The Development of Broadband Access Platforms in Europe

Technologies, Services, Markets

Executive Summary

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1. INTRODUCTION

There are different technologies capable of providing digital access to and from the home or SME. These are summarised as follows:

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 laser generated light 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).
High-altitude Aircraft	Similar concept to satellite transmission, but using unmanned aircraft within the earth's atmosphere. Benefits include lower cost and improved signal (compared to satellite). R&D projects include giant, solar-powered, fixed wing or zeppelin.
Optical Wireless	Laser generated light signals transmitted through open air over distances of up to 2km

The research set out to identify which of these technologies offers most potential as a high-speed access platform for European homes and SMEs. This required the consideration of 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). The research includes penetration data for those platforms already offered to the market, as well as comparison between each Member State of the EU15, in order to compare development within the EU15 as a whole against the US and Japan.

This document represents an executive summary of the study. The full report can be found at www.europa.eu.int/eeurope.

2. SUMMARY OF PLATFORMS

The consequences of digital convergence are just beginning to emerge. Traditional boundaries are merging, and the future of telecommunications is uncertain. In order to determine the direction of change, we have chosen to consider the legacy of the different players in the digital access market.

The ex-national, incumbent telecom operators are now facing competition and are evolving from providing analogue telephony over copper to the delivery of a seamless digital environment with products such as ISDN, leased lines, ADSL, mobile wireless. This is the narrowcast legacy, in which telecommunications was seen as a commodity service charged for according to the amount of time connected. But now, with the new patterns of use and new products such as the Internet and mobile telephony and SMS, telecommunications operators are becoming the new content providers, requiring new charging structures based on consumer value rather than cost.

Broadcasters have used terrestrial transmission, cable and satellite to transmit television and radio. As these technologies are upgraded to digital transmission, considerably more content can be broadcast. In addition, digital transmission makes interactivity possible, which begins to move the broadcasters in the direction of the narrowcast telecom providers. Indeed, many cable operators are already offering the full range of telecom services in addition to television.

Finally, there are the alternative access platforms. Although mostly untested on the wider market, they have the potential to compete directly with legacy access platforms. Although, in most cases they require the expense of new infrastructure, the advantage is that they have been designed specifically with the future of digital communication in mind. Alternative access platforms include fibre optic and fixed wireless access, both of which could provide reliable, ultra high-speed connections.

2.1 THE NARROWCAST LEGACY

ISDN is comparatively slow and will be replaced by ADSL. A market for basic rate ISDN will continue among residential and SME customers with no alternative. The speed of evolution, from basic rate ISDN to other access platforms (typically ADSL and cable), will be influenced by the availability of ADSL, and the pricing strategy of providers. This is, in turn, determined by the extent of competition in the market.

Leased Lines are expensive, but are typically the only alternative for higher speed access. They are not a residential solution, but are popular among SMEs with data intensive businesses. Leased lines are highly profitable for telecom companies, which are reluctant to loose the income from leased lines. However, as ADSL and other access platforms become available, they are likely to erode existing leased line business, particularly among SMEs. As with basic rate ISDN, the speed of evolution from leased lines to other access platforms will be influenced by the pricing strategy

adopted, which will be determined by the extent of competition in the market. There will still be a market for leased lines among larger businesses, but the technology will evolve from primary rate ISDN over coaxial copper to fibre optic transmission.

DSL comes in a variety of forms, which provide different levels of bandwidth over different distances of copper telephone line. This is because one of the principle characteristics of DSL is an acute bandwidth/distance trade-off (larger distance = lower bandwidth). The highest bandwidth is achieved by VDSL, which asymmetrically provides 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. Symmetric DSL (SDSL) is also available at lower speeds (depending upon the distance), and is most appropriate for dedicated business lines. Because most local loop telephone lines are relatively long, given the capabilities of this technology, the form of DSL developed for the home/SME delivers relatively lower asymmetric bandwidth (typically around 500Kbps into the home and 128Kbps out).

ADSL is likely to emerge as one of the principal broadband access platforms, along with digitally upgraded cable (see below), and is currently being rolled out across the developed world. Because ADSL takes advantage of the legacy infrastructure (that is the copper local loop that connects almost all homes/SMEs to a telecommunications network), in theory, it should be possible to roll out the service relatively fast to a wide market. However, there are some practical problems, which are currently slowing the arrival of ADSL. These can be summarised as follows:

Competition between ADSL providers is limited in Member States where full unbundling has not yet occurred. Most incumbents still control their country's local loop, which remains a primary source of revenue to them, but site other reasons for not going ahead with unbundling, such as lack of space for competitor's hardware in exchanges, or greater coverage and reliability of service if rolled out by the incumbent. As a compromise, some have negotiated a partial unbundling process through which they retain control of the local loop and lease their own ADSL lines to competitors on a wholesale basis. Despite the slow progress with unbundling, competition also comes from cable operators with upgraded digital networks. Where this is the case, ADSL roll out has been notably more aggressive and successful.

