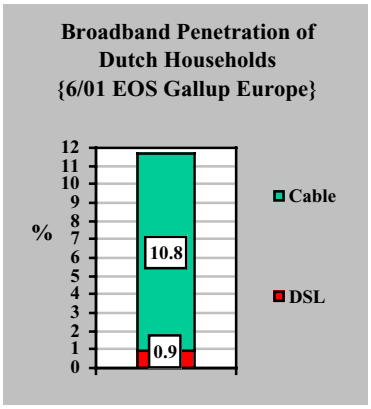
## THE NETHERLANDS

| | |
|---|---|
| GDP[a]: | 23,838 Euro/annum/capita |
| Population[b]: | 16 m (89% urban)[l] |
| Households[c]: | 7 m |
| Main telephone lines[d]: | 9.6 m |
| Cable TV subscribers[e]: | 6.1 m |
| Satellite dish owners[f]: | 0.3 m |
| Mobile subscribers[g]: | 10.7 m |
| PC households[h]: | 3.8 m (54% of households) |
| Internet households[i]: | 3.2 m (46% of households) |
| Internet users[j]: | 3.8 m |
| Broadband subscribers[k]: | 0.25 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c] EOS Gallup Europe 2000 [d]ITU 1999 [e-f]Screen Digest 1999 [g]ITU 2000 [h]Screen Digest 1999 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999



The Dutch government has been proactive in encouraging the development of the Internet and advanced information technologies. For example, they have begun the GigaPort initiative, which aims to develop a 'knowledge platform' and pilot testing ground for new ICT applications. Also, there is an initiative called Kenniswijk (knowledge neighbourhood) which aims to establish public-private partnerships by establishing the city of Eindhoven as a testing ground for broadband technologies.

Combining this commitment to the digital era, and the high demand for the Internet and other new technologies in The Netherlands, makes it a good prospect for broadband technologies. Furthermore, the Government is keen to promote competition within the cable networks as well as through local loop unbundling, and so The Netherlands is likely to evolve into one of the most open markets for broadband access in Europe. It is likely that broadband cable access will eventually be rolled out to the vast majority of households. However, over the next two years there will also be competition from ADSL, which looks well placed to capture market share before the cable operators have extended their reach through upgrading. In five years time, it is likely that the Dutch will have a choice of access competing access platforms perhaps including fibre to the home.

**ISDN:** Over one in ten households access the Internet using an ISDN line. This makes ISDN relatively popular in The Netherlands compared to other Member States, and may indicate a substantial potential market for ADSL.

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** There has been self-imposed open access to the local exchanges since 1996, although officially unbundling occurred in 1999, with the regulator OPTA setting relatively low tariffs to encourage competition. The first offers of ADSL appeared in 1999 from the incumbent KPN. However, the emergence of a competitive environment for ADSL has been slow to arrive.

The KPN ADSL offer, with the brandname Mxstream, is being rolled out and will be available from most exchanges by 2003. At present, subscribers to Mxstream also need to sign up to an ADSL enabled ISP such as Planet Internet, XS4ALL, Sonera, Worldonline, or Euronet Internet.

Atlantic Telecom, which offer SDSL to German SMEs, has recently purchased a majority stake in the Dutch company Telepartner Plus. This gives Atlantic Telecom access to around 500,000 SMEs in The Netherlands and it is likely that they will try to gain access to the local exchanges in order to offer their SDSL product.

Casene Enschede was one of the first companies to offer ADSL in The Netherlands. It targeted businesses and non-profit organisations such as schools and libraries. It is now piloting a project offering ADSL to the students and staff of the Technical University in Twente which, if successful, could encourage the Casene Enschede to go into the residential market.

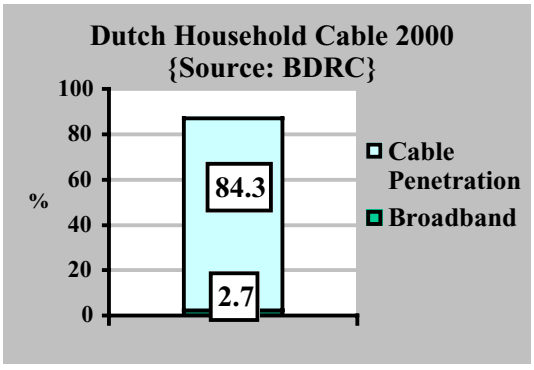
The Dutch company Versatel, in partnership with Northpoint of the US, is planning to provide ADSL to businesses in the Benelux countries and Germany under the company name of Versapoint. Versatel is also planning to attract market share by offering a business ISP product using KPN ADSL lines. This will be branded Zonnet Breedband.

| Examples of ADSL offers | Data Rate Up/Down Kbps | Price* in Rent/month (installation) |
|---|---|---|
| *KPN* (Mxstream Basic) - residential | 64 / 512 Kbps | 23 (?) |
| *KPN* (Mxstream Extra) - residential | 256 Kbps / 1 Mbps | 30 (?) |
| *KPN* (Mxstream Office) - business | 64 / 512 Kbps | 39 (?) |
| *KPN* (Mxstream Office Extra) - business | 256 Kbps / 1 Mbps | 45 (?) |

Given the significance of cable in The Netherlands, there is notable interest in ADSL. Clearly, there is still a long way to go in upgrading the cable infrastructure and ADSL has the potential to capture a significant share of the market. The perception of OPTA is that ADSL will provide strong competition to cable in the consumer market, but that DSL will only attract the business market in the short term.

**Digital Terrestrial Transmission:** DTT has been available since 2000 from Digitenne. However, there are no reported plans to develop a two-way broadband access platform using this technology.

**Digital Cable:** Almost all of Dutch households subscribe to CATV (96% in 2000) and in 2000, almost 3% of households used cable access for a broadband connection to the Internet.




The cable market has evolved from its legacy as a disparate collection of municipally run local networks to a competitive free market.

The industry is dominated by three main players: UPC is the largest cable operator (35% of the market); France Telecom is the second largest player since its acquisition of Casema from KPN in 1998; and Essen is the third largest player. After this there remains a number of much smaller, regional companies. However, an alliance of nine of these smaller players has formed into a group called Mediakable, benefiting from shared technology and content. Some smaller cable Internet providers include bART, Brunssum.net, Kabelfoon, Zeelandnet and Tebenet.

UPC's broadband Internet product called Chello has shown an impressive growth rate with over 200,000 subscribers in 2000. UPC recently acquired the cable Internet business Quicknet, previously a competitor and owned by the Finnish incumbent Sonera. However, its aggressive roll-out plans were recently set back after criticism of service levels to existing customers and a lack of capital to sustain the business plan. These problems have lead to a slow down in the growth rate of UPC, and a collapse in merger plans with ExciteAtHome.

| Examples of Cable Internet offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| *UPC* (Chello) - residential | 128 / 512 Kbps | 40 (135) |
| *ExciteAtHome* (AtHome) - residential | ? | 40 (136) |
| *France Telecom* (Casema) - residential | 32-64 / 96 - 160 Kbps | 41 - 54 (82)* |
| *Sonera* (QuickNet) - residential | 64 / 512 Kbps | 36 - 41 (107 - 164) |

There is a current debate in The Netherlands about opening up the cable networks to ISPs and other businesses wishing to offer broadband access alternatives. As yet, this is unresolved. However, the Dutch regulator OPTA has suggested that the cable access is in need of some regulation to allow access to alternative providers as well as controls on mandatory content.

**Digital Satellite:** Satellite penetration in The Netherlands is relatively low (8% of households in 2000). This is not suprising given the popularity of cable for TV and the commitment of cable operators to upgrading for DTV via cable.

A satellite Internet service has been available from Internet Access Nederland via Astra since 1996, and a company called Ision has been offering a similar service via Eutelsat targeted at businesses. However, both require a fixed line connection for the upstream path and so are not truly 'broadband' two-way access. Europe Online had attempted to offer a two-way connection in The Netherlands and across Europe for 15/month, but technical problems forced it to focus on interactive TV rather than Internet usage.

| Examples of Satellite Internet offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| *Internet Access Nederland* (upstream by standard dial up) | 34-64 / 400-800 Kbps | 16 (85) |
| *Ision* (upstream by ISDN) | 64-128 / 256 Kbps<br>64-128 / 512 Kbps<br>64-128 Kbps/ 1 Mbps<br>64-128 Kbps/ 2 Mbps | 406 (2,949)<br>678 (2,949)<br>951 (2,949)<br>2,176 (2,949) |

**Fibre Optic:** There have been predictions that the business (SME) market in The Netherlands is likely to demand fibre optic within the next 10 years. The government's GigaPort and 'Kenniswijk' (knowledge neighbourhood) projects are specifically aimed at providing a live opportunity for industry to test fibre to the home and related technologies. This is likely to attract fibre providers to The Netherlands and provides an example of how the technology could operate in practice.

Independent from government initiatives, the incumbent, KPN has provided fibre to the basement of an apartment block in Amsterdam as a test project. The apartment has an internal Intranet, which enables residents to transmit data at speeds of up to 1.2 Gbps. The Swedish company Bredbandsbolaget (B2), has also expressed its intention to offer fibre to the home in the Benelux countries by forming a joint venture with Continuum Group, an investment specialist.

**Fixed Wireless:** In October 2000, the Dutch regulator OPTA offered licenses in the following frequencies: 2.4 - 2.62 GHz; 3.4 - 3.6 GHz; 24.5 - 26.5 GHz. Since then there has been a delay in allocating licenses whilst a dispute between Telfort (backed by BT) and the regulator is resolved. Telfort claims it was unfairly excluded from the allocation on the grounds that it already held a national license for fixed telecommunications in The Netherlands.

The allocation of the 27.5 - 29.5 GHz and 40.5 - 43.5 GHz for MWS (MVDS) is under consideration.

**Mobile Wireless (UMTS):** The five GSM mobile operators currently providing a service were all winners of UMTS licenses in July 2000. They are Libertel (majority owned by Vodafone), KPN, Dutchtone (France Telecom), Telfort (British Telecom), and 3G-Blue (Deutsche Telekom, Belgacom & Tele Danmark).

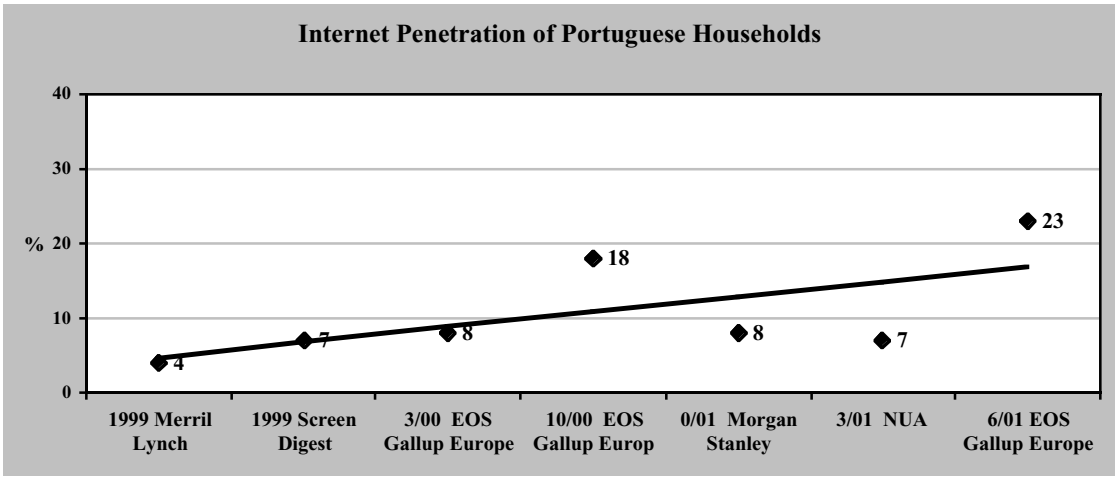
During the process, there was a dispute between Telfort, Versatel (who were also bidding, but pulled out at the last minute), and OPTA. Dutch competition authorities have suspected malpractice in rigging the auction, and are currently investigating Telfort and Versatel. The income from the auction was 2.68 billion, considerably lower than the 9 billion expected. This has fuelled the Dutch government's concern of improper behaviour.

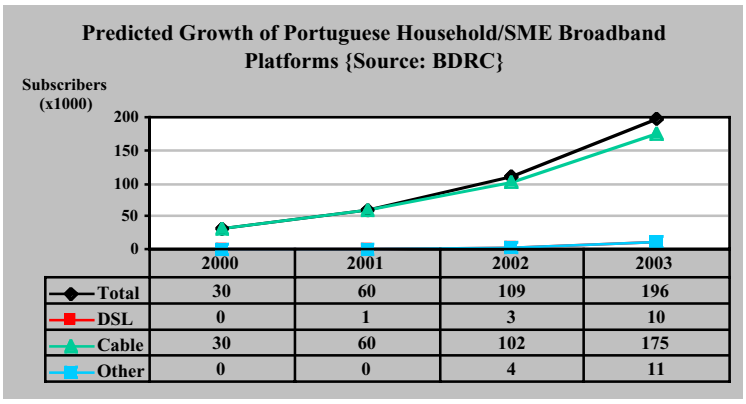
**Powerline:** There are no reports of Powerline projects in The Netherlands at present.

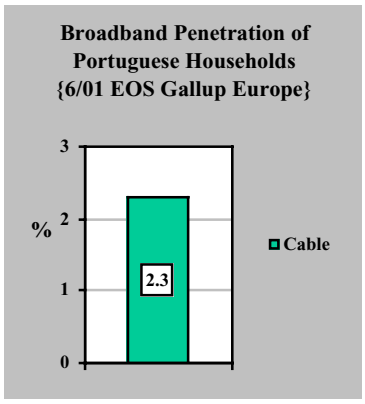
# PORTUGAL

| | |
|---|---|
| GDP[a]: | 16,065 Euro/annum/capita |
| Population[b]: | 10 m (56% urban)[l] |
| Households[c]: | 3.4 m |
| Main telephone lines[d]: | 4.3 m |
| Cable TV subscribers[e]: | 0.8 m |
| Satellite dish owners[f]: | 0.4 m |
| Mobile subscribers[g]: | 6.7 m |
| PC households[h]: | 0.6 m (18% of households) |
| Internet households[i]: | 0.6 m (18% of households) |
| Internet users[j]: | 2 m |
| Broadband subscribers[k]: | 0.03 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]Screen Digest 1999 [d]ITU 1999 [e-f]Screen Digest 2000 [g]ITU 2000 [h]Screen Digest 1999 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999



Although some cable subscribers can connect to the Internet at high-speed, the overall enthusiasm for the Internet has not been as great as in most other Member States. Only around one in ten people are regular users of the Internet in Portugal, and there has been no evidence of the sharp rises in penetration observed in other European countries. The government has launched a scheme to encourage people to get connected by connecting all schools by the end of 2001 and encouraging e-commerce and residential use by increasing the amount of Portuguese content on the Internet. This may stimulate take up.

The incumbent, Portugal Telecom, dominates the telecom, cable and satellite markets and so is under little competitive pressure to roll-out broadband services. Although this situation will change, and interactive TV is planned by Portugal Telecom, things are likely to develop slowly.

Great hope of competition comes from FWA. The frequencies have been allocated and the first offers are likely to get to market within the next year or two. FWA licenses have been awarded on the basis that they compete with telephony, high-speed data transmission, and TV broadcast services.

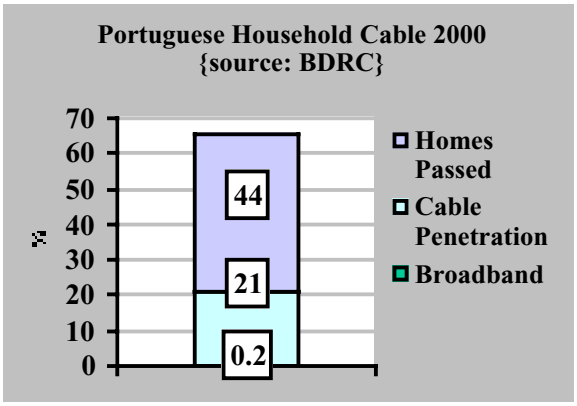
**ISDN:** As might be expected, given the relatively low adoption of the Internet by the Portuguese, ISDN penetration is very low (0.5% of households).

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** The local loop has not yet been unbundled, although ICP, the Portuguese telecom watchdog, had set a provisional target of June 2001. Portugal Telecom is now fully privatised but remains the only operator providing telecom services to the residential and SME market. Portugal Telecom has made no DSL offers to the residential/SME market yet, and there is little pressure for the company to do so at present. However, they have conducted an ADSL trial in Lisbon and Aveiro, and have announced a commitment to make their first public offers in 2001. An ATM based DSL service from Portugal Telecom is available to larger businesses.

**Digital Terrestrial Transmission:** Trials have been underway since June 1998, but it is unlikely that services will commence before 2002.

**Digital Cable:** The majority of Portuguese homes (65%) are passed by cable, and a quarter (24%) of households subscribed in 2000. There was a very fast growth in subscriptions between 1999-2000 (24% growth overall, with up to 55% growth in the central regions).




TV Cabo, owned by the telecom incumbent, Portugal Telecom, is the largest cable operator with a 92% share of the market. Cabovisão has a

further 7% of the market and there are two other, smaller, operators and two companies which have licenses, but which do not yet offer a service. TV Cabo claims to have made swift progress in upgrading the networks to two-way digital connections with three quarters of its market now enabled. This development has focused on the urban populations, particularly in Lisbon and Oporto.

The competitive position in the cable market is clearly limited by the dominance of TV Cabo. Portugal Telecom also controls the satellite direct to home market as well as the rest of the telecommunications market. In the pay TV market, TV Cabo has experienced an annual growth rate of over 100% for the last three years giving it a customer base of 640,000 subscribers and complete national coverage via digital cable or satellite.

Although DTV is fairly popular in Portugal, the cable Internet market has been much slower to develop. The first cable modem packages where made available by TV Cabo in November 1999 and Cabovisão in January 2000, but initial adoption of the service had been slow. There are a number of initiatives likely to drive demand for interactive services. For example, Mircosoft acquired a small stake (2.5%) in TV Cabo with a view to developing interactive video and TV Cabo is now piloting an interactive service among 1,000 households under a new subsidiary TV Cabo Interactiva. There have also been some changes in the structure of TV Cabo resulting in the spin off company PT Multimedia (PTM) which will be responsible for a subsidiary dedicated to Internet services and which will control the main Portuguese portal Sapo, the Brazilian portal Zip.net and the ISP Telepac.

| **Examples of Cable Internet offers** | **Data Rate Up/Down** | **Price* in Rent/month (installation)** |
|---|---|---|
| *TV Cabo* (Netcabo) | ? / 640 Kbps | 43 (75) |
| *Cabovisão* (Netvisão) | 128 / 512 Kbps | 55 (50) |

**Digital Satellite:** Satellite dish penetration is growing fast from a low base (in early 2000, 13% of homes had a satellite dish). Satellite broadcast is available nationwide. The attraction of satellite is for DTV and pay channels and not for data transmission.

**Fixed Wireless:** The following fixed wireless licenses where awarded in December 1999 by the ICP and ICS (Instituto da Comunicacao Social):

3.6-4.2 GHz: E3G (Onitelecom); Sonae; Maxitelsat
24.5-26.5 GHz: Sonae; E3G (Onitelecom), Jazztel Portugal; Eastécnica; Teleweb; Telecel
27.5-29.5 GHz: WTS; Bragatel

The 3.6-4.2 GHz band is specified for low data rate transmission such as voice, whilst the 24.5-26.5 GHz band is specified for 'broadband' access and the 27.5-29.5 GHz band for broadband access including TV broadcast. There are also plans to license the 40.5-43.5 GHz frequencies in the future. FWA is the only technology to threaten the dominance of Portugal Telecom, and has the potential to emerge as a broadband platform before ADSL or cable. Indeed, Portugal may become a significant market for broadband FWA.

