Broadband in Europe:

How Brussels Can Wire the Information Society

Broadband in Europe:

How Brussels Can Wire the Information Society

Dan Maldoom
DotEcon Limited

Richard A D Marsden
DotEcon Limited

J Gregory Sidak
Georgetown University Law Center and American Enterprise Institute

Hal J Singer
Criterion Economics

Springer

Library of Congress Cataloging-in-Publication Data

A C.I.P. Catalogue record for this book is available from the Library of Congress.

Broadband in Europe : how Brussels can wire the information society / Dan Maldoom.... [et al.].
p. cm.
Includes bibliographical references and index.
ISBN-10: 0-387-25386-6 (alk. paper) e-ISBN-10: 0-387-25387-4
ISBN-13: 978-0387-25386-2 e-ISBN-13: 978-0387-25387-9
1. Telecommunication—Europe. 2. Broadband communication systems—Europe.
3. Information networks—Europe. 4. Information society—Europe. I. Maldoom, Dan.

HE8084.B76 2005
384′.094—dc22 2005042643

Printed in the United States of America.

9 8 7 6 5 4 3 2 1 SPIN 11325147

springeronline.com

Contents

Tables and figures

Preface

Broadband is a key enabler of the information society, increasing productivity and competitiveness across all sectors of the economy. Unlike traditional narrowband connections, broadband provides high speed, always-on connections to the Internet and supports innovative content and services. Direct consumer welfare gains from mass-market adoption of broadband across the EU could easily reach 50 billion euros or more per annum. This is quite apart from the more profound societal shifts that ubiquitous broadband could bring. It may allow the individual to distribute content and ideas independent of traditional media and bring together communities of interest without regard to borders.

Public policy for broadband will have a big impact on whether and how quickly these benefits are realised. Getting policy right could bring large benefits for consumers, firms and the economy at large; getting policy wrong risks stifling both the rollout of broadband and new innovative services, and thus the realisation of the EU's e-Europe vision.

In this book, we focus on the residential market for broadband access in EU countries, analysing the current and prospective level of competition and drawing implications for public policy. A key aim is to understand better the relative importance of facilities-based and access-based provision in fostering competition and promoting take-up of broadband services.

To date, regulatory policy in EU countries has tended to carry over the approach of traditional voice telephony regulation, with its emphasis on wholesale access to incumbent networks, rather than encouraging facilities-based competition between providers with their own end-to-end infrastructure. However, broadband provision is not a natural monopoly; effective platform competition is already possible. In many areas of Europe, consumers already have a choice between alternative providers using DSL and cable platforms. New platforms using fibre-to-the-home have been built in Sweden and Italy. Wireless technologies that could dramatically change the marketplace (such as 3G, WiFi and various broadband wireless services) are also being launched.

There are encouraging signs that full facilities-based competition can be a reality for broadband. However, a clear message through this book is that commercial organisations respond to the incentives that regulatory systems place in front of them; every care must be taken to ensure that incentives set by public policy encourage efficient rather than distorted outcomes.

Whilst there have recently been some encouraging noises from regulators about the importance of promoting facilities-based competition, it takes time and patience to achieve such goals. Tough access regulation can always generate competition in the short-run, but this is not the deep and lasting competition over the whole value chain that only infrastructure-based competition can bring. It requires a far-sighted regulator to hold out for these long-terms benefits.

How competitive are European broadband markets? What factors explain the wide variation in broadband take-up across EU member states? What is the relative role of facilities and access-based entry in promoting broadband take-up? Does the availability of regulated access products increase or diminish incentives for infrastructure investment? What policies could the EU and member state governments adopt to further development of broadband over the next decade? These are the questions that we attempt to answer, drawing on evidence and analysis of Western European markets, and lessons from the experiences of other countries, such as the United States and South Korea.

This book was originally conceived as a research project by DotEcon Limited and Criterion Economics, two independent consultancy firms that are specialists in applying economics to telecommunications and other network industries. The authors of this book – Dan Maldoom, Richard Marsden, J. Gregory Sidak and Hal Singer – work for DotEcon and Criterion.

The initial project was funded by the Brussels Round Table, a forum for leading European telecommunication operators and equipment manufacturers. A report was completed in September 2003, and its findings were presented at the Brussels Round Table on the Future of the European Telecommunications Industry with BRT member CEOs and EU Information Society Commissioner Erkki Liikanen. The members of the BRT at the time were: Alcatel, BT, Deutsche Telekom, Ericsson, France Telecom, Siemens, Telefnica de Espaa and Telecom Italia.