On the demand side, although demand exists among heavy Internet users, the wider market will need more persuasion of the benefits of ADSL. This is most likely to be achieved by offering bundles of services in cost effective packages, or by delivering new content that will stimulate demand in the wider market.

Other potential limitations of ADSL include the fact that it is asymmetric. Although suited to the flow of data into the home/SME, which is appropriate for current Internet and other existing media delivery, ADSL is not suited to sending large files out of the home (this may become a significant disadvantage as the digital age evolves). Furthermore, because the technology is pushing the technical boundaries of an ageing infrastructure, ADSL may struggle to cope with further increases in demand for bandwidth.

Current penetration of ADSL is low. However, the technology is at least present in all Member States with penetration figures increasing every day. For most Member States, the current low level of ADSL penetration reflects its infancy in the market. Countries with the highest level of ADSL household penetration are Sweden (4.6%), Denmark (3.9%), Belgium (3.9%) and Austria (3.3%)[1].

ADSL currently faces most competition from cable modem access in The Netherlands and Belgium, the only Member States where ADSL is cheaper than cable. Competition from cable operators is likely to rise significantly as networks are upgraded, and if progress is made in unbundling the local loop, ADSL prices are set to come down in the future.

2.2 THE BROADCAST LEGACY

DTT (Digital Terrestrial Transmission) is the digitally upgraded version of the analogue radio transmission used to broadcast television and radio in many countries around the world. It uses the same hardware, but upgraded so that the signal is sent and received as digital information. For those with analogue TV sets and radios, a digital converter (or set top box) is necessary, alternatively digital TV sets and radios can be used. Digital transmission allows for as many as 100 channels of broadcast TV/radio.

DTT is not suitable for Internet access, as an additional access platform would be required for the upstream path (such as the telephone line), and the existing infrastructure is geared toward broadcast. However, DTT will encourage people to switch from analogue to digital reception and will introduce consumers to some of the possibilities of digital technology. To benefit from the full potential of interactive services consumers will have to switch to one of the other access platforms described here.

Digital Satellite transmission is widely used as a broadcast technology for DTV. It is also widely used by larger businesses for two-way communication, particularly as part of a telecommunications network. Although there have been some serious attempts at developing a fully two-way residential/SME solution, none have proved viable to date. New developments in interactive systems are emerging which offer limited access to the Internet and may capture some of the SME market, but 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. Whilst digital satellite broadcast will continue to grow in popularity and will, like DTT, encourage the switch from analogue to digital, it is unlikely to compete as a mainstream broadband access platform because of the lack of an upstream path. However, satellite combined with the telephone may allow remote locations, which are not served by ADSL, digital cable or other platforms, to gain limited access.

[1] EOS Gallup Europe 6/2001

Digital Cable, in particular upgraded or new cable networks can provide high-speed, two-way, digital access as well as TV broadcasting and telephony. Homes/SMEs situated in areas with an upgraded cable network can gain access at speeds of up to 27Mbps in either direction. However, initial offers are in the region of 500Kbps downstream and 128Kbps upstream. One of the issues effecting cable is that users on one street, for example, may all share a limited capacity. This means that speeds will be slower during peak usage, although it is a scaleable system that could increase capacity further if required.

Of the broadcast mediums, cable appears to offer most potential as a broadband access platform. All Member States have a legacy cable network passing at least half of all homes, except Spain, Portugal, France, Greece, and Italy[2]. 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 popular[2]. 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.

Upgraded cable is now made of fibre or a copper fibre hybrid, and this new infrastructure is reaching closer and closer to the home (particularly in new infrastructure found in the UK, Ireland and Spain). Ultimately, cable operators may provide fibre to the home, although this would require a different network architecture to the upgraded cable networks currently in operation.

Broadband or two-way digital cable remains in its infancy. Currently, The Netherlands (10.8%), Belgium (6.4%) and Austria (6.4%) have the highest penetration of cable for Internet access[3]. The quality of network not only varies from country to country, but from region to region within each country (as many cable networks were installed my municipalities of towns and districts). The fragmentation of networks has, to some extent, inhibited the potential for consolidation through mergers and acquisitions among operators. Finally, even where the network is new, the market for telephony and DTV may drive demand, rather than Internet connection.