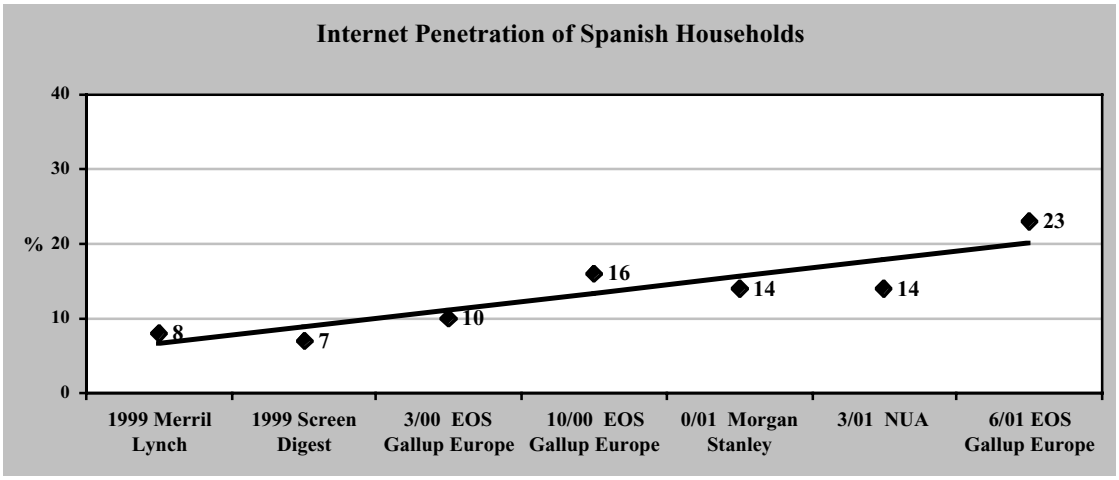
**Mobile Wireless (UMTS):** GSM mobile phones have been very popular in Portugal, as in other Member States. According to EOS Gallup Europe, only 69% of homes have a fixed line telephone connection, which may explain partly the popularity of mobile phones. 3G will offer an alternative means of accessing the Internet in a country where in home PC penetration is relatively low. Licenses were awarded following a beauty contest in December 2000 to: Telecommunicacoes Moveis Nacionais (Portugal Telecom); Telecel (Vodafone); Optimus (Sonae); and OniWay (a consortium including Electricidade de Portugal). The intention is that services will be available at the beginning of 2002. The fixed fee was 100m.

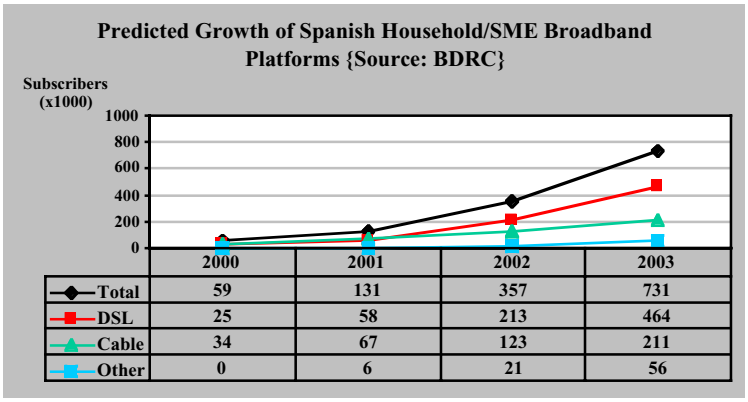
**Fibre Optic and Powerline:** There are no reports of Fibre-to-the-home or Powerline projects in Portugal.

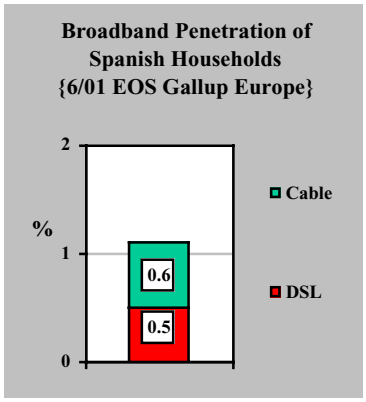
## SPAIN

| | |
|---|---|
| GDP[a]: | 17,319 Euro/annum/capita |
| Population[b]: | 40.6 m (77% urban)[l] |
| Households[c]: | 12.8 m |
| Main telephone lines[d]: | 17.1 m |
| Cable TV subscribers[e]: | 0.5 m |
| Satellite dish owners[f]: | 1.6 m |
| Mobile subscribers[g]: | 24.7 m |
| PC households[h]: | 2.6 m (20% of households) |
| Internet households[i]: | 2 m (16% of households) |
| Internet users[j]: | 5.4 m |
| Broadband subscribers[k]: | 0.06 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]Screen Digest 1999 [d]ITU 1999 [e-f]Screen Digest 1999 [g]ITU 2000 [h]Screen Digest 1999 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999



The Spanish have been slow to adopt the Internet, although as the amount of Spanish content grows, so Internet usage is rising. Mobile phones have been very popular, indicating that UMTS Internet connections may also be popular as demand for Internet services grows.

Cable networks are relatively new and, although expanding, will not offer widespread competition to ADSL for some time. However, because the networks are new, they do offer high-speed access from the outset. Cable uptake is driven by product bundles, introducing competition to the telephony market, exclusive TV programming as well as Internet access for some.

The incumbent telecom operator, Telefonica has committed itself to ADSL as the principle, broadband access platform, on the grounds that the investment required for cable is too great. The company also has significant interests in Central and South America, which may benefit the future of broadband in Spain in terms of economies of scale. However, there is little competition in the market and so ADSL roll-out may prove to be slower than forecast. FWA may be the solution to the general lack of competition in the Spanish market.

**ISDN:** Spain has one of the lowest penetration of ISDN lines among Member States (0.3%).

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** Spain was relatively late to privatise its national telecommunications industry and so the incumbent, Telefonica, still dominates the fixed access network. Full local loop unbundling has not yet happened, although Telefonica does allow ISPs wholesale access to its ADSL lines. ISPs' offering ADSL include: Teleline (owned by Telefonica); Jazztel; and Arrakis.

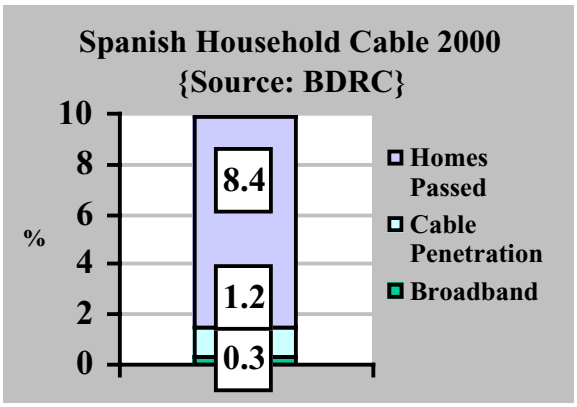
Telefonica first offered ADSL in September 1999 and is now rolling it out to all major cities, although there have been criticisms of delays in the roll out after first offering a service. The company is aiming to have 200,000 lines by 2001. In addition to this, Telefonica are planning to install a further 400,000 ADSL lines in Central and South America.

| Examples of ADSL offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| *Telefonica* (Terra ADSL) - residential | 128 / 256 Kbps | 47 (138-204) |
| *Telefonica* (Terra ADSL) - business | 128 / 512 Kbps<br>300 Kbps / 2Mbps | 97 (203)<br>190 (384) |

**Digital Terrestrial Transmission:** According to current broadcast licenses, services should commence before 2002. However, this platform is unlikely to be used for broadband transmission.

**Digital Cable:** The cable industry is very young in Spain with most licenses obtained in 1998 and some operations not beginning service until 1999. Despite this, cable is proving to be very popular in Spain, with subscriber numbers rising rapidly (from

around 1m in 1999 to 4.7m in 2001). In 2000, 10% of all Spanish homes were passed by cable, and 1.2% actually subscribed with Internet access being taken by just 0.3%.




Of the twelve cable operators, eleven have formed an association called the Agrupación de Operadores de Cable (AOC). The company Ono, which is backed by Callahan Associates, remains outside this group.

Telefonica has threatened to move into the cable market, but at present is concentrating on developing its ADSL service. However, it is coming under increasing pressure from the cable operators as they attract customers away from the Telefonica telephony product with bundled offers of telephone, TV and possibly Internet. Auna, a consortium of Telecom Italia and Spanish electricity companies Endesa and Union Fenosa, owns the cable operator Madritel and is mainly responsible for providing competition to Telefonica.

UPC has also shown some interest in the Spanish market with UPC España, which is in talks with to merge its Spanish interests with RSL Telecom's Alo. This is particularly interesting because UPC and RSL Telecom are also involved with FWA in Spain and could be in a position to offer a broadband service via cable or FWA anywhere is Spain.

Because most of the network infrastructure is new or upgraded, there are plenty of Internet access offers, which tend to be bundled with TV and telephony.

| Examples of Cable Internet offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| *Ono* (Ono Internet) | ? / 512 Kbps | 66 (84) |
| *Madritel* (Internet 777) | ? / 777 Kbps | 11 (90) |
| *Reterioja* (AVE 256) | ? / 256 Kbps | 48 (90) |
| *Retena* (AVE 256) | ? / 256 Kbps | 48 (90) |
| *Supercable* (Super 256) | ? / 256 Kbps | 41 (90) |

The fragmentation of the market may limit the potential of individual operators to provide high speed broadband services in the future.

**Satellite:** Satellite DTV broadcast direct to home has been growing in popularity. In 2000, around 15% of households had a satellite dish. The market is covered by two rival companies, Via Digital (owned by Telefonica) and CanalSatellite Digital (owned by Canal Plus). The opportunities for DTV via satellite are good, as the cable infrastructure cannot match the coverage at present.

Since two-way satellite transmission for the home/SME has not yet resolved its technical limitations, satellite is unlikely to become a leading broadband access platform. Europe Online had attempted to provide two-way Internet access via satellite, but technical problems forced it to stop the service.

**Fibre Optic:** There are no reports of fibre to the home/SME projects reported in Spain at present.

**Fixed Wireless:** The Spanish Government has been keen to introduce competition through FWA and was one of the first Member States to awared licenses. The following licenses where issued in April 2000 by the Ministerio de Ciencia y Tecnologia:

3.4 - 3.6 GHz: Retevision; FirstMark; Abrared; Banda Ancha
24.5 - 26.5 GHz: Retevision; UNI2; Broadnet; Sky Point; Banda 26

The first commercial offers of FWA to the consumer/SME are likely to appear in 2002-2003. There are no immediate plans to develop the 40 GHz 'broadband' spectrum.

**Mobile Wireless (UMTS):** GSM mobiles have been very popular in Spain, as in other Member States. Because the Spanish have been slow to adopt the Internet (perhaps on the grounds that most of the content is written for Anglophone cultures), some commentators have suggested that 3G may be popular as a low cost alternative to accessing the Internet via a PC.

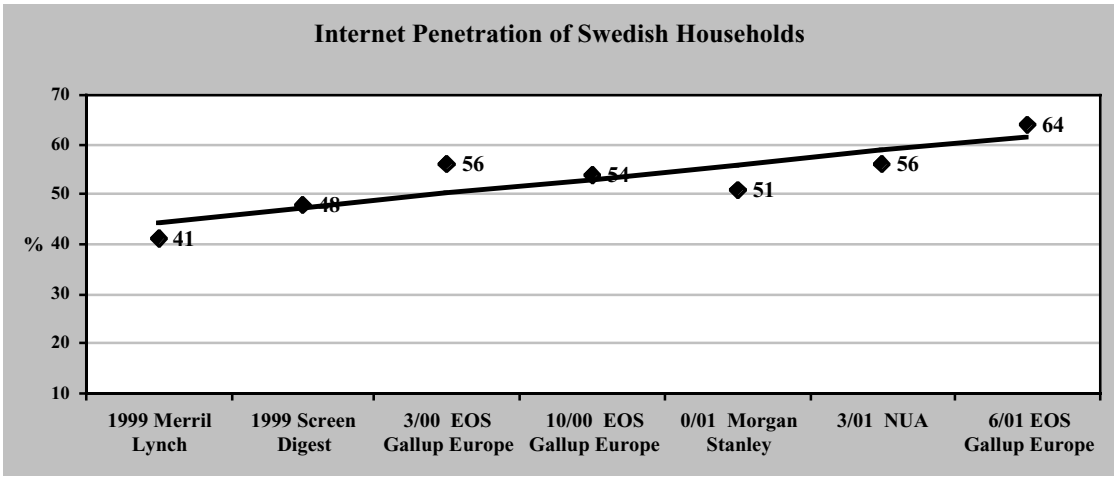
Following a beauty contest, UMTS licenses were awarded in March 2000 to: Xfera (Vivendi and Sonera consortium); Telefonica; Airtel; and Amena. Service was expected to start by August 2001, but this has been delayed because of problems in the deliver of handsets. An annual fee of 127m is to be paid, although the Spanish government is attempting to raise this to 150m

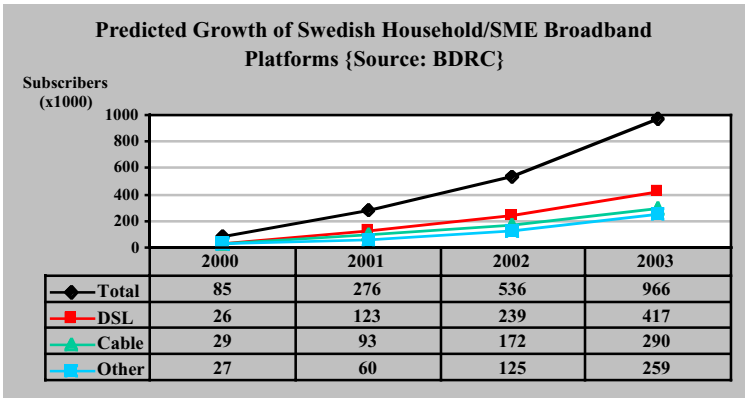
**Powerline:** There are no reports of Powerline projects in Spain.

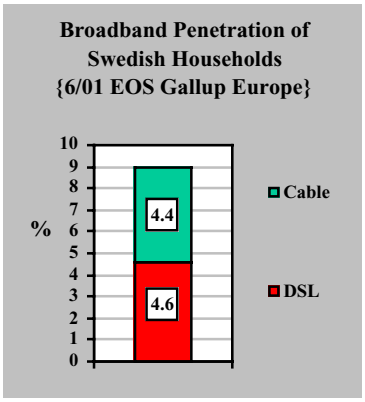
## SWEDEN

| | |
|---|---|
| GDP[a]: | 21,620 Euro/annum/capita |
| Population[b]: | 8.9 m (83% urban)[l] |
| Households[c]: | 4.3 m |
| Main telephone lines[d]: | 6.1 m |
| Cable TV subscribers[e]: | 2.2 m |
| Satellite dish owners[f]: | 0.5 m |
| Mobile subscribers[g]: | 6.3 m |
| PC households[h]: | 3 m (69% of households) |
| Internet households[i]: | 2.3 m (54% of households) |
| Internet users[j]: | 4 m |
| Broadband subscribers[k]: | 0.09 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]EOS Gallup Europe 2000 [d]ITU 1999 [e-f]Screen Digest 2000 [g]ITU 2000 [h]Screen Digest 2000 [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999




NB: The 6/01EOS Gallup Europe figure for household cable penetration appears high. This may due to an interpretation error in which survey respondents with FTTH answered cable. Other industry sources have suggested that cable Interent penetration was closer to 1% of households at the end of 2000.

The Swedish telecommunications market is one of the most deregulated in Europe. Since the Swedish telecommunications industry was fully deregulated, a large number of new operators have entered the market, particularly in the capital Stockholm, where more than 30 companies compete. The incumbent, Telia, does maintain its dominant position and has interests in all the main broadband access platforms. However, there is competition in all areas, encouraged by the Swedish government.

Government commitment to develop broadband access is manifest, 950m has been earmarked for investment to ensure that 98% of all households have a broadband connection by 2005. Svenska Kraftnät will receive 295m to build a national backbone, regional networks will be built with 307m and a further 378m will be spent on the local loop. The money will be used to provide tax incentives for private investment in remote areas and to support developments funded by municipalities. The plan includes an assessment that communities of over 3,000 people (70% of Swedish towns and cities), will be reached though market forces. The cost of reaching a further 28% of the population would be almost 1 billion.

A peculiarity of the Swedish market, which has a big impact on the development of broadband services in the country, is that the majority of the population rents apartments in multi-tenant buildings. Furthermore, when cable was installed, the cable operators negotiated deals with the owners of the buildings, rather than the individual tenants. Part of the deal was that the cable operator would have exclusive access to the tenants for at least 25 years. Dealing with the owner of the building has now become well established. This means that cable operators and providers of other new access platforms (with the exception of ADSL) are unable to offer service to individual tenants, but must focus their strategy on supplying solutions that are attractive to the owners of the buildings. The Swedish government is in the process of investigating this situation through concerns that it may limit competition and have a knock on effect on the development of broadband.

**ISDN:** The household penetration of ISDN is relatively low in Sweden (3%), considering the popularity of the Internet.

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** Despite the high level of competition in the telecommunications industry as a whole, and very high levels of Internet usage, ADSL has been slow to come to market. However, the prospects for ADSL look very promising, not least because Sweden has relatively short local loops with most under 3km. This means that higher bandwidth DSL products will be possible and so gives DSL a longer life span, assuming that demand for bandwidth may, one day, exceed the capacity of ADSL.

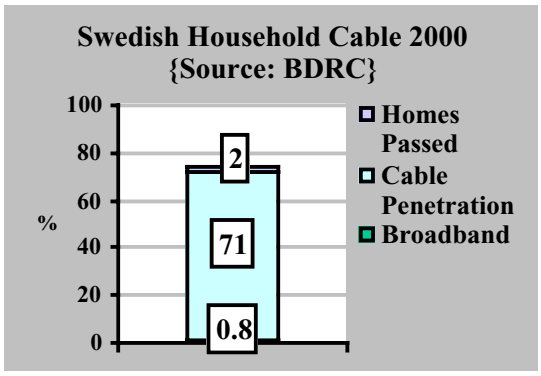
Telia began a trial in June 1998, which lasted until the end of 1999. It then set very aggressive roll out targets of 300,000 customers within a year, but only managed to connect 25,000 and did not launch its consumer product until mid way through 2000. A factor in this slow roll out may be that the local loop is not yet unbundled and so there is no direct competition for Telia to respond to.

Telia have announced that local loop unbundling has begun with wholesale leasing of lines installed by Telia for 168 per year, rather than full access to the local exchanges with co-location of competitors hardware. Currently, the only alternative provider offering ADSL is Tele 1 Europe which resells Telia lines connected to Tele 1 Europe's own fibre optic network. This service is aimed at larger businesses at present. There are currently no alternative offers of ADSL to the residential/SME market, although KPNQwest are in discussions with Telia about gaining access to the local loop for an SME only product. Other companies are also likely to enter the market when the opportunity arises.

| Examples of ADSL offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| *Telia* (Telia Flexicom) - residential | ? | c. 82 (?) |
| *Telia* (Telia Flexicom) - business | 400 Kbps / 2 Mbps | 283 (?) |

**Digital Terrestrial Transmission:** DTT has been in service over the five most populated areas of Sweden since April 1999. However, there are no signs that the technology will be developed to support two-way broadband access.

**Digital Cable:** Cable is widely available in Sweden, passing around 74% of households in 2000, with almost all of these subscribing to the service (71% of households in 2000) and almost 1% of all households connecting to a 'broadband' Internet service in 2000. Because most people live in multi-tenant buildings and because the agreement to supply cable services is made with the owner of the building and not the individual tenants, marketing opportunities are limited compared to other countries.




Telia's cable subsidiary, Com Hem, controls half of the market. It has recently been looking to divest this business and, having failed to sell it privately, has opted to float the company on the stock exchange. One reason for this move was to allay regulatory concerns in the light of Telia's proposed merger with the Norwegian incumbent Telenor. However, this merger has collapsed.

Com Hem has been offering broadband Internet access via cable since mid-1999 and estimates that around half of its network has now been upgraded (at the start of 2001).

In July 1999, UPC bought the Swedish cable operator MSO StjärnTV and so is now a major player and competitor to Com Hem, particularly in the Stockholm area. MSO StjärnTV began offering broadband Internet in April 1999 and this was converted to UPC's Chello Internet service in November 1999. Like Com Hem, half of UPC's network was still in need of upgrading at the beginning of 2001.

Smaller players also offering Internet access via cable include: Tele2 (owned by Netcom and offering services via the company Kabelvision); Telenordia; and Sweden Online.

| Examples of Cable Internet offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| *Telia* (Internet Cable) | 128 / 512 Kbps | 24 (111) |
| *UPC* Stjärn TV (Chello) | 128 / 512 Kbps | 22-33 (143) |
| *Tele2* (Connect2Internet) | 128 / 512 Kbps | 24 (0-167) |

**Digital Satellite:** Two way Internet is not planned in Sweden, and Europe Online recently withdrew its satellite Internet product. There have been some recent developments in broadcast satellite, with Telia and Eutelsat planning a digital video broadcasting (DVB) and DTV service.

**Fibre Optic:** Sweden has become one of the forerunners in the acceptance and development of the Internet. Internet usage is very high, and there is considerable demand for high bandwidth access platforms. In this environment, fibre to the home is the favoured access platform, as its capacity far exceeds current demand. A stated ambition of the Swedish government is that almost all homes (98%) shall benefit from a broadband connection by the year 2005, and a significant proportion of homes shall have a fibre optic connection.

Such is the interest in fibre to the home, that in some places the residents and municipalities have begun to build their own networks. However, there are a number of companies that stand out in this area. Bredbandsbolaget (B2) are already offering fibre to the home and by the end of March 2001 had 125,000 households connected. Although this is way below their stated target of 500,000, it does place B2's fibre to the home alongside Telia's ADSL in terms of subscription rates.

In addition to its aggressive roll out plans in Sweden, B2 is also actively looking to expand its network to the whole of Europe. It has begun operating a service in Denmark and Norway and has an agreement with FastWeb and MetroWeb to help develop fibre to the home in Germany and Italy and has the backing of an investment firm with a view to expanding in the Benelux countries.

Another company currently offering fibre to the home in Sweden is Thalamus. They have come to agreements with landlords to offer fibre to the home as a way for them to attract tenants to their apartments.

The company Utfors is involved with Tele 1 Europe and Telia in building a fibre optic network which stretches the length of Sweden. They are also building their own network which connects all the major Nordic cities to other European and American networks. There stated position is to guarantee capacity on their network and to gradually extend their network to homes and SMEs. They are currently offering telephony and narrowband Internet.

In the municipality of Sundbyberg in Stockholm, the municipal housing company called Förvaltaren is building its own network to connect around 10,000 households, businesses and local authorities. And in the city of Gävle there also a plan to connect around 10,000 households to a municipally owned fibre optic network.

Another solution proposed by the national power grid company Svenska Kraftnat, is to lay fibre optic along the existing ducts, poles and pylons that carry power lines. The plan is to connect every city and small town to a fibre optic network from which fibre to the home would be possible.

| Examples of Fibre-to-the-Home offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| *Bredbandsbolaget B2* | 10 - 100 Mbps | 24 (?) |

**Fixed Wireless:** The National Post and Telecommunications Authority, will allocate spectrum on a first come, first serve basis. The spectrums available for license are 3.4 - 3.6 GHz, 24.5 - 26.5 GHz, 27.5 - 29.5 GHz. There are plans to offer the 3.6 - 4.2 GHz, the 31.0 - 31.3 GHz, the 31.8 - 33.4 GHz and the 40.5 - 43.5 GHz bands in the future. For allocation of all these spectrums, The National Posts and Telecommunications Authority is waiting for approaches from industry.

**Mobile Wireless (UMTS):** Following a beauty contest in December 2000, four UMTS licenses were awarded by The National Post and Telecoms Agency (PTS) to: Europolitan (Vodafone); Tele2 (Netcom) with Société Européenne de Communication; Orange Consortium (a joint venture of France Telecom, Berdbandsbolaget, FramFab, Skanska, NTL and Schibsted); and Hi3G (Investor and Hutchison Whampoa). Surprisingly, Telia failed to win a license because its proposal did not offer the same level of geographic coverage as others. They plan to appeal against this decision.

Roll out of 3G is set to begin in 2001, with full national coverage expected by 2003.

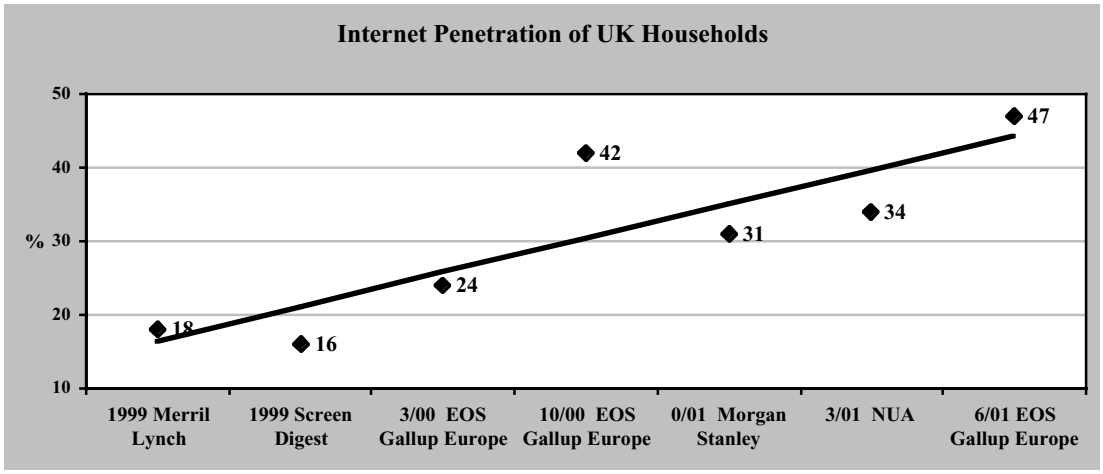
**Powerline:** There are no reported Powerline projects in Sweden.

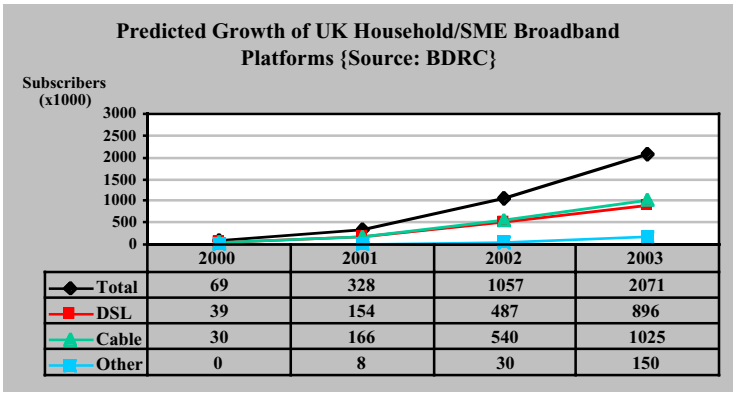
**Wireless Optic:** The Swedish incumbent, Telia, has bought wireless optic equipment from a US company called Optical Access and may offer a service in conjunction with fibre optic access.

## THE UK

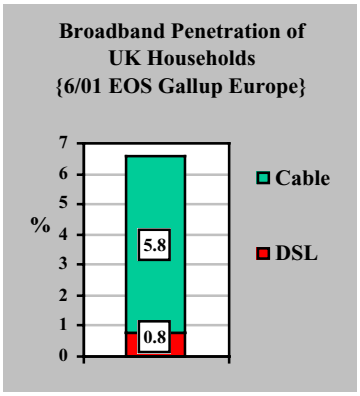
| | |
|---|---|
| GDP[a]: | 21,598 Euro/annum/capita |
| Population[b]: | 59.8 m (89% urban)[l] |
| Households[c]: | 24.6 m |
| Main telephone lines[d]: | 33.8 m |
| Cable TV subscribers[e]: | 3.2 m |
| Satellite dish owners[f]: | 5.4 m |
| Mobile subscribers[g]: | 40 m |
| PC households[h]: | 7.9 m (32% of households) |
| Internet households[i]: | 5.9 m (24% of households) |
| Internet users[j]: | 15.4 m |
| Broadband subscribers[k]: | 0.07 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]EOS Gallup Europe 2000 [d]ITU 1999 [e-f]Screen Digest 1999 [g]ITU 2000 [h]Screen Digest [i]EOS Gallup Europe 10/2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999




| | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|
| Total | 69 | 328 | 1057 | 2071 |
| DSL | 39 | 154 | 487 | 896 |
| Cable | 30 | 166 | 540 | 1025 |
| Other | 0 | 8 | 30 | 150 |




Oftel research, conducted in May 2001, found that 3% of consumers claimed to be using cable modem (but Industry estimates in May 2001 suggest less than 1% actually use cable modem). Clearly the EOS Gallup Europe figures above exaggerate the proportion of households using cable for Interent access.

Internet use in the UK is relatively high by European standards, although it is not at the level of the Nordic Member States and The Netherlands. The incumbent, BT, still controls the local loop and only partial unbundling has occurred in which new entrants can make their own offers by BT's ADSL leasing. However, the high price of line rental, and reliance on the incumbent's roll out plans, has made it very difficult for these new entrants to develop their ADSL business. Hence, there is considerable demand for full unbundling in order that competitors can install their own equipment. Whilst arguments about the unbundling process continue, BT is slowly rolling out its own ADSL offer.

The cable industry is relatively new in the UK and has been going through a period of consolidation. Two major players, NTL and Telewest, have now emerged and are pressing ahead with their expansion plans. Ultimately, ADSL will achieve greater coverage faster, however where broadband cable Internet is available as an alternative it is likely to be more competitive in terms of lower price and higher bandwidth. It is still uncertain which technology will offer the most reliable level of service.

Because the cable network is relatively new, there is potential for fibre to the home to be installed.

**ISDN:** Household penetration of ISDN was around 3% in 2000. ISDN has been available for some time, but high price and no additional services beyond telephony and Internet connection has limited the residential market. Hence the importance of marketing ADSL as offering additional services such as video on demand. ISDN has been very popular among SMEs, as until recently it was the only higher speed access available.

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** Despite deregulation of the telecommunications market over 10 years ago, the incumbent, BT, still dominates. The company first offered ADSL, under the brand name BTOpenworld in July 2000 to the business market, and then in September 2000 to the residential market with the aim of connecting over a million households by the end of 2001. BT have also announced that they plan to launch an SDSL service called IPStream offering symmetrical access at speeds up to 2Mbps, but the first offers have not yet been made.

Partial unbundling has occurred and ADSL offers bundled with ISP services are being made by operators who have leased ADSL lines from BT. Companies offering such a service to residential customers are ClaraNET, Demon, Freeserve, and Madasafish, and to business customers ClaraNET, Demon, Easynet, and Zen Internet.

Companies such as KPNQwest, Energis and Colt Telecom are very keen to install their own equipment in the local exchanges. The legal framework for open access is currently being negotiated between BT and the regulator OFTEL, and full unbundling is planned for July 2001. BT have been criticised by its competitors for employing delay tactics in allowing access to there exchanges while they roll out their own

ADSL service. However, similar behaviour has been reported of many incumbents within the European Union and beyond.

Kingston Communications operates its own telecommunications network in the Hull area, allowing it also to offer ADSL to businesses. The company has plans to expand by gaining access to local exchanges across the country and installing its own ADSL equipment, and by extending its own network.

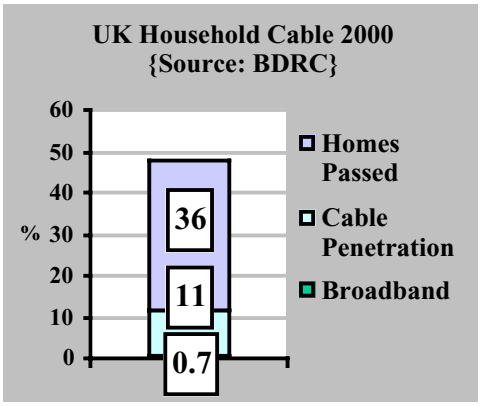
| Examples of ADSL offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| *BT* (BTOpenworld) - residential | 250 / 500 Kbps | 63 (235) |
| *BT* (BTOpenworld) - business | 250 / 500 Kbps - 2 Mbps | 63-167 (248-435) |
| *Kingston Communications* - business | 256 Kbps - 1 Mbps / 500 Kbps - 2 Mbps | 16 - 25 (94) |

Developments in the UK are also interesting in terms of the content that is being developed to run over ADSL lines. BT have teamed up with Video Networks to offer video on demand to its ADSL customers. Video on demand is also planned from companies such as Yes Television and Filmgroup. Furthermore, BskyB are considering the possibility of providing television content via ADSL.

Interestingly, there have been reports (in August 2001) that offers have been made to buy the fixed line network from BT. A US consortium has offered £8bn ( 13bn), and this was quickly followed by an offer of £18bn (29bn) from the German investment bank WestLB. The attraction for BT would be to pay off its considerable debts, remove itself from the unbundling issue, and concentrate on its mobile, leased line and international businesses.

**Digital Terrestrial Transmission:** The UK is the most advanced European country in terms of DTT. It was launched in late 1998 offering a combination of free-to-air services and pay-TV services. In addition to digital video broadcasting (DVB), OnDigital currently offer narrowband digital transmission and are evaluating plans for launching broadband services via ADSL. In the future, OnDigital are likely to remain a television and video broadcaster, but may offer Internet services to the television industry. For broadband access, video and TV via DSL is also planned for the future.

**Digital Cable:** There has been extensive building of cable networks recently and now half of all households are passed by cable and 12% of households subscribe to cable (2000) with almost 1% connecting to the Internet via cable. Because the infrastructure is mostly new, hybrid fibre/copper, the network is ready for high speed Internet connections.




The cable industry has undergone a period of consolidation and there are now two main players in the market, NTL and Telewest. They are both offering bundled deals of DTV, telephony and Internet connection. In addition to a low cost, narrow band Internet connection for PCs or TV, NTL is also offering a broadband Internet. Telewest also has a broadband Internet product called Blueyonder, however there have been some technical problems and so Telewest have been slow to sign up new customers.

| Examples of Cable Internet offers | Data Rate Up/Down | Price* in Rent/month (installation) |
|---|---|---|
| *NTL* (NTLWorld) - residential | ? / 512 Kbps | 66 (245) |
| *Telewest* (Blueyonder) - residential | ? / 512 Kbps | 54 (82 - 124) |

There were reports that NTL and Telewest may merge in order to compete more effectively against BT's ADSL product. However, the pan-European cable operator UPC has now acquired a 25% stake in Telewest (Microsoft had a minority share in both UPC and Telewest).

**Digital Satellite:** The UK has the third largest proportion of households with satellite dishes (23% in 2000) after Austria and Germany. The main operator, BskyB, currently offers interactive TV, but this is achieved using the telephone line for the upstream channel. Another company called Activator is planning to launch an interactive gaming service using satellite download and fixed line upstream.

The fact that BSkyB are discussing the possibilities of offering their content over ADSL rather than via satellite is a strong indication that two-way satellite is not about to happen in the consumer market. The implication is that interactivity is better achieved over a fixed line, or possibly FWA, but satellite interaction involves a transmission delay, which is unacceptable when high-speed interaction is required.

**Fibre Optic:** As the cable infrastructure is relatively new, and based on a copper/fibre hybrid solution, there is the potential for these networks to extend fibre to the home as demand for bandwidth grows. There are unconfirmed reports that NTL is installing fibre to the home in Ireland. This is a possibility as NTL have a 25% in the Swedish company, Bredbandsbolaget, which is planning to expanded its fibre to the home solution within Europe.

**Fixed Wireless:** Bidders were reluctant to pay large sums for FWA licenses at an auction held in December 2000 and a number of the licenses were not allocated at the time they were offered. Furthermore, in the UK, potential operators see FWA as a solution primarily for SMEs and business and not as an alternative to the local loop to the residential market. Hence, the lower frequency and lower bandwidth spectrum generated little interest.

The following spectrums were offered by the Radiocommunications Agency (RA) in December 2000:

| | |
|---|---|
| 2.029-2.281 GHz: | not yet allocated |
| 2.4-2.62 GHz: | not yet allocated |
| 3.6-4.2 GHz: | not yet allocated |
| 10.15-10.65 GHz: | not yet allocated |
| 27.5-29.5 GHz : | Broadnet; Energis; Norweb; Faultbasic; Eircom; Chorus Com. |

The 27.5 - 29.5 GHz frequencies have been licensed for broadband transmission. There are also plans to allocate 40.5 - 43.5 GHz frequencies, which will also be for broadband.

**Mobile Wireless (UMTS):** The UK auction of 3G licenses, concluded in April 2000, generated £22 billion (37 billion). This was far higher than expected, as the initial reserve for a license was set at £500 million (828 million) per license. The subsequent reaction from the industry, in the face of falling stock market values, has been to suggest that paying these sums has crippled their attempts to actually build the networks and get to market. This has led to some reports that UMTS will initially be launched as a premium business service.

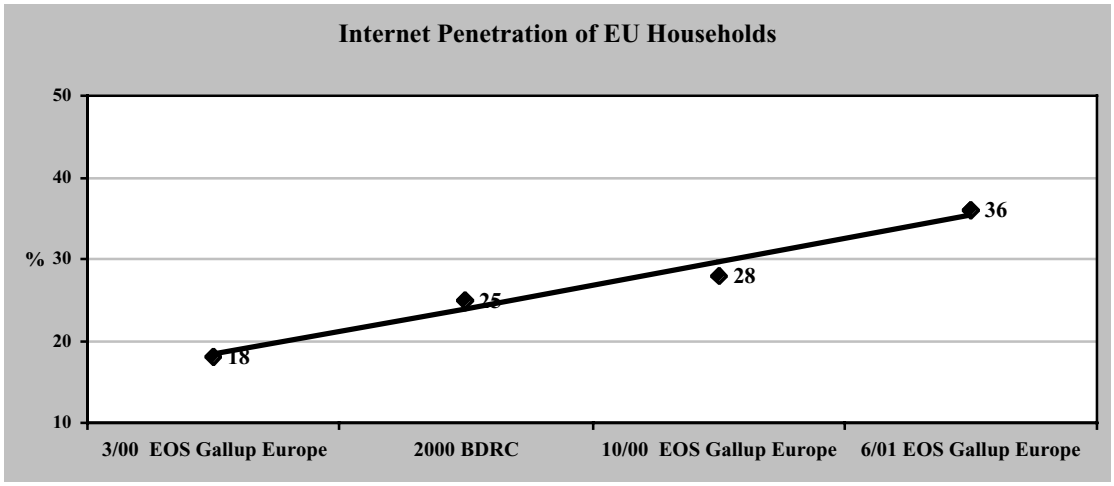
The five license winners are: Hutchison 3G (consortium of TIW, Hutchinson Whampoa, KPN and DoCoMo); Vodafone; BT3G; One2One and Orange. The first launches are expected in 2002, with 80% national coverage planned by 2007.