Although cable is the best solution in terms of practical applications of existing infrastructures for a high bandwidth connection into and out of the home, it is facing strong competition from ADSL. Upgrading networks is a slow and expensive process, whilst ADSL benefits from faster roll out to a wider market.

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

2.3 ALTERNATIVE TECHNOLOGIES

Fibre Optic provides the fastest and most reliable transmission of digital information of any technology. Symmetrical access of 10-100Mbps or more, can easily be provided to the home/SME if they are connected to a network designed to cope with the combined demand of all customers. In an environment in which new technologies rapidly become dated, fibre optic is described as a 'future proof' solution. It outperforms other transmission technologies by many factors of ten and yet continues to show greater potential than any other alternative. Consequently, fibre optic is now the favoured medium for digital networks across the globe. In some countries, there is even a glut of unused capacity waiting to be lit up as demand for bandwidth continues to rise.

Despite the clear advantages of fibre, and its extensive use in backbone networks, it is not yet being widely deployed as an access platform for the home/SME. The principle barriers to the realisation of fibre to the home in Europe are that: 1) it is not economically viable to lay new infrastructure underground, and to install the necessary hardware; and 2) the competitive environment does not encourage such development.

There are examples where fibre optic has been successfully deployed as an access platform to the home/SME. In Sweden, were demand for high-speed digital access has been driven by the popularity of the Internet, new fibre optic systems have been built which connect apartment blocks to metropolitan area networks. This is really 'fibre to the basement.' In other Member States, circumstances have not yet arisen to initiate the deployment of 'fibre to the home/SME' on a large scale. In some cases (e.g. in the UK, Ireland and Spain), new cable networks are being constructed using a copper and fibre hybrid solution which brings fibre much closer to the home.

A more realistic solution to meet the immediate demand for higher bandwidth is to upgrade existing infrastructures. The two favoured solutions are to use ADSL over the existing copper telephone network and to upgrade existing CATV (or cable TV) networks.

Fixed Wireless Access (FWA) using microwave radio transmission has the potential to become an important alternative to ADSL. Indeed, FWA is particularly attractive in countries where the incumbent operator has been slow to unbundle the local loop as it could provide a 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. It also has the potential to outperform ADSL and cable in terms of the available bandwidth.

Mobile Wireless (3G), whilst enabling mobile access to the Internet and other digital services, will provide only limited downstream and upstream bandwidth (100-300Kbps). Whilst mobile wireless connection has considerable potential in its own right, it is unlikely to compete with the fixed access market. Indeed, there are some arguments to suggest that high-speed fixed access from conveniently situated 'hot spots'[4], used in combination with a mobile memory in a lap-top or similar device may be a better fit between technology and human behaviour.

Powerline access is interesting in theory, but there are technical barriers. This is a legacy technology in which 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. An attraction of powerline is the almost universal coverage of the existing infrastructure, an advantage it shares with ADSL. Although Powerline may provide an alternative in some niche markets, better ways of transmitting data now exist.

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.

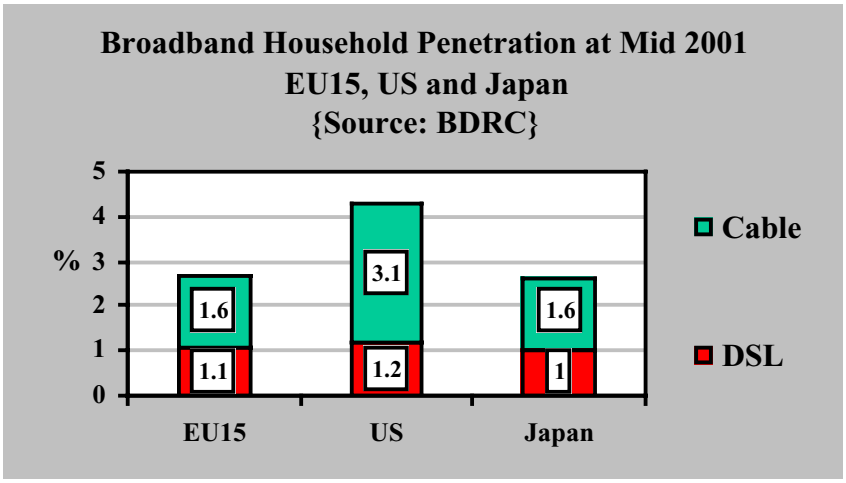
High altitude aircraft such as zeppelins or fixed wing aircraft have been proposed as an alternative to satellite. Such aircraft would fly unmanned at around 100,000ft and would probably be geo-stationary (e.g. above cities). This would offer the advantages of satellite, but would be much less expensive 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.