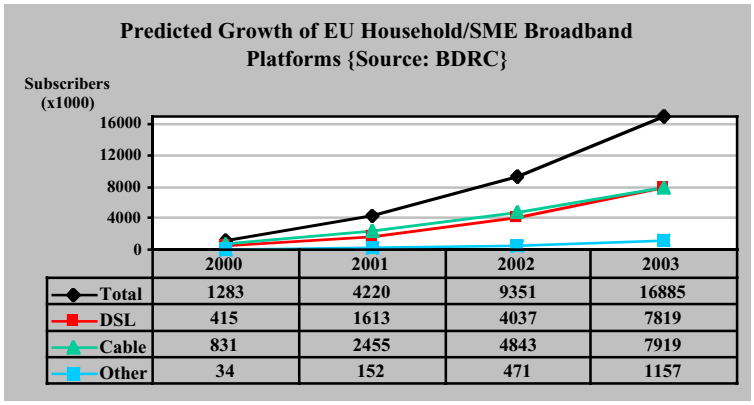
**Powerline:** The company NorWeb began UK trials of the technology in early 1999, but these were halted in September 1999 as other high-speed broadband solutions such as ADSL developed.

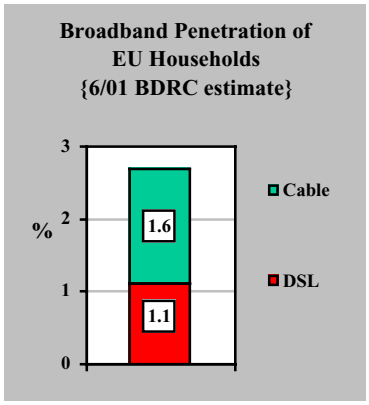
## EU15

| | |
|---|---|
| GDP[a]: | 21,131 Euro/annum/capita |
| Population[b]: | 377.3 m |
| Households[c]: | 152.3 m |
| Main telephone lines[d]: | 205 m |
| Cable TV subscribers[e]: | 45.2 m |
| Satellite dish owners[f]: | 27.5 m |
| Mobile subscribers[g]: | 235.8 m |
| PC households[h]: | 49.1 m (32% of households) |
| Internet households[i]: | 38.1 m (25% of households) |
| Internet users[j]: | 79 m |
| Broadband subscribers[k]: | 1.3 m |

[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c-k]BDRC estimate based on sum of data for each Member State.



Taking an overall view of the fifteen Member States, the EU is successfully deploying broadband access platforms. Although digital cable access is currently the most prevalent high-speed platform among broadband subscribers, ADSL is fast catching up. Over the next two years, ADSL will become the most widespread access platform across the EU with the largest total number of subscribers.

**ISDN:** EOS Gallup Europe put household ISDN penetration across the EU at 6.3% (6/2001).

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper E1 technology (see Appendix A) is being replaced by the other broadband access platforms described below.

**DSL:** EOS Gallup Europe put household ADSL penetration across the EU at only 0.8% (6/2001)

**Digital Terrestrial Transmission**: Progress is being made toward analogue switch off. The first Member State is likely to switch off within the next 5 years, but this will only happen when political conditions are right. For other Member States, analogue switch off may not occur for many years, unless an economically viable means is found to convert analogue TV sets to digital (i.e. almost free to the consumer).

**Digital Cable:** At present, cable access has the highest penetration of any European high-speed access platform (EOS Gallup Europe put this at 3.3% of households on 6/2001). Digital cable is set to rival ADSL. In some Member States, cable will remain the most popular platform, in others there will be no digital cable infrastructure for some time.

**Digital Satellite:** Satellite leads the digital broadcast revolution in the EU. But currently, there is no residential/SME solution for Internet connection. If technical problems can be overcome, then satellite could capture a very significant share of the broadband market in the future, particularly in non-urban regions.

**Fibre Optic:** Fibre optic is reaching ever closer to the home/SME. The EU does have some fibre-to-the-home subscribers, although only a fraction of a percentage of all households.

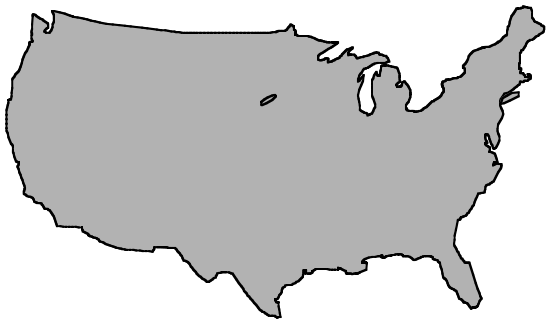
**Fixed Wireless:** There are trials of FWA underway and some larger organisations are using the technology. The first residential/SME offers are yet to emerge.

**Mobile Wireless (UMTS):** Most licences have now been allocated across the EU. Trials are underway in some Member States, and the first offers are likely to emerge in early 2002.

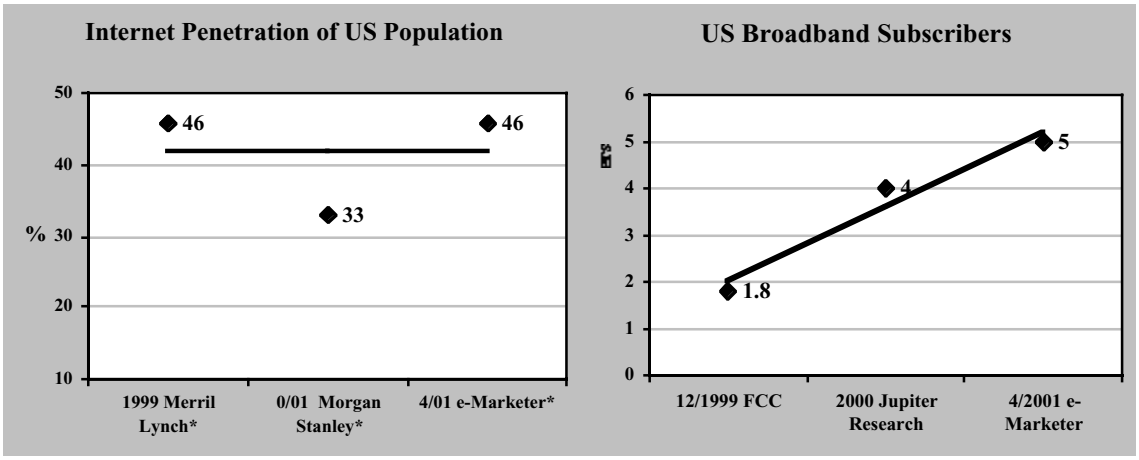
**Powerline**: There have been some trials, but technical limitations have stopped Powerline from developing fast enough to become a viable access platform, except perhaps in some exceptional situations, where there is no alternative access platform.

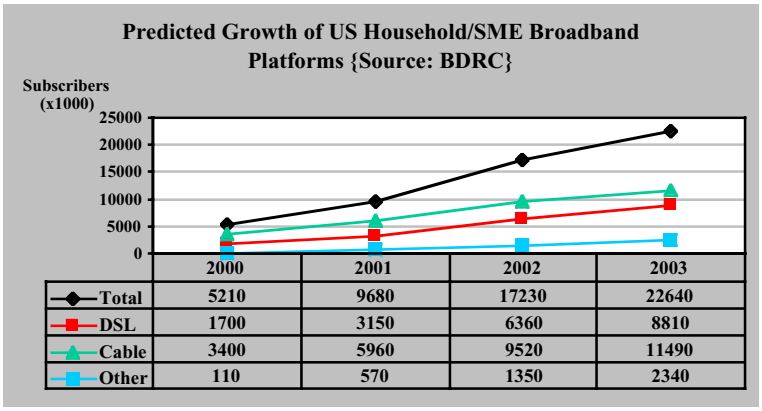
# USA

| | |
|---|---|
| GDP[a]: | 32,867 Euro/annum/capita |
| Population[b]: | 275.1 m |
| Households[c]: | 103 m |
| Main telephone lines[d]: | 192.5 m |
| Cable TV subscribers[e]: | 70 m |
| Satellite dish owners[f]: | 24.7 m |
| Mobile subscribers[g]: | 100.3 m |
| PC households[h]: | 45 m (44% of households) |
| Internet households[i]: | 32 m (31% of households) |
| Internet users[j]: | 95.3 m |
| Broadband subscribers[k]: | 5.2 m |

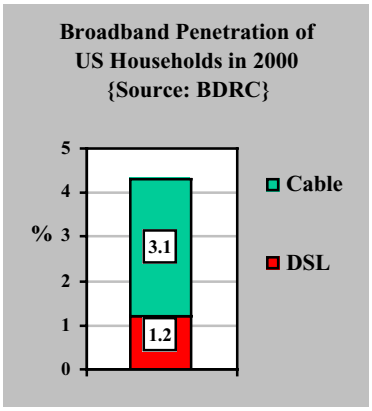


[a] Eurostat 1999 [b] UN,IMF,World Bank 2000 [c] US Census 2001 [d] ITU 1999 [e] US Census 2000 [f] Nua Research 2001 [g] ITU 2000 [h] US Census 2000 [i] US Census 2000 [j] ITU 2000 [k] FCC 8/2001




| | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|
| Total | 5210 | 9680 | 17230 | 22640 |
| DSL | 1700 | 3150 | 6360 | 8810 |
| Cable | 3400 | 5960 | 9520 | 11490 |
| Other | 110 | 570 | 1350 | 2340 |




NB: The FCC figures for broadband penetration among US households and SMEs are 3.2% for cable and 1.6% for ADSL. The BDRC figures above have been adjusted to reflect households only in order to make comparison with other countries in this report.

The US is currently the largest market for broadband access platforms in the world. According to US Federal Communications Commission (FCC) figures (released on 8/2001), there were 5.2m residental/SME broadband connections at the end of 2000. The country is also widely regarded as the most advanced country in terms of broadband technologies. Whilst innovations do emerge from other countries, including the Member States of the EU, most access technologies have been developed and deployed in the US before any other country. This is not surprising, given the high penetration of PCs, the rapid adoption of the Internet and the popularity of DTV in the US. Cable modem connections and DSL services are now widely available and there are sufficient levels of competition in the telecoms, Internet and cable markets to continue to drive prices down. Furthermore, alternative access platforms such as fixed wireless, two-way satellite and fibre optic are also close to, or have actually entered the market.

Internet penetration of the population at the beginning of 2001 stood at 46%. Although higher penetration levels are apparent in the Nordic Member States of the EU, these markets are very small compared to the 103 million users in the US in 2000 which would compare with the whole of Eastern and Western Europe combined (108 million in 2000). The US has the advantage of being one of the largest single market in the world, with a homogenous, anglophone culture.

The US has ample backbone capacity to meet the immediate requirements of broadband demand. Middle mile facilities (i.e. the connection between the backbone and the final node or local exchange) are more developed in urban area, although there may be bottlenecks in some areas in the near future. Roll out of last mile facilities (i.e. the connection between the last node in the network and the customers premises) is still at an early stage. Some competitors are now fighting legal battles to gain co-location space in the local exchanges or to gain access to consumers via a competitor's infrastructure.

The commercial imperative has forced the industry to focus on those areas that are likely to be most profitable in the short term such as businesses and densely populated urban areas in which the population has high income. As a consequence of these market forces, the US Federal Communications Commission (FCC) has identified a digital divide in the US, in which low-income consumers, those living in sparsely populated regions and minority groups have poor availability to digital technologies, including high speed access platforms. To address this, Congress are currently considering a white paper proposing tax incentives for companies offering broadband access in deprived regions.

Predictions have been made that by 2005, a third of all households will have some form of high-speed connection. However, the economic slowdown in the US, which has hit the technology sector hard, is likely to slow the growth of broadband. To achieve sustained growth in roll-out of broadband access, the US telecommunications industry will have to go even further to link content provision with access technologies and so drive demand for high speed connectivity.

The cable industry is well ahead of other access platforms in terms of availability with almost 60% of households passed by Internet ready cable. Furthermore, the cable companies are experienced content providers and consumers are prepared to pay for

the service. These factors suggest that cable will remain the dominant broadband access platform in the US. In December 2000, there were about 3.2m residential/SME subscribers to high-speed coaxicable cable compared to about 1.6m to ADSL (FCC, 8/2001)

Despite being widely available, ISDN take up remains low (2% of all households), whilst standard dial up remains the most popular means of accessing the Internet (c. 40% of all households). This would suggest that, American's are not prepared to pay more for higher speed access to the Internet in the home, when they can get standard dial up connection for free. This issue is now facing ADSL providers, who are more likely to target businesses than residential customers. However, as the broadband market develops, there may be a rapid switch from standard dial up to high-speed access platforms.

The largest, and single most important ISP in the US market is AOL. Since its acquisition of Time Warner, AOL has a strong presence in the cable access market as well extensive involvement in all other broadband access platforms. The challenge for AOL is to migrate its subscribers away from free standard dial up to the Internet toward paying more for broadband content.

The broadband business model in the US (and other unregulated markets) is currently based on paying for access. Because the majority of Internet users expect free or almost free access, it has been hard to convince large numbers of consumers to pay more simply for a higher speed connection. The business model follows that the basic subscription charge for high-speed access will come down as the number of subscribers grows and so broadband providers gain revenue from e-commerce and other non-access services such as video-on-demand. However, this model requires a high volume of transactions, which in turn requires a large number of subscribers. This 'chicken and egg' situation has stalled the take up of broadband as it remains a relatively expensive service, which only the well-off can afford, considering the offer is simply faster access at present. The trigger to mass-market broadband deployment in the US is the provision of popular content.

| **Selected Offers** | | | |
|---|---|---|---|
| **Company** | **Platform** | **Bandwidth (up/down)** | **Cost in (Month/Initial)** |
| *Excite@Home* | Cable | 128 Kbps / 400 Kbps | 41-64 / 175 |
| *Verison* (Bronze Plus) | ADSL | 128 Kbps / upto 768 Kbps | 39 / + ISP Charge |
| *DirectPC* (Direct PC - AOL Plus) | Satellite | 128 Kbps / 400 Kbps | 26 / 581 (or AOL package) |

**ISDN:** US Household penetration of ISDN in 2000 was only 2% (according to Ovum), despite it being available to 80% of households.

**Leased Lines:** Leased lines are not a residential solution. SMEs with data intensive operations use lease lines, but the copper T1 technology (see Appendix A) are being replaced by the other broadband access platforms described below.

**DSL:** Despite being available for almost three years, take up of ADSL has been slow in the US. This serves as an example of how long it can take to roll out ADSL service and then capture market share. There have been technical problems, which have effected quality of service. At the beginning of 2000, 26% of all households where

ADSL enable. This rose to 45% at the beginning of 2001, with forecasts that this will rise to 80% by 2003[8]. However, despite the fact that almost half of households could access ADSL by the end of 2000, only about 1.5% where actually subscribing. As the preceding chart indicates, around 8.5% of households are expected to be subscribing to ADSL by 2003.

There have been some criticisms of the high price of ADSL relative to the very low price of standard dial up in the US. This is also linked to the issue of stimulating demand through content rather than simple high-speed access. This business issue is apparent, irrespectively of the broadband technology providing the access (e.g. subscriptions to high-speed cable access is relatively low given the availability of cable Internet).

The DSL market is highly competitive, with the regional incumbent operators such as Bell South, Qwest and SBC under pressure from new and aggressive businesses such as Covad Communications, NorthPoint Communications, Verizon and Rhythms NetConnections. The two largest in terms of numbers of DSL subscribers at the beginning of 2001 were SBC with 516,000 and Verizon with 350,000.

In the US, DSL is particularly well positioned to be the preferred access platform for SMEs as the cable market is focused on residential customers. With bandwidth guarantees, DSL will become a more competitive alternative to ISDN and T-1 leased lines. Indeed, some commentators have suggested that the market will grow from its current level of around 0.5m business subscribers to almost 2 million by 2003[9].

**Digital Terrestrial Transmission**: The analogue switch off target has been set at 2006 and, although there are no plans to offer full Internet access via DTT in the US, it is currently being used to broadcast popular webpages (data casting). The company iBlast is currently broadcasting media-rich web content via local TV stations directly to PCs, TVs and other receiving equipment (albeit with no DTT return path). Geocast Network Systems and DirecTV are also interested in this use of DTT.

**Digital Cable:** The legacy cable infrastructure has been in place in the US for many years, as subscription to analogue cable was a popular means of receiving TV content. After extensive upgrading (which is still underway), digital cable and cable modems for Internet access are now widely available in the US. Almost 60% of all households now have Internet enabled cable passing them, with estimates suggesting that this could rise to over 70% by 2003[10]. Despite high levels of availability, penetration was only about 3.2% of all households at the end of 2000.

Since its merger with Time Warner, AOL has become the dominant force in cable Internet provision in the US in terms of content and infrastructure. AT&T, Comcast and Cox Communications are the three other major cable operators which provide and operate most of the rest of the US cable infrastructure. In addition to AOL, the other major ISPs offering cable Internet access, via the different operators, are

[8] Goldman Sachs
[9] Morgan Stanley Dean Witter, 2000
[10] Goldman Sachs, 1999

Excite@Home and Road Runner. Excite@Home is the leading cable modem ISP with over 3 million subscribers and Road Runner is the leading broadband ISP which provides Internet access for Time Warner Cable (although it is now in an uncertain position following the merger with AOL, since AOL is also the leading ISP in the US).

A cable modem requires a one-off cost to consumer of around $200 or a monthly rental in addition to the cable and ISP subscription of between $30 - $50 per month.

**Digital Satellite:** There has been considerable investment made by companies such as Lockheed Martin, Loral, Hughes, Alcatel and Teledesic, in efforts to deliver two-way satellite for the residential and SME markets. The first offers have been made under the brand names DirecPC (a subsidiary of DirecTV, a leading US satellite broadcaster) and Starband. These offers include upstream speeds of 128 Kbps and higher, with up to 500 Kbps downstream, for a monthly rate compatible with DSL and cable offers. However, an initial outlay of around $500 is required for the satellite dish.

Despite these developments, there are still concerns over whether two-way satellite will work effectively as it is scaled up and more subscribers place demand on the system. Indeed, recent reports from DirecPC have stated that broadband Internet use is not the best application for satellite technologies[11].

**Fibre Optic:** There are a number of fibre to the home projects in the US. In many new developments, fibre to the home is being installed as an additional feature of the property. In some US cities, there is plenty of room in underground ducts and so fibre can be more economically laid than in most European cities, where the ducts are full.

Despite this advantage, fibre to the home solutions remain prohibitively expensive for a mass-market roll out. The Denver based company WinFirst have estimated that it would cost them $2,000 per home to install a fibre solution.

Although some companies such as American Broadband in Massachusetts continue to plan to offer FTTH, based on a business model of bundling services at a lower overall price to the customer, there is no proven commercial success as yet. So, although FTTH is recognised as the ultimate broadband solution, there is no viable business model in the US as yet.

**Fixed Wireless:** Broadband FWA is now firmly established and fully operational in the US. The principle players are as follows:

| | |
|---|---|
| 2.5 GHz: | AT&T, Sprint, MCI WorldCom |
| 24 GHz: | WinStar, Teligent |
| 28 GHz: | XO Communications |
| 38 GHz: | WinStar, Teligent |

Broadband FWA is being offered as a competitive alternative to businesses and residential customers in densely populated, high rise areas. However, it will remain

[11] Broadband Week, 5/2001

an alternative solution in these circumstances, its unique selling points being fast connection with bundled services at a low price (particularly attractive to the start up SME market).

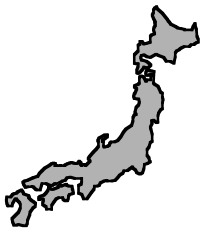
**Mobile Wireless (3G):** Licenses have not yet been allocated in the US, with the planned date being 15th June 2002 for awards to be made (although this may be delayed until 2003). The US spectrum is likely to be in the 700Mhz region, rather than the 2Ghz region allocated in Europe and elsewhere.

The FCC has placed no restrictions on the 3G radio systems to be used, provided they do not interfere with other systems using similar frequencies. Hence, it is up to the market to decide which technology will be favoured in the US. Clearly, as the market evolves there will be more emphasis on global roaming solutions which operate in most countries were mobile use has become common. CDMA technology is likely to be favoured.

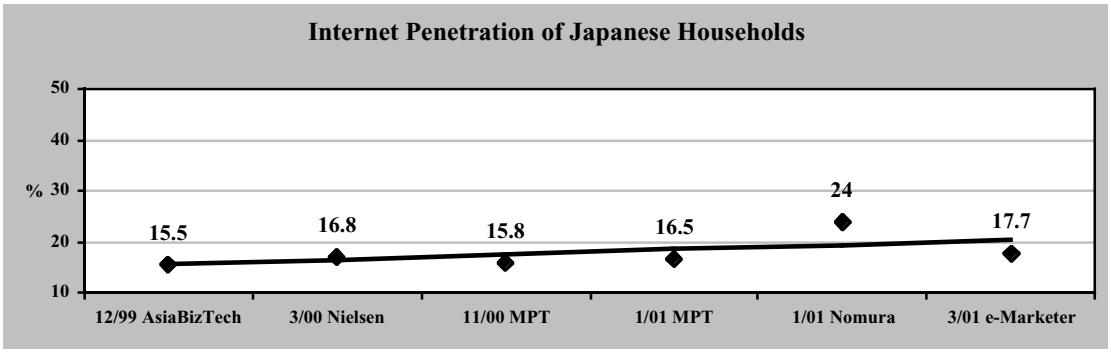
**Powerline**: There have been trials of Powerline technology in the US. Indeed, the company called Ambient is persevering with tests (funded by Consolidated Edison Company and Sumimoto Corp), but this access platform is unlikely to succeed on a large scale, if at all, given the development of other access platforms.

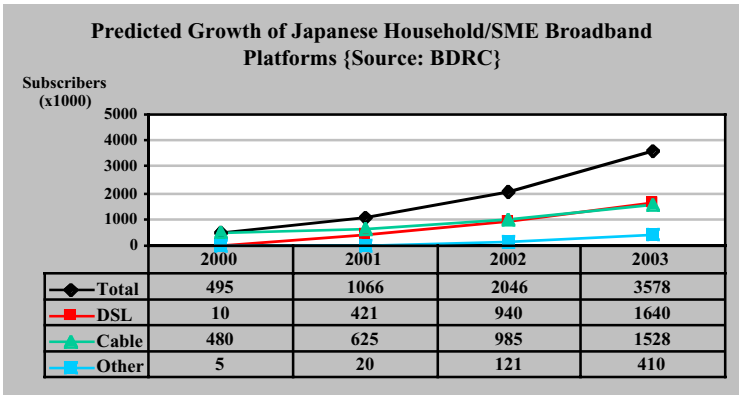
## JAPAN

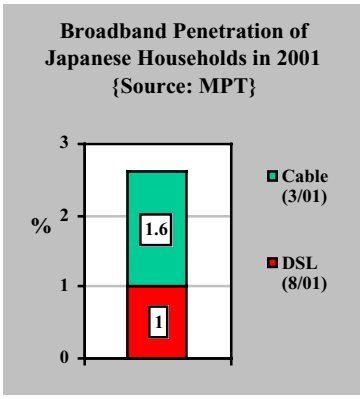
| | |
|---|---|
| GDP[a]: | 22,874 Euro/annum/capita |
| Population[b]: | 126.9 m (79% urban)[l] |
| Households[c]: | 48 m |
| Main telephone lines[d]: | 82.9 m |
| Cable TV subscribers[e]: | 9.5 m |
| Satellite dish owners[f]: | 0.013 m |
| Mobile subscribers[g]: | 66.8 m (24 m with Internet)[m] |
| PC households[h]: | 21 m (44% of households) |
| Internet households[i]: | 11.5 m (24% of households, fixed only) |
| Internet users[j]: | 47.1 m (mobile or fixed) |
| Broadband subscribers[k]: | 0.9 m |

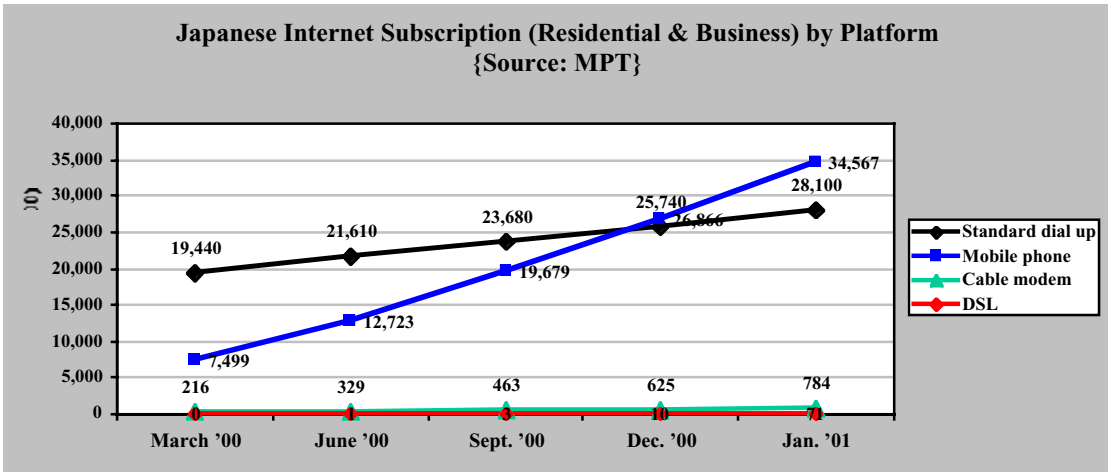


[a] Eurostat 1999 [b]UN,IMF,World Bank 2000 [c]MPT 2000 [d]ITU 1999 [e]MPT 2000 [f]MPT 2000 [g]ITU 2000 [h]Nomura 2000 [i]Nomura 2000 [j]ITU 2000 [k]BDRC estimate 2000 [l]UN 1999 [m]KDDI 10/2000



Cable has taken the lead and will remain the dominant broadband platform in Japan for the next few years. ADSL is making rapid progress from a low start and given the popularity of ISDN (4.5M residential subscribers), and the fact that the incument telecoms operator, NTT, are offering ADSL over ISDN, there is a considerable market that may upgrade from ISDN to ADSL. Despite this, the Japanese have been relatively slow to adopt the Internet at home and so ADSL is likely to be most popular among SMEs. Unique to Japan has been the huge popularity of i-Mode mobile phones, offered by NTT's mobile unit DoCoMo, which allow access to the Internet. Although I-Mode bandwidth is not at the level of broadband, it does indicate that residential Internet is most likely to be accessed via a mobile device, whilst demand for broadband to the home is likely to be driven by the need to send and receive larger amounts of data. For broadband entertainment in the home, the favoured solution is likely to remain cable, and perhaps this will evolve into FTTH in the future.

Despite the current efforts of cable companies to capture market share, the future of broadband in Japan remains in the hands of the incumbent NTT. It has considerable power over the telecommunications industry and influence over government policy. Although the government is pressing ahead with reforms (under new Prime Minister Junichiro Koizumi) which would encourage further competition in the telecom sector, such changes tend to occur very slowly in Japan. For example, NTT was split into three separate businesses in 1999, however the perception in the industry is that it still operates as a whole and so does not compete on the same level as other businesses. There is currently a bill under review proposing further reforms to NTT by 2003, but lobbying by NTT has stopped this moving forward.

NTT controls 96% of all access platforms to the home/SME (including telephony) and is reported to be reluctant to give this away. Standard call charges set by the government and NTT are relatively high, a factor in slowing the growth of the Internet in Japan. Furthermore, in Japan there is no law set down to enable fair competition and avoid dominance, so there is little that new entrants can do to influence the situation (e.g. The 'Fair Competition Council' established by the Japanese government includes a senior representative from NTT itself). However, the benefits of close links between the incumbent and government may yet be demonstrated. If NTT successfully implement government policy it would put Japan ahead of any other nation in terms of broadband development.

The government has set a broadband target that by 2005 half of all households (30m) will have either ADSL or cable access and a sixth of all households (10m) will have FTTH with the longer term goal of low cost, fixed rate, broadband access for the whole country. The Ministry of Posts and Telecommunications (MPT), now The Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT), has drawn up plans for the deregulation of the sector, and partial unbundling has occurred such that new entrants can lease NTT's local loop at a price fixed by government. However, NTT sees ADSL and other broadband alternatives (such as cable, fixed wireless access and fibre to the home) as a direct threat to its existing business interests (i.e. ISDN, leased lines and standard dial up) and so, until recently, has been reluctant to develop ADSL access. In response to the threat of competition and in conjunction with government policy, NTT is in the process of laying fibre to the curb (to the last node) across the country with the intention of offering FTTH (fibre to the home) to the whole of Japan by 2005. If this is achieved,

it would put Japan at the top of broadband countries in the world. However, although representing a significant step toward the broadband era, there is still considerable investment needed in connecting individual buildings to the last node which may be achieved via fibre or VDSL.

Government regulations are in place to allow open access to the fibre in the curb, and tax incentives and subsidised loans are available for companies prepared to make the investment. However, it would appear that there is still a 5+ year window of opportunity for other access platforms such as cable and ADSL. Competitors offering these alternatives include Tokyo Mettakuri Communications which is now offering ADSL, and Jupiter Communications offering triple play bundles via cable. Apparently, the government is also considering subsidising ADSL and cable to further encourage competition.

Another significant factor in the future of broadband, is the popularity of mobile access platforms (e.g. i-Mode). Although the next generation service (3G), currently on trial, will only provide up to 64Kbps for circuit switched video streaming and up to 384Kbps for packet based data transmission, in the medium term, demand for large mobile bandwidth will not be widespread and so the focus will be on content provision within the constraints of a modest bandwidth.

**Table of Current Offers**

| Market | Company | Platform | Bandwidth (up/down) | Cost in (Month/Initial) |
|---|---|---|---|---|
| Resi-dential | *Usen Broadband Networks* | FTTH | 100 Mbps / 100 Mbps | 59 / 320 |
| | *NTT (Eastern and Western)* | FTTH | 10 Mbps / 10 Mbps | 48 - 179 / 270 |
| | *Tokyo Mettakuri Communications* | ADSL | 288 Kbps / 1.6 Mbps | 56 / 465 |
| | *NTT (Eastern and Western)* | ADSL | 224 Kbps / 512 Kbps | 49 / ? |
| | *Jupiter Communications* | CATV | 256 Kbps / 512 Kbps | 63 / ? |
| | *Odokyu Cable Vision* | CATV | 256 Kbps / 1.5 Mbps | 56 / 465 |
| | *NTT (Eastern and Western)* | ISDN | 64 Kbps / 64 Kbps | 53 / 98 - 704 |
| Bus-iness | *Usen Broadband Networks* | FTTH | 100 Mbps / 100 Mbps | 106 / 513 |
| | *NTT (Eastern and Western)* | FTTH | 10 Mbps / 10 Mbps | 401 / 270 |
| | *Tokyo Mettakuri Communications* | SDSL | 1.6 Mbps / 1.6 Mbps | 561 / 967 |
| | *NTT (Communications)* | ADSL | 512 Mbps / 224 Kbps | 69 / ? |
| | *Cable Television Tokyo* | CATV | 512 Kbps / 256 Kbps | 658 / 193 |

**ISDN:** Japan has a high penetration of ISDN with 4.5m households (10% of households). This would suggest ADSL or other broadband platforms may become popular. However, ISDN is a profitable area of business for NTT which is under threat from alternative access technologies.

**DSL:** Compared to standard dial up and ISDN, the ADSL offer from NTT is for always-on ADSL at ¥5-6,000 ( 49-58) / month. This represents good value to the customer in terms of price of bandwidth, but at this price competitors offering ADSL

will struggle to make a return on their investment and could easily be put out of business if NTT lowered the price further.

ADSL is likely to offer higher bandwidth than cable (for those customers who are prepared to pay more). However, ADSL providers are currently not content providers and so, in the short term, are likely to attract Internet users rather than TV viewers. NTT offered their pilot ADSL service at the end of 1999, but there were service quality problems due to the nature of ADSL, and some problems from interference between ISDN and ADSL which are now resolved. Apart from these technical hitches, competitors have suggested that NTT have little incentive to roll out ADSL as their profit from telephone dial up, ISDN and leased lines will be threatened by always on ADSL.

Full unbundling has not occurred, and does not look likely at present. However, Tokyo Mettakure Communications currently offer ADSL as a pilot service by leasing local loop from NTT. NTT have a product called Flet's ADSL, in which the ISP is connected via an NTT IP network to the DSLAM (see appenix B) and then to home. This system is less expensive and more reliable than a direct connection from ISP to DSLAM to home (not using NTT's IP network). Competitors are likely to lease Flet's ADSL from NTT rather than build their own network. This still leaves NTT in control as they can undercut competitors' ADSL offer (generating a condition of unfair competition and forcing rivals to compete on content and bundled services rather than commoditising bandwidth).

**Digital Terrestrial Transmission:** Digitisation is progressing with the aim of meeting government target for analogue switch off by 2010. The alternatives to terrestrial broadcast will dominate such as DTV to 3G mobile and via other fixed technologies.

**Digital Cable:** As in many European countries, the legacy of cable television is as community access television (CATV) using local networks which are operated by local government and private enterprise partnerships. This means that CATV has been subsidised to some extent by government (up to half of the costs in some cases).

CATV companies (e.g. Titus Communications) have been providing flat rate Internet plus TV plus phone since 1998. However, only recently has the industry begun to push forward with offers of high speed Internet access. The legacy of CATV is one of many local cable TV operators with individual networks that vary in terms of their condition and preparedness for two-way digital transmission. Jupiter Communications has grown rapidly through acquisition of CATV operators in the principle urban areas of Japan (e.g. recently acquiring Titus Communications) and is now offering triple play service (undercutting NTT's telephone service, offering TV in line with regional governments requirements, and also offering high speed Internet access).

Cable television operators such as Jupiter Communications are now in direct competition with ADSL providers. However, they tend to attract customers by focusing on quality content and cost saving bundles of services, rather than commoditising bandwidth. The important factor is not the bandwidth, but delivery of content over the available bandwidth to the satisfaction of customers. This can be

achieved by having close control over the ISP (e.g. AtHome Japan, a new company 42.9% owned by the US cable broadband operator AtHome, 21.4% by Sumitomo and 35.7% by Jupiter Telecommunications). Although there may be occasions (about 20% of the time) when the Internet channel cannot cope with demand and customers experience a reduction in capacity, at present the majority of subscribers remain highly satisfied with the service. An advantage of the cable network architecture is that it is scalable, so if demand rises further, more capacity may be allocated for Internet use.

**Digital Satellite:** There are currently two distinct satellite services operating in Japan: Broadcast Satellite ('Bsat'), which began as an analogue service in 1987 and subsequently launched a digital service in December 2000; and Communication Satellite ('Csat'), which began in 1989 and 1992 as two analogue services called Skyport and CS-BAAN respectively.

Two digital Csat platforms, PerfecTV and DIRECTV Japan, were subsequently established, and each absorbed one of the analogue services. PerfecTV merged later with Japan Sky Broadcasting to form SkyPerfecTV. DIRECTV Japan failed to attract enough subscribers and shut down in 2000. Meanwhile, new digital Csat broadcast services are scheduled to begin in 2001 on-board N-SAT-110, a new communications satellite launched in October 2000. The digital Bsat service comprises television, radio and data broadcasting services with some interactive features. The service is dominated by the national public broadcaster NHK, the independent broadcaster Wowow, and satellite affiliates of the five major terrestrial networks. A number of dedicated datacast networks are expected to provide home banking and other transaction services. The analogue Bsat service, which delivers only NHK and Wowow, will be phased out as subscribers migrate to the digital service.

Competition continues in the digital Csat realm. In 2000, SkyPerfecTV drove DIRECTV Japan out of business and absorbed its subscribers, but new broadcast businesses are preparing to start service in 2001. Although satellite penetration is growing in Japan, there are no immediate launch plans for two-way interactive satellite for the residential/SME markets.

**Fibre Optic:** In conjunction with a government initiative to encourage Japan to keep up with the rest of world in terms of broadband access, NTT announced its plan to provide FTTH to all homes and businesses back in 1996. By 2000, claims have been made that 1m (out of 60m) households had FTTH, with dark fibre to the curb now reaching 45% of all final nodes (95% in cities). Although this would appear to be a major achievement by NTT, competitors argue that apart from complying with government policy, NTT has had little incentive to roll out FTTH as it would undermine its existing business. They also argue that the fibre network that has been laid should be regarded as a government asset rather than and investment by NTT, as the funding of the fibre optic project came from the profits of high telephone charges whilst NTT was owned by the government.

Recent growth in competition from ADSL and cable providers has spurred NTT forward in developing FTTH (some would say out of fear of loosing market share). Furthermore, a company called Usen Broadband Networks is building its own fibre network and currently provides FTTH in three of the twenty three wards (or districts)

of Tokyo and is expanding fast. Their offer is either a 10Mbps or 100Mbps Ethernet to the home for ¥6,000/month (55) using their own network. They forced their way into the market by handing their own fibre optic cable through the streets using the existing infrastructure of poles in the street. These poles are also used by NTT and so Usen were forced to come to an agreement with the Ministry for Posts and Telecommunications allowing them to pay to use the poles and gain the right to occupy the road for installation. Reports say that Usen's actions took NTT by surprise and may have force them to hurry in offering FTTH for fear of loosing market share (NTT recently brought their FTTH plans forward by 10 years). Clearly, if NTT choose to move fast in this direction it will have dramatic consequences for competing providers in all broadband access platforms.

The fibre optic laid by NTT typically goes underground and only surfaces at the final node on the street. From here the only existing infrastructure is copper to the home, however, there is little talk about using VDSL over the last few 100 yards of copper. The suggestion from all sources is that the next step is to connect homes using fibre (i.e. FTTH). Clearly, considerable investment is required to do this and VDSL equipment and potential technical considerations may mean that it is more cost effective to complete the network with fibre. FTTH in this case is likely to be the best solution in terms of reliability as well as bandwidth.

What may make Japan unique (certainly if compared to Europe) is the legacy infrastructure of poles for telecommunications and electricity supply. In Japan there, would be little objection to hanging the fibre optic through the streets from poles, whilst in many European cities this would be considered an intrusion on the visual landscape.

**Fixed Wireless:** The market for FWA in Japan has focused on larger businesses, typically multinational companies who want to set up site in Japan and don't want to wait for the installation of fibre optic, so they choose FWA as it can be in use within days. Also, FWA is marketed for use as a wireless network within multi-tenant buildings linked to the parent transponder on the roof. However, Japanese law requires that a telephone carrier (such as a FWA provider) must offer the service to everyone in a multi-tenant building via the landlord of the whole building. This can cause problems, and so FWA tends to be most successful in situations where the whole building is occupied by the same company.

In June 1999, KDDI Winstar began offering a tailored FWA service to larger businesses at a price of ¥118,000 (1,150) per month for 1.5 Mbps (although the service can provide up to 6Mbps). Since then they have generated ¥1.2 Billion (11m) in revenue from FWA. Consumer service was first offered in August 1999 by Softbank (joint venture by Tokyo Electricity and Microsoft) at several thousand Yen per month, but there are no published subscriber figures. Speednet have also been offering a service in the 2.5GHz band since late 2000, but again there are no figures available for the success of the venture. However there have been concerns about interference as the 2.4GHz band is currently unlicensed and there have been some concerns raised by the police, who may be planning to use a frequency close to 2.5GHz.

In Japan, as elsewhere, FWA is positioned as an alternative technology which complements the main broadband technologies (i.e. fibre, ADSL and cable). FWA and other indoor wireless solutions may attract a niche market demanding fast deployment and portable infrastructure rather than a fixed solution such as fibre.

**Mobile Wireless:** Portable electronic devices have long been popular in Japan, partly because of the large amount of time spent commuting to and from work (estimated at 3hrs a day on average in Tokyo). By adhering to the sense of familiarity with portable electronics, NTT DoCoMo's i-mode phone has been a huge success. It employs 'html' based access to the Internet and has been popular for text messaging, accessing i-mode enabled websites, as well as voice calls (which remain the first priority). Of the 500 or so i-mode enabled websites, the majority target the younger generation offering games and choice of ring tones and screen icons, etc. News and other information services are also popular. Most of the content is text based and the popularity of I-mode Internet access has not been based on the use of graphics (although limited video streaming is possible and the newest versions are Java enabled).