[4] Such 'hot spots', are places where a mobile device could gain access at very high bandwidth to download large files to be retrieved whilst on the move. This could be achieved using wireless local area network (or wireless LAN) technology connected to a fibre optic network.

3. THE FUTURE OF BROADBAND IN THE EU15, US AND JAPAN

Despite the recent slow down in the high-tech and telecoms markets, household/SME penetration of broadband access platforms continues to grow. This growth is driven by the popularity of the Internet leading to increasing demand for higher speed access to the Internet. However, bundled offers of telephony, TV and Internet access also make broadband attractive, as do offers of new services such as interactive TV and video-on-demand.

ADSL and digital cable will, between them, capture the majority of the broadband market over the next five to ten years. At present, broadband cable has a head start over ADSL in those countries which have a legacy cable infrastructure and which have begun to upgrade this to digital transmission. But ADSL is likely to catch up, and overtake cable as the principle access platform, particularly in those countries that have little cable infrastructure or are slow in upgrading existing cable infrastructure. In these countries, the rate of growth of ADSL will depend upon the extent of competition among ADSL providers and the extent of competition from alternative platforms such as fibre to the home and fixed wireless access (as well as ISDN in the short-term).



The US is ahead of the EU15 and Japan in terms of broadband development and is likely to stay this way for the next three to five years. Broadband penetration in the US continues to grow, with household penetration figures of around 3.1% for digital cable and 1.2% for ADSL[5]. In Japan, digital cable and ADSL are at a similar stage of roll out to the EU15, with household penetrations of 1.6% and 1% respectively[6]. The Japanese government, and the incumbent telecom operator NTT, have also been installing a nation-wide fibre optic network designed to provide fibre to the home. If successful, Japan would become one of the most advanced countries in the world in terms of broadband access (along with South Korea and Singapore, both of which have extensive fibre networks providing fibre to the home).

[5] Source: BDRC 8/2001 (adapted from FCC figures for residential/SME penetration 8/2001)
[6] Source: MPT 3/2001 - cable, 8/2001 ADSL

Taking the EU15 as a whole, household penetration of digital cable is currently at around 1.6% and ADSL is at 1.1%[7]. Compared to the relatively homogeneous markets of the US and Japan, the principal feature of broadband in the European Union is diversity. The market for broadband access platforms to the home and SMEs is quite different in each of the fifteen Member States. Consequently, any strategy for the development of broadband access platforms across the EU as a whole has to take national differences into account. This makes Europe a relatively difficult market for broadband. Whilst some Member States are pressing ahead with broadband roll out (particularly the Nordic and Benelux countries), others are showing less enthusiasm for the Internet and broadband access. Based on this experience, it is clear that broadband access will develop faster in those EU Member States that:

1) Have the highest Internet penetration levels,
2) Have been fastest in liberalising their telecom market (i.e. achieving full local loop unbundling) and
3) Have the highest level of cross-platform competition (mainly ISDN/cable/ADSL for the time being, but fibre optic and fixed wireless access in the future).

Penetration of ADSL will continue to grow over the next three to five years and may ultimately become universally available. As penetration grows, the price will come down, particularly where there is competition from other ADSL operators and other access platforms. However, where digital cable is available, it is likely to be the preferred access platform and, provided bandwidth capacity can grow with demand, cable will have a much longer life cycle than ADSL, especially if existing cable networks are upgraded with fibre optic. Other access platforms, which can be quickly installed, such as fixed wireless access, may capture niche markets and will help to increase competition. Where there is no competition from cable, the success of fixed wireless access, or other alternative to ADSL, will play a crucial role.

Whilst ADSL will help to fuel the development of broadband, it does have technical limitations and could be seen as an interim solution until higher-bandwidth solutions, such as fibre to the home, become economically viable to a large market. An analogy could be made with the success VHF video, over Betamax and Phillips. It wasn't the best technical solution, but it was the best marketed. Similarly, at this stage, the main obstacle to achieving the best broadband solution for the consumer is financial rather than technical, as the current business model for an entirely new infrastructure such as fibre to the home/SME is difficult to justify in most Member States. Ultimately, successful access platforms will be those that provide the content and services which the consumer is willing to pay for. The challenge is to ensure that this is also the best technical solution.

[7] Source: EOS Gallup Europe 6/2001

4. 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.

1) 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

2) 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.

3) Stimulate demand for digital broadcasting (which will encourage the wider population to access digital content):

- provide tax incentives/subsidies for analogue TV converters

4) 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

5) Further investigate the possibilities of Fixed Wireless Access and Optical Wireless Access as viable alternatives to laying new physical infrastructure to every home/SME.