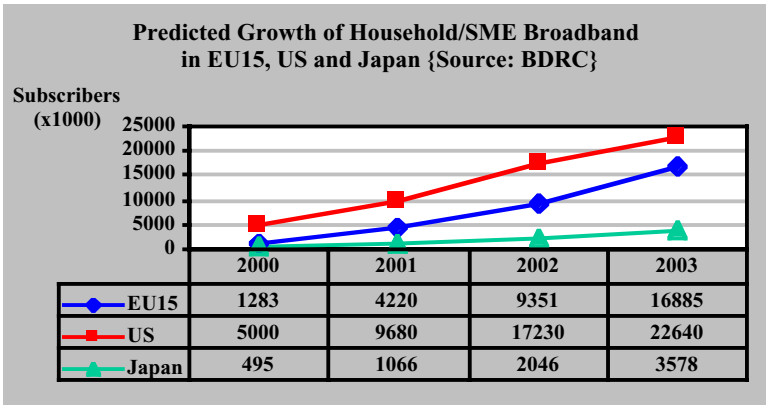
The commercial success of i-mode is partly due to DoCoMo's ability to charge micro payments and pass on this revenue to the content provider via the telephone bill. Back in 1998, DoCoMo recognised the importance of content provision and head hunted a leading figure in Japanese publishing to deal with I-mode content. This publisher insisted that the price of content via I-mode must be the same as the price of the magazines that provide similar content. The concept of paying for content was a totally new approach for NTT, but it certainly worked.

3G licenses were awarded in June 2000 to DoCoMo, Japan Telecom and KDDI. There was no contest and no charge made. In May 2001, NTT DoCoMo began a trial of its 3G service and is planning on launching it in September 2001. The initial offer will be an upgraded i-mode, but the plan is to develop the service to offer video streaming and access to TV broadcast via IP. Interestingly, video streaming will be circuit switched and will be charged at a different rate than packet data transmission. 4G is also in development with talk of achieving a bandwidth of 10+Mbps by 2010. The technological challenges are in the area of antenna size and sensitivity and the number of co-location sites required.

**Powerline:** Since the deregulation of the telecommunications sector in 1985, there have been some trials, by electricity companies, but the possible service was slow and expensive. Electricity companies in Japan are now more likely to invest in laying fibre optic along with electricity cables. Currently, there are no reports of Powerline projects under development in Japan.

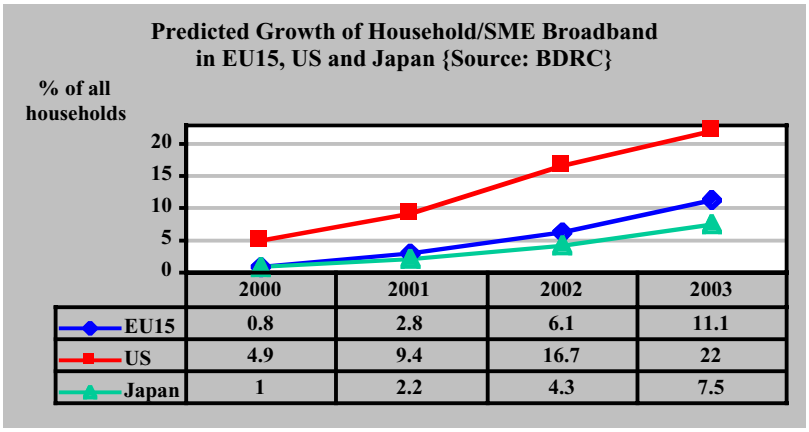
## 10. BENCHMARKING THE EU15 WITH THE US AND JAPAN

The charts below compare the predicted growth of household/SME broadband access in the EU15 with the US and Japan, and show that the US is clearly ahead in terms of number of broadband subscribers and proportion of households with broadband access. Furthermore, it is likely to maintain this position, but by 2002 when over 15% of US households have broadband access, the rate of growth will slow slightly. By comparison, the EU15 and Japan will continue to grow between 2000 and 2003. By this time, both the EU15 and Japan might expect to have reached a penetration of 11% and 8% of households respectively, or around 17m subscribers in the EU15 and 4m in Japan.




| | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|
| EU15 | 1283 | 4220 | 9351 | 16885 |
| US | 5000 | 9680 | 17230 | 22640 |
| Japan | 495 | 1066 | 2046 | 3578 |

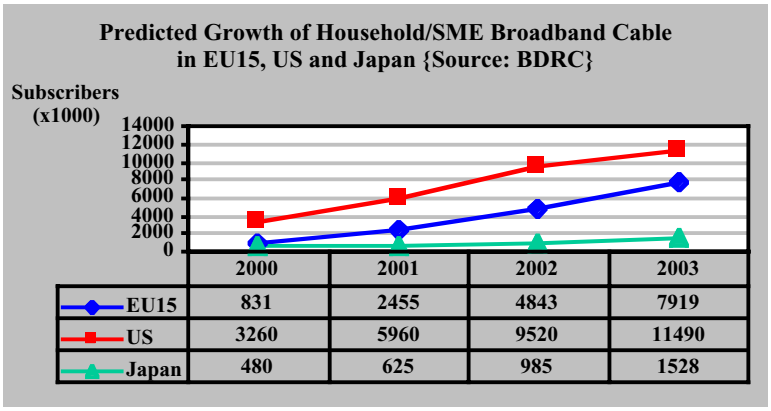
In terms of raw numbers of broadband subscribers, the EU15 had over 1m in 2000, whilst Japan had 0.5m, and the US 5m. When represented as a percentage of total number of households (EU15: 152m; US: 103m; and Japan: 48m), current penetration in the EU15 is behind both the US and Japan. Furthermore, penetration in the EU15 looks set to continue to follow behind the US until 2003, but will overtake Japan in 2001. A closer examination of EU Member States shows considerable variation in terms of broadband development and potential. In both Denmark and The Netherlands, household penetration is almost at the same level as in the US and along with other Northern European Member States, looks set to grow rapidly until 2003, perhaps even outperforming the US in some cases.




| | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|
| EU15 | 0.8 | 2.8 | 6.1 | 11.1 |
| US | 4.9 | 9.4 | 16.7 | 22 |
| Japan | 1 | 2.2 | 4.3 | 7.5 |

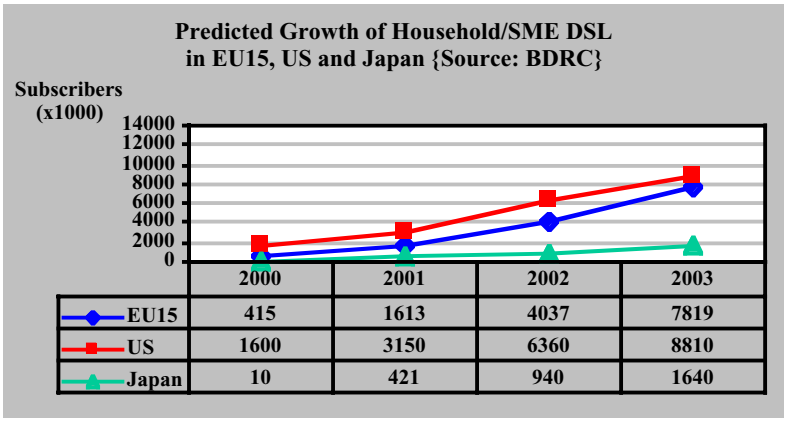
The US dominance can be attributed to the current and potential penetration of broadband cable access (see chart below), which reflects the extent of the legacy cable networks in place to provide DTV and the relatively advanced state of the market. Across the majority of the EU15, either there is no legacy cable infrastructure in place, or extensive upgrading is required before broadband cable can be provided.

Also, with the notable exception of the Benelux Member States, the EU15 cable industry has yet to undergo the market consolidation and separation from incumbent and regional CATV operators necessary before upgrading becomes a possibility. Whilst Japan has an extensive network of cable providing regional CATV, in most cases this is still operated as a joint venture between the local municipal bodies and small private enterprises. New entrant cable operators are gradually buying and upgrading those networks which offer the most potential.




| | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|
| EU15 | 831 | 2455 | 4843 | 7919 |
| US | 3260 | 5960 | 9520 | 11490 |
| Japan | 480 | 625 | 985 | 1528 |

The rate of growth of DSL in the EU15 is predicted to follow that of the US, and may even exceed the US by 2003. Given the current barriers to the development of broadband cable in the EU15, DSL (especially ADSL) penetration is set to catch up with cable over the next three years. However, there will be considerable variation between the EU Member States, with Germany, The UK, France, Italy, Spain, and the Nordic Member States all likely to achieve faster penetration of ADSL than cable between 2000 and 2003. The future of ADSL in Japan depends upon the extent of competition encouraged in the market. However, the view of this study is that the incumbent NTT has little incentive to deliver a fast, large-scale roll out of ADSL.




| | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|
| EU15 | 415 | 1613 | 4037 | 7819 |
| US | 1600 | 3150 | 6360 | 8810 |
| Japan | 10 | 421 | 940 | 1640 |

Alternative access platforms, particularly FWA, are likely to provide competitive pressure for cable and ADSL operators, but will remain niche market products. Perhaps with some governmental incentive, alternative access platforms may also 'fill the gaps' in service left by cable and ADSL. In the longer term, between 2003 and 2010, bandwidth demand will begin to exceed the potential of ADSL and co-axial copper. At this point, fibre to the home will be the obvious solution. Japan is particularly well placed to move quickly to fibre to the home in the future.

# 11. CONCLUSIONS

Considering the technical potential of each access platform, it is apparent that there is a clear winner in terms of speed, reliability and future potential. Of all currently available technologies, fibre optic is the most suited to digital data transmission. Light is the fastest medium known to man, and the current speed of sending and receiving light is faster than any other technology[12], and offers the greatest potential for increased speed in the future. Fibre optic has considerable technical potential and so provides a relatively future proof solution. It is also a reliable platform, which allows for fully symmetric transmission and so is the preferred, and now most commonly deployed, transmission technology for network trunks, country backbones and intercontinental transmission[13].

Despite its proven benefits, fibre optic is not being widely considered as an access platform for the home/SME because of the considerable investment required. The principle barrier is financial, not technical. The problem is that the business model for fibre to the home is hard to justify. To ensure that the best technical solution gets to market, it is necessary to take a long-term perspective. However, like building a 'railroad' through the desert of the 'wild west', such an investment requires almost blind faith in the future of the digital age. But it is precisely this type of belief (albeit in the Internet specifically) that lead to the unprecedented interest in 3G licences and the rapid global growth in value of tech stocks and Internet related businesses at the beginning of 2000. However, when this 'bubble burst', so did the immediate chances of rapid and extensive deployment of broadband access platforms.

Continuing the logic that fibre optic technology is the best solution for data transmission, it becomes apparent that the recent enthusiasm for high-speed mobile transmission (3G) may prove to have been misplaced. To compromise on speed in order to receive and transmit data at any location and at any time, may not be the best fit between human behaviour and the available technology. Perhaps a better solution may prove to be geographically fixed 'hot-spots' (wired or wireless), which allow very large amounts of data to be stored in the memory of a mobile terminal (PDA, laptop, etc.), and then accessed while on the move. This could then be combined with comparatively low-speed mobile access. Furthermore, innovations such as Wireless Optical Access and Fixed Wireless Access have the potential to provide seamless connections which overcome the need to lay fibre, but are as fast as fibre over distances of 1-2km.

In the current market climate, with the threat of further economic slow-down and large debts among many incumbent telecommunications operators, businesses are likely to prefer to maximise short-term returns rather than invest in the future. The likelihood is that interim technical solutions (e.g. ADSL and 3G) may prevail for many years and hold back the potential of ultra high-speed access to the home (e.g. fibre optic). However, it is in this climate that a decisive and forward thinking action by a competitor could stimulate the market.

[12] The speeds achieved using Fixed Wireless Access and Optical Wireless Access over short distances using very high frequencies may approach that of fibre optic.
[13] In some cases satellite solutions are used, as an alternative to fibre optic.

Although ADSL, coaxial cable, FWA, and satellite are technically limited in different respects, they have other advantages that make them quick to get to market as access platforms (see chapter 4 for full explanation). Given the relatively early stages of demand for broadband access, and the lack of alternatives available to the market, these platforms are likely to be adopted by those prepared to pay for faster access to the Internet. But the Internet remains a relatively new phenomenon and it will take time for the mass-market to adjust their behaviour to take advantage of the, as yet undiscovered, potential of the digital era. Furthermore, broadband access appears expensive to consumers when presented as merely faster access to the Internet in its current form.

The answer to developing the market for broadband access is to market content and not access. The content that is currently most popular is TV (plus films, games, radio, music and the web) and as digital convergence progresses, and new interactive media emerge, the market will become increasingly willing to pay for new forms of content (perhaps without even considering how it arrives). Only when this occurs will broadband stimulate use, which in turn will stimulate demand.

Across the EU, the principle characteristic of the broadband market is diversity (see chapter 10). This represents both a danger and a potential strength. In terms of the roll out of physical infrastructure, such diversity could lead to a highly fragmented market in which different regions have different alternatives. This would be very bad for the future of broadband as investment in digital transmission systems works best where there is technical harmonisation and a common vision of the future. However, diversity of technical solutions could become a great strength if it leads to a wider choice of access platforms to the home/SME. For example, ADSL, cable and FWA (plus other platforms), all available in the same market to the same customers.

Given the importance of content, the diversity of cultural contexts in the EU also represents a danger and a potential strength. For example, the anglophone nature of the Internet was initially a strength assisting its rapid growth, but now non-English speaking cultures are beginning to develop their own Internet content. Such cultural diversity increases the depth and richness of the content available, and encourages more people to benefit from the potential of the digital era. The EU is very well placed to benefit from such rich and varied content.

## 12. RECOMMENDATIONS

Given the current market climate, which may not be conducive to rapid broadband deployment, government may play an important role to encourage a faster development of broadband platforms in Europe. Below are measures that could be implemented in Europe – some at EU, others at national level - to accelerate broadband take-up. These measures also cover important issues such as ensuring access to broadband platforms in all regions and cities in Europe.

- For the short to medium term, stimulate demand for broadband by encouraging the widest possible roll out of all platforms and the possibility of low cost access:
  - maintain pressure on incumbents to unbundle local loops fully
  - ensure that cable operators do not gain exclusive access to customers
  - encourage competition between platforms (e.g. ADSL, cable & FWA)
  - ensure a strong legal position with regard to anti-competitive situations
  - encourage Member States to learn from the experiences of others
  - provide tax incentives/subsidies for investment in less profitable regions
  - promote standardisation of components and protocols

- Encourage European wide business strategies by harmonising the regulatory environment across the EU, with regard to broadband deployment. In particular, to encourage a common situation regarding the deployment of physical infrastructure such as hanging cables through the streets, digging and occupying ducts, and the installation of wireless co-location sites.

- Stimulate demand for digital broadcasting (which will encourage the wider population to access digital content):
  - provide tax incentives/subsidies for analogue TV converters

- For the long term, provide a clear vision toward universal fibre optic transmission:
  - provide tax incentives/subsidies for fibre optic development
  - develop pan-European policy on physical infrastructure for fibre optic
  - encourage industry to share ideas and agree common standards

- Further investigate the possibilities of Fixed Wireless Access and Optical Wireless Access as viable alternatives to laying new physical infrastructure to every home/SME.

# APPENDIX A: GLOSSARY

**3G**
UMTS (Universal Mobile Telecommunications Service) is the third generation (3G) of European cellular mobile communications. It uses wide-band CDMA technology, which is a packet-based system for the transmission of digital information such as text, voice, video, and multimedia at data rates up to 2Mbps upstream and downstream.

**BRI (Basic Rate Interface.)**
An alternative term for ISDN2 used over the local loop

**Broadband Access**
The US Federal Communications Commission defines advanced telecommunications capability as "high-speed, switched, broadband telecommunications capability that enables users to originate and receive high-quality voice, data, graphics, and video telecommunications using any technology." For the purposes of this report we concur with the FCC but would add that packet based as well as switched telecommunications are included in our definition of advanced telecommunications capability (or broadband access). Furthermore, our definition of 'high speed' is not absolute, but reflects current expectations. So for example, 'high-speed' would include ADSL at 128Kpbs upstream and 512Kbps downstream, although there are access platforms, such as fibre optic, that could provide 10-100 Mbps in both directions. Platforms that only provide high-speed in one direction have limited applications. This issue is discussed within the report.

**Cable Modem**
A cable modem is a device that enables you to hook up your PC to a local cable TV line. The data rate far exceeds that of the prevalent 28.8 and 56 Kbps telephone modems and the up to 128 Kbps of Integrated Services Digital Network (ISDN). A cable modem can be added to or integrated with a set-top box that provides your TV set with channels for Internet access. In most cases, cable modems are furnished as part of the cable access service and are not purchased directly and installed by the subscriber.

A cable modem has two connections: one to the cable wall outlet and the other to a PC or to a set-top box for a TV set. Although a cable modem does modulation between analogue and digital signals, it is a much more complex device than a telephone modem. It can be an external device or it can be integrated within a computer or set-top box.

**CATV Community Access Television**
Cable TV is also known as "CATV" (Community Antenna TV or Community Access TV). This is because of its origins, particularly in Europe, as a community orientated broadcast media. Often the cable TV network has been built up to provide service to particular town or region. The content of CATV includes regional programmes as well as national and even international channels.

**CDMA**
The term CDMA refers to Code Division Multiple Access, and can mean any of several protocols used in so-called second-generation (2G) and third-generation (3G) wireless communications. As the term implies, CDMA is a form of multiplexing, which allows numerous signals to occupy a single transmission channel, optimising the use of available bandwidth. The technology is used in ultra-high-frequency (UHF) cellular telephone systems in the 800-MHz and 1.9-GHz bands.

The original CDMA standard, also known as CDMA One and still common in cellular telephones in the U.S., offers a transmission speed of only up to 14.4 Kbps in its single channel form and up to 115 Kbps in an eight-channel form. CDMA2000 and Wideband CDMA deliver data many times faster.

**Co-axial cable**
Coaxial cable is the kind of copper cable used by cable TV companies between the community antenna and user homes and businesses. Coaxial cable is sometimes used by telephone companies from their central office to the telephone poles near users. It is also widely installed for use in business and corporation Ethernet and other types of local area network.

Coaxial cable is called "coaxial" because it includes one physical channel that carries the signal surrounded (after a layer of insulation) by another concentric physical channel, both running along the same axis. The outer channel serves as a ground. Many of these cables or pairs of coaxial tubes can be placed in a single outer sheathing and, with repeaters, can carry information for a great distance.

**Dark fibre**
Fibre optic that has been installed but remains unlit

**DSL**
DSL (Digital Subscriber Line) refers to a set of similar technologies that facilitate the transmission of digital data over copper 'twisted pair' cable, without amplifiers or repeaters and without the need for conversion to analogue.

There are various types of DSL, the most significant of which are described below:

*HDSL (High bit-rate DSL)* – This was the first version to be developed. It is 'symmetrical' DSL where an equal amount of bandwidth is used for transmission into and out of a user's premises.

*VDSL (Very high-bit-rate DSL)* - Provides very high bandwidth asymmetrically (up to 26-52Mbps in one direction and 2-3Mbps in the other).

*G.Lite* - A low cost version which overcomes the need for signal splitter equipment in the home and which, in theory, eliminates the need for an engineer to visit each user's home to install equipment.

*ADSL (Asymmetric Digital Subscriber Line)* - This is the technology currently being offered to the market. It is called "asymmetric" because most of its bandwidth is devoted to the downstream direction, sending data to the user.

**DSLAM**
A Digital Subscriber Line Access Multiplexer (DSLAM) is a network device, usually at a telephone company local exchange or central office, that receives signals from multiple customer Digital Subscriber Line (DSL) connections and puts the signals on a high-speed backbone line using multiplexing techniques.

**DTT Digital Terrestrial Television**
Digital broadcasting is a relatively new system of transmitting TV, radio and other new media. It turns pictures and sound into a string of binary digits (rather than a variable wavelength) which are transmitted to the customer and decoded by a set-top box. Digital TV (DTV) can be broadcast across terrestrial networks, (DTT) or from satellite (DTH). In the case of DTT, the digital signal is transmitted using the existing analogue infrastructure.

**DTV Digital Television**
Digital broadcasting is a relatively new system of transmitting TV, radio and other new media. It turns pictures and sound into a string of binary digits (rather than a variable wavelength) which are transmitted to the customer and decoded by a set-top box. Digital TV (DTV) can be broadcast across terrestrial networks, (DTT) or from satellite (DTH).

**DTH Direct to home…satellite transmission**
Digital TV (DTV) can be broadcast across terrestrial networks, (DTT) or from satellite (DTH). The transmission is sent to the satellite via an up link from a ground-station, and then it is simultaneously broadcast to a wide area (known as multi-casting). To receive the signal, and so have access to many channels of TV, the user requires a satellite dish and set top box linked to an ordinary TV set. This method of reception is called Direct to Home (DTH). Alternatively, the broadcast can be received by a cable company, and transmitted down the cable network to homes.

**Ethernet**
Ethernet refers to the most widely installed local area network (LAN) technology. Specified in a standard, IEEE 802.3. An Ethernet LAN typically uses coaxial cable or special grades of twisted pair

wires. The most commonly installed Ethernet systems are called 10BASE-T and provide transmission speeds up to 10 Mbps.

**FTTC Fibre to the curb**
Where fibre-optic networks have been deployed, if the fibre is installed up to the curb outside the home, this is known as FTTH. The last connection into the home will be usually mad using copper.

**FTTH Fibre to the home**
Where fibre-optic networks have been deployed, if the fibre is installed right into the home (compared to FTTC), then this is known as FTTH. Once in the home, there will be a box installed to convert the light into electrical signals.

**FWA Fixed Wireless Access**
FWA is used in this report as the generic name for any radio technology, which provides a fixed wireless link between the end of the physical telephone network and the users premises. This technology is also referred to as Wireless Local Loop and Radio Wireless Access.

**GSM**
GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of time division multiple access (Time Division Multiple Access) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitises and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band.

GSM is the de facto wireless telephone standard in Europe. GSM has over 120 million users worldwide and is available in 120 countries, according to the GSM MoU Association. Since many GSM network operators have roaming agreements with foreign operators, users can often continue to use their mobile phones when they travel to other countries.

**HFC Hybrid Fibre Coax**
A hybrid fibre coaxial (HFC) network is a telecommunication technology in which fibre optic cable and coaxial cable are used in different portions of a network to carry broadband content (such as video, data, and voice). Using HFC, a local CATV company installs cable from the cable head-end (distribution centre) to serving nodes located close to business and residential users and from these nodes uses coaxial cable to individual businesses and homes. An advantage of HFC is that some of the characteristics of cable (high bandwidth and low noise and interference susceptibility) can be brought close to the user without having to replace the existing coaxial cable that is installed all the way to the home and business.

Both cable TV and telephone companies are using HFC in new and upgraded networks and, in some cases, sharing the same infrastructure to carry both video and voice conversations in the same system.

**IP Internet Protocol**
The Internet Protocol (IP) is the method or protocol by which data is sent from one computer to another on the Internet. Each computer (known as a host) on the Internet has at least one IP address that uniquely identifies it from all other computers on the Internet. When you send or receive data (for example, an e-mail note or a Web page), the message gets divided into little chunks called packets. Each of these packets contains both the sender's Internet address and the receiver's address.

Because a message is divided into a number of packets, each packet can, if necessary, be sent by a different route across the Internet. Packets can arrive in a different order than the order they were sent in. The Internet Protocol just delivers them. It's up to another protocol, the Transmission Control Protocol (TCP) to put them back in the right order.

**ISDN**
Integrated Services Digital Network (ISDN) allows for simultaneous analogue and digital data transmission. It is a set of digital transmission standards, and a network infrastructure that allows digital transmission over existing copper telephone wiring (as well as over other media). ISDN2 and ISDN30. Broadly, there are two types of ISDN, *Primary Rate Interface (PRI) or ISDN30*, which is

used over higher performance copper cable to provide leased lines for businesses (see section on Leased Lines). And *Basic Rate Interface (BRI) or ISDN2*, which is used over the local loop (i.e. 'twisted pair' copper), and is available for the home/SME. In common parlance, ISDN refers to ISDN2 or BRI.

**iTV Interactive TV also known as 'Click through TV'**
Interactive TV means allowing the viewer to interact with the television set in ways other than simply controlling the channel and the volume and handling videotapes. Typical interactive TV uses are selecting a video film to view from a central bank of films, playing games, voting or providing other immediate feedback through the television connection, banking from home, and shopping from home.

Interactive TV involves adding a special "set-top unit" to the existing television set. In addition, other installation and infrastructure arrangements are required, depending on the particular approach. Most services involve offering special programming, news, and home shopping and a number offer video-on-demand and home banking. Since interactive TV still requires a considerable investment by both the service provider and the consumer and because interactive applications are still being explored, it is somewhat difficult to predict how soon it will become widely deployed.

**Local loop**
In telephony, a local loop is the wired connection from a telephone company's office (local exchange) in a locality to its customers' telephones at homes and businesses. This connection is usually on a pair of copper wires called twisted pair.

**Leased line**
A leased line is a telephone line that has been leased for private use. It is a dedicated connection, rented as an "always-on" service for exclusive 24-hour, 7 -days-a-week service, usually as an alternative to a switched or dial-up line.

**MAN Metropolitan Area Networks**
A MAN (metropolitan area network) is a network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network () but smaller than the area covered by a wide area network (wide area network). The term is applied to the interconnection of networks in a city into a single larger network (which may then also offer efficient connection to a wide area network). It is also used to mean the interconnection of several local area networks by bridging them with backbone lines. The latter usage is also sometimes referred to as a *campus network*.

**MP3**
MP3 is a standard technology and format for compression a sound sequence into a very small file (about one-twelfth the size of the original file) while preserving the original level of sound quality when it is played. MP3 files (identified with the file name suffix of ".mp3") are available for downloading from a number of Web site.

MP3 files are usually download-and-play files rather than streaming sound files that you link-and-listen-to with RealPlayer and similar products (However, streaming MP3 is possible.)

**OA Optical Access**.
Data transmission via laser signals through open air.

**PDA Personal Digital Assistant**
PDA (personal digital assistant) is a term for any small mobile hand-held device that provides computing and information storage and retrieval capabilities for personal or business use, often for keeping schedule calendars and address book information handy. The term handheld is a synonym. Many people use the name of one of the popular PDA products as a generic term. These include Hewlett-Packard's Palmtop and 3Com's PalmPilot.

Most PDAs have a small keyboard. Some PDAs have an electronically sensitive pad on which handwriting can be received. Apple's Newton, which has been withdrawn from the market, was the first widely-sold PDA that accepted handwriting. Typical uses include schedule and address book storage

and retrieval and note-entering. However, many applications have been written for PDAs. Increasingly, PDAs are combined with telephones and paging systems.

**POTS**
POTS is a term sometimes used in discussion of new telephone technologies in which the question of whether and how existing voice transmission for ordinary phone communication can be accommodated. For example, Asymmetric Digital Subscriber Line and Integrated Services Digital Network provide some part of their channels for "plain old telephone service" while providing most of their bandwidth for digital data transmission.

**Powerline**
The concept of using the existing network infrastructure of electrical power suppliers for data transmission. Digital Powerline (DPL, also known as Power Line Technology or PLT), as developed by Nortel and NorWeb (United Utilities), is capable of continually transmitting data at a rate of 1-2Mbps over the existing electricity infrastructure which brings electrical power to homes and businesses.

**SME (Small/Medium Enterprise)**
SME is a term used to categorise the smaller end of the business market in demographic terms. SMEs will be defied in terms of turnover or employees, but the upper limit varies. Typically, SMEs may be defined as having up to 150 employees. Turnover will depend on the market sector being assessed.

**Twisted pair**
Twisted pair is the ordinary copper wire that connects home and many business computers to the telephone company. To reduce crosstalk or electromagnetic induction between pairs of wires, two insulated copper wires are twisted around each other. Each connection on twisted pair requires both wires. Since some telephone sets or desktop locations require multiple connections, twisted pair is sometimes installed in two or more pairs, all within a single cable. For some business locations, twisted pair is enclosed in a shield that functions as a ground. This is known as shielded twisted pair (STP). Ordinary wire to the home is unshielded twisted pair (UTP).

**UMTS**
UMTS (Universal Mobile Telecommunications Service) is the third generation (3G) of European cellular mobile communications. It uses wide-band CDMA technology, which is a packet-based system for the transmission of digital information such as text, voice, video, and multimedia at data rates up to 2Mbps upstream and downstream.

# APPENDIX B: TECHNICAL DESCRIPTIONS

## ISDN

Integrated Services Digital Network (ISDN) allows for simultaneous analogue and digital data transmission. It is a set of digital transmission standards, and a network infrastructure that allows digital transmission over existing copper telephone wiring (as well as over other media). ISDN evolved in order to provide a reliable end-to-end digital connection of higher bandwidth than standard dial up, whilst also continuing to supporting legacy analogue equipment. In this way, ISDN was designed to allow for the gradual migration of technologies from analogue to digital.

Broadly, there are two types of ISDN, Primary Rate Interface (PRI) or ISDN30, which is used over higher performance copper cable to provide leased lines for businesses (see section on Leased Lines). And Basic Rate Interface (BRI) or ISDN2, which is used over the local loop (i.e. 'twisted pair' copper), and is available for the home/SME. In common parlance, ISDN refers to ISDN2 or BRI.

To benefit from an ISDN connection it is necessary to have an adapter installed in the home/office (in place of a modem). The user can then increase connection speed up to 128 Kbps in one direction, or 64Kbps both. In practice, however, most people are limited to 56 Kbps or 64 Kbps.

For the purposes of benchmarking broadband access, ISDN (at BRI) does not qualify as a 'broadband' technology on the grounds that, even at the maximum of 128Kbps, this level of bandwidth is not high enough.

## DSL

DSL (Digital Subscriber Line) refers to a set of similar technologies that facilitate the transmission of digital data over copper 'twisted pair' cable, without amplifiers or repeaters and without the need for conversion to analogue. This technology has evolved in order to provide increased bandwidth over the 'last (or first) mile' between the customer and the first node within the network, which is typically the local telephone exchange.

Higher bandwidth is achieved through advanced modulating techniques, which overlay a digital data stream onto a high speed analogue signal. The Digital Subscriber Line Access Multiplexer (DSLAM) is the cornerstone of the DSL solution and is used to interconnect multiple DSL users to a high-speed backbone network. In upgraded networks, the DSLAM connects to an asynchronous transfer mode (ATM) network that can aggregate data transmission at gigabit data rates. At the other end of each transmission, a DSLAM de-multiplexes the signals and forwards them to appropriate individual DSL connections. In addition to handling traditional circuit switched applications, the DSLAM is designed to process packet based data necessary for Internet Protocol (IP) routing.

There are various types of DSL, the most significant of which are described below:

HDSL (High bit-rate DSL) - This was the first version to be developed. It is 'symmetrical' DSL where an equal amount of bandwidth is used for transmission into and out of a user's premises. This has also evolved into SDSL (Symmetrical DSL) which represents a viable alternative to a leased line for businesses sending and receiving large amounts of data.

VDSL (Very high-bit-rate DSL) - Provides very high bandwidth asymmetrically (up to 26-52Mbps in one direction and 2-3Mbps in the other). However, this speed is limited to copper lines up to 300 meters in length. In the future, VDSL may be suited to businesses and residences benefiting from a Fibre-To-The-Curb (FTTC) network or those situated very close to the local exchange. It is envisioned that VDSL may emerge somewhat after ADSL is widely deployed, and will co-exist with it. The transmission technology in some environments is not yet determined, but when these issues are resolved, VDSL technology may be part of the next generation of high-speed user access equipment. At these speeds, full convergence with broadcast television (supporting DTV) and video streaming will be possible in addition to fast Internet access and telephone. However, VDSL moves away from the basic premise of DSL as a local loop technology and the level of investment required for such a new infrastructure is currently not viable.

G.Lite - A low cost version which overcomes the need for signal splitter equipment in the home and which, in theory, eliminates the need for an engineer to visit each user's home to install equipment. The trade off is lower bandwidth. In practice there have been some technical difficulties which have held up the roll out of this type of DSL.

ADSL (Asymmetric Digital Subscriber Line) - This is the technology currently being offered to the market. It is called "asymmetric" because most of its bandwidth is devoted to the downstream direction, sending data to the user. Only a small portion of bandwidth is available for upstream or user-interaction. This form of DSL has evolved because a higher-speed signal is more reliably transmitted from the local exchange to the remote location than could be achieved in the other direction. This is because of the effects of cross talk and attenuation (see explanation below), which are more prevalent at higher amplitudes and frequencies, and explains why the lower frequencies are used for the upstream path.

Of all the DSL technologies, ADSL is designed to maximise bandwidth over the longest possible distance. Of course, the asymmetry can also be marketed on the grounds that most Internet use requires lots of downstream bandwidth (for graphics and multi-media experiences), but user requests and responses are small and require little upstream bandwidth.

The upper limits of ADSL bandwidth, which are widely quoted, are 6 to 8Mbps downstream and up to 640Kbps upstream. This would enable continuous downstream transmission of motion video, audio, and even 3-D effects, but would not be sufficient for live DTV at the quality currently expected via other available access platforms (i.e. satellite, cable, and terrestrial). The upper limit on the upstream would, for example, allow a 16Mb file (or 20 high resolution photographs) to be sent in approximately 4 minutes.

However, there are certain technical limitations to ADSL. These are: Attenuation, or weakening of the signal over distance; and Crosstalk, or interference at points in the network where twisted pairs are bundled together (i.e. at the exchange). The impact of these limitations is, primarily, determined by the distance the signal has to carry (i.e. the length of the local loop). However, the gauge of copper wire (typically 0.4mm or 0.5mm, although newer cable is 0.6mm) and the quality of insulation (which is related to the age of the network) are also significant. Also related to the age of the network, is reduced bandwidth caused by 'bridged taps' or un-terminated extensions to the loop were networks have undergone changes and alternations in the past.

Deliberately imposed bandwidth limitations allow the operating companies to manage any attenuation and cross talk interference as the technology is rolled out, since the effects are situation specific and so difficult to predict. Furthermore, ADSL subscribers have to share network bandwidth beyond the local exchange so a fairly conservative bandwidth offer will ensure that there is sufficient network capacity to maintain the quality of service that is promised if take up is very high.

Typically, the initial offers have been in the region of 512Kbps to 1.544Mbps downstream and about 128Kbps upstream. Whilst this bandwidth will make the current Internet appear instant and will further improve IP-based, compressed video such as MPEG2, there will remain significant limitations to the degree of convergence with other broadcast media. If a definition of broadband as 2Mbps and above is used, then ADSL does not yet qualify as a true broadband technology. At 512Kbps down and 128Kbps up, ADSL represents an improvement on ISDN for a land line connection, but not the great leap in bandwidth as is often implied. What may prove significant at these speeds, is the ability of new media to convergence with UMTS content, which will be supported by a similar bandwidth.

In theory, some users could receive a much higher bandwidth than others depending upon their distance from the local exchange. For example, a loop length of 2.75km can support a maximum bandwidth of 1.5Mbps at full rate ADSL while a local loop of 5.5km will not support ADSL without additional interventions. This speed/distance trade off is a crucial factor in the likely roll out of DSL and is discussed below under industrial characteristics. Future developments of DSL are likely to focus on improving bandwidth over distance.

## LEASED LINES

A leased line is a telephone line that has been leased for private use. It is a dedicated connection, rented as an "always-on" service for exclusive 24-hour, 7 -days-a-week service, usually as an alternative to a switched or dial-up line. Typically, large companies rent leased lines from the incumbent operator to interconnect different geographic locations in their company. Originally, leased lines were used to interconnect a LAN telephony system, or for point-to-point data transfer. However, the Internet has generated enormous demand for leased lines between organisations and ISPs.

The line itself often uses ISDN30 (Primary Rate Interface of PRI IDSN) as a transmission standard. ISDN30 provides 30 channels carried on coaxial copper cable and is known as an E-1 connection in Europe. To increase bandwidth, multiples of the E-1 cable can be laid together as E-2, E-3 typically up to E-5 connections. A PRI line does not usually terminate at the end users' terminal equipment; rather it serves as a trunk between customer-based switching equipment (a PBX) and an ISDN termination at the central office. As an example, ISDN30 over E-1 can transmit 30 x 64Kbps (or around 2Mbps).

Depending upon the type of cable used (multiples of E-1 or even ) a leased line can provide a multi-channel bandwidth of anywhere between 65 Kbps up to 10Gbps in both/either directions. A leased line is arranged to suit the needs of the user in terms of interactivity and symmetry. In the case of a business to business line the need is likely to be symmetrical. In the case of Internet access the need may be more asymmetrical.

## DIGITAL TERRESTRIAL

When television began in the 1940s and 1950s, the favoured broadcast platform chosen by many countries was an analogue signal transmitted through the air from regional broadcast stations and picked up by the customers rooftop or indoor aerial. This analogue method still remains the norm in many countries across Europe (see below).

Digital broadcasting is a relatively new system of transmitting TV, radio and other new media. It turns pictures and sound into a string of binary digits (rather than a variable wavelength) which are transmitted to the customer and decoded by a set-top box. This set-top box is, in turn, connected to the old analogue TV, which, depending on the set-top box characteristics, can effectively be turned into an Internet terminal. Alternatively, the digital signal can be displayed directly through a digital TV set.

The first commercial digital television (DTV) service in Europe, was offered by Canal+ in 1996. Indeed, DTV services via satellite and cable are recognised as being the pre-cursors to the subsequent development and implementation of DTV via terrestrial broadcast (also known as digital terrestrial television or DTT). In the case of DTT, the digital code is transmitted via the existing analogue infrastructure (i.e. from regional broadcast stations to the customers old analogue aerial).

The advantages of DTV over analogue TV include:

- Superior image resolution (detail) and audio quality for a given bandwidth
- Smaller bandwidth for a given image resolution (meaning 30+ digital channels can be transmitted, rather than 5 over the same bandwidth in analogue)
- Interactivity between viewer and broadcaster
- Consistency of reception over varying distances
- Convergence with other digital broadcast platforms (cable and satellite)

- As set-top boxes evolve into 'home consoles' there are likely to become compatible with other digital devices in the home (Internet over PC, DVD, games etc.)

The design of a set-top box depends upon the standard adopted for decoding the signal. In Europe the standard is known as DVB (Digital Video Broadcast), whilst in the US the standard is known as ATSC (Advanced Television Standards Committee). More sophisticated set-top boxes also contain a hard drive for storing recorded television broadcasts, for downloaded software, and for new media applications provided by your DTV service provider (e.g. Internet, games etc.).

In terms of bandwidth, DTT can broadcast 30 or more standard definition channels at any one time, each demanding up to 6Mbps (e.g. a broadcast bandwidth of c.200Mbps, depending upon the range of frequencies available). With a digital signal, comes the possibility to receive multi-cast Web pages (or Web-casts). In other words, broadcast channels could be made available for transmission of particular Web content. For interacting with such a Web site, the set-top would contain a Web browser (i.e. a Hypertext Transfer Protocol client) and would code and decode transmissions using IP (Internet Protocol). However, DTT does not yet allow for a return or upstream path (although there are radio frequency return channels under development, they are not yet effective enough to deploy commercially). So, as with satellite connection, a limited interactivity is achieved with the upstream path returning via the telephone line. This is not an ideal solution as it ties up a standard phone line while interaction takes place, unless the customer has a dedicated line installed or upgrades to ISDN or ADSL.

Apart from limited interactivity, critics also say that most people are unlikely to notice any improvements in picture quality or sound, as they will not be apparent if experienced on a typical analogue TV set. And there have been concerns raised about the ability of indoor aerials to pick up a digital signal. In summary, it seems it will be necessary for the user to upgrade their entire system in order to experience improvements in quality. Of course, even with old analogue equipment and a set-top box the number of channels will increase significantly.

## CABLE AND CABLE MODEMS

Historically, coaxial copper cable was the preferred high bandwidth carrier. Much of the telecommunication network beyond the local loop was coaxial copper cable (and still is in less developed countries), and coaxial copper cable is widely deployed as the carrier for 'cable TV'. However, in recent years most telecom companies and some cable operators have upgraded their networks to fibre optics. In the case of the cable operators, they have build hybrid fibre networks, which use coaxial and fibre at different points in the network architecture.

This cable is called "coaxial" because it includes one physical channel that carries the signal surrounded (after a layer of insulation) by another concentric physical channel, both running along the same axis. The outer channel serves as a ground. Pairs of coaxial cable can be placed in a single outer sheathing and, with repeaters, can carry

information for a great distance. The construction and shielding of a coaxial cable give it a good combination of high bandwidth and excellent noise immunity.

There are two types of coaxial cable: baseband and broadband.

Baseband is a 50-ohm cable, which is commonly used for digital transmission in local or wide area networks (LAN or WAN). The bandwidth possible depends on the cable length. With 1km cables, a maximum data rate of 1 to 2 Gbps without repeating is feasible.

Broadband is a 75-ohm cable, which is commonly used for analogue transmission by Cable TV operators. Broadband systems are divided up into multiple channels, with the 6Mhz channel typically used for television broadcasting. Each channel can be used for analogue television, CD-quality audio, or a digital bit stream at about 3 Mbps, independent of the others. Television and data can be mixed on one cable.

Cable TV is also known as "CATV" (Community Antenna TV or Community Access TV). This is because of its origins, particularly in Europe, as a community orientated broadcast media. Often the cable TV network has been built up to provide service to particular town or region. The content of CATV includes regional programmes as well as national and even international channels. With the rise in demand for low cost Internet access, cable networks have become a popular way to access the Internet and other new forms of multimedia information and entertainment services (especially in the USA and The Netherlands).

A cable modem is used to convert the signal from analogue into digital for use with digital equipment in the home (in much the same way as a dial-up modem over the telephone line). It connects the PC to the local cable TV socket in the home/business. In the best possible circumstances, the available bandwidth for Internet service over CATV coaxial cable is up to 27Mbps downstream, and about 2.5Mbps upstream. However, there are other factors limiting this potential.

Before a cable network can be used for full Internet access, the connection points (or nodes) have to be upgraded to allow two-way data transmission. This represents a major investment for cable companies and takes time to roll out. Furthermore, a consequence of CATV network architecture is that a single coaxial cable is often shared by a number of houses on the same street as this design is well suited to the broadcast of identical channels to all subscribers. However, the narrowcast demands of the Internet mean that every user will require a different data for the downstream path and the upstream. This then places an accumulative load on the system, rather than sharing the same downstream data. Hence achievable bandwidth depends upon the nature of the network, and the number of Internet users at any one time.

## SATELLITE

There are three types of satellite, as follows:

Geo-stationary (GEO) are typically used for meteorology and orbit the earth at a height of 35,500 km. There are projects which plan to use GEO constellations to

provide DTV and broadband access. In this case, a constellation of 4, high power satellites are required for global coverage. They tend to be very heavy and very expensive, but wide coverage is achieved with fewer launches. Current projects are planning to launch such satellites which have the routing and switching hardware and software on board as well as the transponders necessary to receive and transmit from point to point as well as broadcast.

Elliptical Orbit are used, to a limited extent, by government and some commercial services. They move fastest at their lowest altitude (apogee) and slowest at highest (perigee). These are not typically used for DTV or broadband access.

Low and Medium Earth Orbit (LEO and MEO) are used for telecommunication and broadband access. They fly close to the earth in order to minimise signal attenuation. This means that they have to travel at high speed (an orbit can range from 90 minutes to a few hours). For uninterrupted communication, at least one satellite must be in line of sight. To achieve this, they are lightweight and are flown in constellations so that one takes over from the other at fixed intervals. This type of satellite is sometimes referred to as a 'bent pipe' solution as they are used to bounce a signal to a terrestrial routing and switching centre, minimising the hardware required onboard.

Modern communication satellites can receive and re-transmit thousands of digital signals simultaneously. The transmission is sent to the satellite via an up link from a ground-station, and then it is simultaneously broadcast to a wide area (known as multi-casting). To receive the signal, and so have access to many channels of TV, the user requires a satellite dish and set top box linked to an ordinary TV set. This method of reception is called Direct to Home (DTH). Alternatively, the broadcast can be received by a cable company, and transmitted down the cable network to homes.

Digital television (DTV) services by satellite were first launched in 1994, by DirecTV in the United States and in Europe by Canal+ in 1996. Satellite communications are very well suited to broadcast and multi-cast applications such as DTV as they can transmit a very large number of channels, simultaneously to any subscriber situated within a 'footprint' the size of a country or continent. Although expensive to deploy, the incremental cost per viewer is very low.

Because it is possible to multi-cast hundreds of different channels simultaneously, operators can give the limited impression of interactivity by allowing subscribers to switch between multiple channels of the same TV programme (e.g. different camera angles at a sports match).

To achieve greater interactivity, it is necessary to connect the set-top box to the telephone line (or any other out-going network) for the return path. This is known as the Broadband Data Dissemination Network (BDDN). Because, in most cases, the user will be relying on standard dial up speeds via analogue modem, this return path is used for simple control information for basic levels of interactivity. There can be a slight delay between command and response. The BDDN system, offers bandwidths of 56kbps upstream (unless ISDN or DSL are available) and 2 Mbps downstream. This downstream bandwidth is dependent only on the processing power of the computer installed in the satellite.

Communication satellites are currently used for point-to-point, two-way broadband communication. However, there are issues with signal latency and attenuation, which increases with distance from the satellite (hence LEO constellations are preferred). Latency is the delay between transmission and reception, slowing real time interaction (despite potentially high bandwidth) and attenuation refers to the weakening of the signal over distance, requiring a powerful transmitter (which is large and expensive) and a large receiving dish (also expensive). Because of the cost, this form of satellite is only viable for large organisations that typically have a need for a dedicated communication network with international coverage.

There are also small mobile systems available which allow two-way, point to point communication. However, the connection speeds are extremely low, connection is unreliable and the cost of equipment and usage is high. This technology suits situations where there is no alternative infrastructure for voice communication and very limited data transfer (e.g. very remote locations, or in crisis situations when existing infrastructure is not available). In summary, the hardware currently required for broadband, two-way, point-to-point satellite communications too expensive for the residential user or SME.

## FIBRE OPTIC

Fibre optic refers to the medium and the technology associated with the transmission of information as light impulses along a glass or plastic fibre. Fibre optic technology carries much more information than conventional copper wire and is far less subject to electromagnetic interference and errors. Furthermore, a fibre connection offers a high level of security (which is popular among business users) since, unlike copper which can be easily 'tapped', there is currently no known method of listening in on the line, without interrupting the signal.

Existing fibre optics have a theoretical capacity of 50 Tbps (Tera bits per second) or 50,000,000 Mbps. However, this is limited by the technology currently available to convert light into electricity and visa versa. The history of development in this area can be traced from RS-232 attached terminals, which gave way to 10Mbps Ethernet and 4 or 16 Mbps Token Ring, now these are giving way to Fast Ethernet (100Mbps), ATM (155Mbps), Fibre Channel (1062Mbps), and Gigabit Ethernet (1000Mbps). With each of these increases in speed, the physical layer of the infrastructure is placed under more stress. Given current constraints, 50 Mbps might be considered a base speed for fibre with speeds up to 20 Gbps (assuming this can be received). This bandwidth is available in both directions.

## FIXED WIRELESS ACCESS

Fixed Wireless Access (FWA) technology can be implemented across a number of categories of wireless technology, such as: digital cellular; analogue cellular; personal communications network (PCN); mobile wireless; and proprietary implementations.

FWA is used in this report as the generic name for any radio technology, which provides a fixed wireless link between the end of the physical telephone network and the users premises. This technology is also referred to as Wireless Local Loop and Radio Wireless Access.

In practice, each subscriber would have a transceiver to communicate with a local base station connected to the network or with another discreet transceiver. Depending upon the frequency used, there is a trade off made between bandwidth and distance. Broadly there are three categories of solution emerging:

Local Multi-point Distribution Services (LMDS), typically the 26GHz band in Europe (28-32GHz in US), which is a line-of-sight technology. LMDS is most suited for densely populated urban areas where it is difficult and expensive to deploy additional or new wired infrastructures. Typical speeds are c. 40Mbps downstream in a point-to-multi-point configuration but could be as high as 2Gbps. This bandwidth is then shared between subscribers using the system at one moment in time. Distances between sites are limited to 4km. LMDS appears to provide an effective last-mile solution and can be deployed by incumbents or competitive service providers to deliver services directly to end users.

Multi-channel Multi-point Distribution Service (MMDS), typically the 3.5GHz band in Europe (2-3GHz in US), is less susceptible to interference than LMDS, and is also line-of-sight. MMDS can support greater distances than LMDS, up to 48 km between sites. The trade-off is that MMDS is slower, delivering downstream speeds of around 10-20 Mbps per channel, which is shared between all accessing the system at one moment in time.

The 32GHz and 40GHz channels may also be made available in some countries (e.g. Germany). Given the bandwidth/distance trade off, 32GHz and 40GHz can, in theory, provide data rates in the Gbps range, however, this is only possible over distances of around 1-2 km and has to be line of sight. In practice, these higher frequencies are very prone to interference and bandwidth can be severely effected even by the weather. These technical issues must be overcome, before such high frequencies have any practical application.

The 10.5GHz channel has also been made available in Germany, and perhaps will be used for fixed wireless solutions in other Member States in the future. This frequency is suitable for LMDS, but at lower bandwidths and over greater distances compared to higher bandwidth channels.

## MOBILE WIRELESS (UMTS)

UMTS (Universal Mobile Telecommunications Service) is the third generation (3G) of European cellular mobile communications. It uses wide-band CDMA technology, which is a packet-based system for the transmission of digital information such as text, voice, video, and multimedia at data rates up to 2Mbps upstream and downstream.

Based on the GSM (Global System for Mobile) communication standard, and endorsed by major standards bodies and manufacturers, UMTS is the intended standard for mobile users around the world by 2002. While UMTS is being gradually implemented, users can have multi-mode devices that switch to the currently available technology (e.g. GSM 900 and 1800) if UMTS is not yet available.

Today's cellular telephone systems are mainly circuit-switched, with connections always dependent on circuit availability. Packet-switched connection, using IP (Internet Protocol), means that a virtual connection is always available to any end point in the network.

The maximum theoretical UMTS bandwidth of around 2Mbps in either direction compares to GSM at 9.6kbps, and GPRS (up to 164Kbps). In practice, bandwidth is likely to be restricted to 100s of Kbps with increased bandwidth at a price in order to ensure that a certain level of service will be available despite the number of users sharing the cells capacity at any one time.

## POWERLINE

The concept of using the existing network infrastructure of electrical power suppliers for data transmission is already several decades old. The utility companies originally started to transmit data over their wiring networks for simple control purposes. These early systems were based on analogue technology and were therefore slow, unidirectional, and suitable for non-time critical applications. It was only during the past few years that Powerline technology became an emerging possibility for data communication at higher transmission rates. This was made possible by the availability of digital technology at a favourable price/performance ratio and new improved algorithms for signal processing.

Digital Powerline (DPL, also known as Power Line Technology or PLT), as developed by Nortel and NorWeb (United Utilities), is capable of continually transmitting data at a rate of 1-2Mbps over the existing electricity infrastructure which brings electrical power to homes and businesses. It was initially viewed as a solution to creating a network infrastructure within a home environment where additional wiring is not an option.

DPL uses a high frequency conditioning power network to transmit data and electrical signals. An in home conditioning unit sends electricity to the outlets in the home and sends data signals to a communication module or service unit. Local electricity substations typically serve around 50 households, all of whom could then connect to communications servers at the substations which would then be connected to the Internet via fibre or coaxial cable.

DPL allows a bandwidth of 1-2Mbps upstream and downstream, suitable for high speed Internet access, but not at downstream rates which compete with ADSL or cable. Benefits include the following, though these are not necessarily exclusive to DPL:

- High Speed Internet access to nearly all homes and businesses (though certainly not the fastest alternative)
- Use of existing infrastructure, and therefore little need for additional installations, beyond the substation server equipment and customer conditioning/service units.
- Continual connection, therefore power utilities could market a basic Internet connection service at a flat-rate monthly subscription, like some cable operators.
- Allowance of multiple lines for a single household, thus enabling simultaneous use of different equipment at the same time without interruptions.

# APPENDIX C: METHODOLOGY DETAIL

## SECONDARY RESEARCH SOURCES:

Sources of secondary research included (see appendix for full listing):

- CEC Reports
- Independent market reports
- Internet Web sites
- Media (e.g. Broadbandweek.com, FT, Economist etc.)
- Technology reports from broadband players
- White papers

General broadband Web sites include:
www.ispo.cec.be
www.etsi.org
www.itu.int
www.fcc.gov
www.ntt.co.jp

Technology news and Web sites include:
www.broadbandweek.com
www.europemedia.net
www.whatis.com
www.totaltele.com
www.tbs-satellote.com
www.umts-forum.org
www.telecomresearch.com
www.msua.org
www.inter-com.co.uk
www.3g-generation.com
www.broadbandyear.com

Exhibitions attended:

- Broadband 2000, Paris, 30 October - 1 November 2000
- BCE (Broadband Communications Europe) 2000, London, 17-19 October 2000
- Workshop on Design for Broadband Wireless Access Proceedings, Cambridge, UK, 3 May 2001.

## PRIMARY RESEARCH SOURCES

In Europe, 104 interviews were conduced by BDRC researchers with senior representatives of selected businesses and government departments. The organisational level of the respondents was high (typically Director level, occasionally CEO or VP level). In all cases, the respondents were able to comment on a strategic level as well as discuss some of the relevant details. Each meeting lasted approximately one hour, and telephone discussions lasted between 30 minutes and 1 hour. All European interviews were conducted between November 2000 and February 2001.

Face to face interviews were conducted with senior representatives of the following 53 organisations:

| Organisation | Platforms Discussed | Country Discussed |
|---|---|---|
| AOL Online | All | UK |
| BBC | All | UK |
| Belgacom | DSL | Belgium |
| Belnet (Regulator) | All | Belgium |
| Bertelsmann/AOL | Content | Europe |
| BetaReseach (Kirch Gruppe) | Satellite | Germany |
| Bredbandbolaget | Fibre | Sweden |
| BT Openworld | All | UK |
| Chello | Cable | Netherlands |
| CMT | All | Spain |
| Coditel Brabant | Cable | Belgium |
| Corning | Fibre | Europe |
| Deutsch Telekom | DSL | Germany |
| DTI | All | UK |
| EBU | All | Europe |
| Ericsson | All | Europe |
| Eurobell | DSL | UK |
| Eutelsat | Satellie | Europe |
| Forfos | All | Ireland |
| FramFab | Content | Sweden |
| France Telecom | All | France |
| GCPKNT | Cable | Netherlands |
| Greek Ministry | All | Greece |
| Hughes Network Systems | FWA | Europe |
| Intel | All | Europe |
| Investec | All | Europe |
| Nma | All | Netherlands |
| Nortel | All | Europe |
| NSAB | Satellite | Sweden |
| NTL - Ireland | All | Ireland |
| NTL Interactive | All | UK |
| Oftel | All | UK |
| Ono | Cable | Spain |
| OTE | All | Greece |
| Pirelli | Fibre | Europe |
| Regulatory Authority | All | Germany |

| Organisation | Platforms Discussed | Country Discussed |
|---|---|---|
| SES - Astra | Satellite | Europe |
| Siemens | All | Germany |
| Sony | Supporting Technologies | Europe |
| Southampton Photonics | Fibre | Europe |
| SSSB | All | Europe |
| TeleDanmark | Cable | Denmark |
| Telespazio | Satellite | Europe |
| Telestyrelsen (Danish Regulator) | All | Denmark |
| Thalamus | Fibre | Sweden |
| Two Way TV | Content | UK |
| UPC | Cable | Netherlands |
| Via Digital | All | Spain |
| Viatec | All | Spain |
| Vivendi | DSL | France |
| Vodafone | UMTS | Europe |
| WMA (Regulator) | All | Netherlands |
| Worldcom | All | Europe |

Telephone interviews were conduced with senior representatives of the following 51 organisations:

| | | |
|---|---|---|
| 3com | Supporting techs | UK |
| ADC | xDSL | Sweden |
| Agency.com | Terr DTV | Denmark |
| Airspan Networks | BFWA | UK |
| Austrian Chamber of Commerce | Govt. | Austria |
| Barco Comms. | Cable | Belgium |
| Broadnet | BFWA | Belgium |
| Broadnet | Supporting tech.s | Belgium-(aboutUK) |
| BT Openworld | xDSL | UK |
| Caly Networks | BFWA | France |
| Cisco | Supporting techs | UK |
| Colt | xDSL | UK |
| Corning | Fibre | UK |
| Easynet | xDSL | Belgium |
| EBU | Terr DTV | Switzerland |
| Eircell | UMTS | Ireland |
| Ericsson | 3G UMTS | Sweden |
| Formus | BFWA | Netherlands |
| Formus | BFWA | Sweden |
| Formus Broadband | BFWA | Ireland |
| France Television | Terr DTV. | France |
| Freeserve | ISPs | UK |
| Helsinki Television | Cable | Finland |
| IMagic TV | Content | UK |
| Luxembourg Government | Regulatory issues | Luxembourg |
| Matsushita(Panasonic) | Supporting techs | UK |
| Metromedia | Leased Lines | Netherlands |
| Nera | BFWA | Denmark |
| Nokia | 3G UMTS | Finland |
| ODTR | Govt. | Ireland |
| OnDigital | Terr DTV | UK |

| Organisation | Platforms Discussed | Country Discussed |
|---|---|---|
| OpenTV | Content | France |
| OPTA | Govt. | Netherlands |
| QS Communication | xDSL | Germany |
| Redback Networks | xDSL | Netherlands |
| RTE | Terr DTV | Ireland |
| Skygate BV | Satellite | Netherlands |
| Sonera | ADSL | Finland |
| Telekom Control | Govt. | Austria |
| Teleste | Content | Germany |
| Telewest | Cable | UK |
| Telia | ADSL | Sweden |
| Tevelo | Cable | Belgium |
| T-Mobil | UMTS | Germany |
| UPC | Cable | UK (About Austria) |
| Utfors | ISPs | Sweden |
| Versatel | Cable | Belgium |
| Viag Interkom | BFWA | Germany |
| Vialis | fibre | France |
| Video Networks(Homechoice) | Video on demand | UK |
| YesTelevision | Content | UK |

Interviews were also conduced in the US and Japan in May 2001 as follows:

| | | |
|---|---|---|
| Fujitsu | All | Japan |
| JCom | Cable | Japan |
| KDDI | All | Japan |
| KDDI/Winstar | BFWA | Japan |
| NEC | All | Japan |
| NTT DoCoMo | 3G | Japan |
| NTV | Content | Japan |
| Sony | All | Japan |
| Agilent | FWA | US |
| FCC | All | US |
| Verizon | All | US |
| Motorola | Cable | US |
| Texas Instruments | All | US |
| Worldcom | All | US |