This book is based on the report that was released in October 2003. It was updated by the authors in late 2004, taking into account a number of new developments in European markets over the last 12 months.

The authors are grateful for the assistance of colleagues at DotEcon and Criterion for research and helpful comments in finalising both the original report and this draft. In particular, we would like to thank Christian Koboldt, John Gunnigan, Roger Salsas, Tamara Linnhoff, Justyna Majcher, Vesna Milenkovic, Robert Crandall and Brian O'Dea. We would also like to express our gratitude to members of the BRT Working Group in identifying information sources for the original report and providing expert comments on drafts of the original report. However, we wish to emphasise that BRT members have not

had any role in commenting on this revised book. Further, this book is the work of the authors, and does not necessarily represent the views of any other party.

Dan Maldoom

Richard Marsden

J. Gregory Sidak

Hal Singer

April 2005

1 Introduction

This book focuses on mass market broadband access and take-up, analysing the current and prospective level of competition and drawing implications for public policy. A distinction is drawn between '*facilities-based competition*', where providers are using all (or some of) their own infrastructure, and '*access-based competition*', where providers depend on access to someone else's network. Amongst EU Member States, there is a general consensus that infrastructure-based competition is desirable in telecommunications and has an important role in delivering innovations such as broadband. However, public statements from national regulatory authorities (NRAs) about the benefits of infrastructure competition have not always been matched by coherent regulatory policy designed to facilitate such competition.

Broadband is a new service. Typically, new services are not subject to specific regulation, owing to the risk that this would discourage investment and stifle innovation. However, from its inception, the development of broadband access has been influenced by intervention from policy makers and regulators. This intervention includes both local and national government initiatives to promote the supply and demand of broadband, and ex-ante obligations on incumbent telecom operators to provide access to their networks.

Broadband penetration is widely portrayed as being disappointingly slow. Although this claim is debateable – penetration is actually quite fast relative to the adoption of comparable technologies – it is often used as a justification for public policy intervention. However, given the prevalence of intervention to date, an equally valid response is to question the effectiveness of existing regulation. Both new entrants and incumbent operators are rational agents who inevitably respond to regulatory incentives; if broadband deployment in the EU has been too slow, regulatory policy is a key area where one should look for an explanation. The current approach of NRAs to broadband is heavily influenced by the existing regulatory framework for traditional telephony services, with its emphasis on access to the local loop. The appropriateness of this approach may be questioned, given that broadband is a new service that requires building new infrastructure (even if existing networks are used) and that it can and is delivered over many different types of platforms, including cable, satellite, fixed wireless and mobile networks.

The introduction of the EU's New Regulatory Framework (NRF) for telecommunications, and its adoption and interpretation by member states provides a critical opportunity to reassess regulatory policies towards broadband. In particular, the EU has a key role in guiding and constraining NRAs in defining new markets for ex-ante regulation and applying remedies that are proportionate to the problems identified.

Against this background, this book has a number of objectives:

- to determine the extent of competition in European broadband markets;
- to explain the wide variation in broadband take-up across EU member states;
- to assess the relative effectiveness of platform competition and access-based entry in propelling growth in broadband take-up and consumer choice;
- to assess the impact of existing public policy on incentives to invest in infrastructure; and
- to identify policies that the EU and member state governments could adopt to further development of broadband over the next decade.

The book is divided into six main chapters:

- Chapter 2 provides background on the broadband market: we review the definition of broadband; discuss the economic benefits of broadband diffusion; and explore the range of technologies that can be used to deliver broadband services.
- Chapter 3 describes the extent of competition in broadband markets. Section 3.1 defines facilities-based and access-based competition, and the different types of access products that regulatory systems distinguish. Section 3.2 reviews the extent of platform and access-based competition in broadband provision and assesses their impact on product and pricing innovation. Section 3.3 provides a summary of our findings from case studies of broadband competition in Germany, the Netherlands, Republic of Ireland, South Korea, Sweden, the United Kingdom and the United States. The full case studies are included in Annex I.
- Chapter 4 examines the current and potential role of new entrants in broadband service provision, and scenarios for the further development of competition. This section is illustrated with a summary of our findings from case studies of 'new' entrant broadband providers, including Bredbandsbolaget (Sweden), FastWeb (Italy), HanseNet (Germany), Ono (Spain), UPC chello (Netherlands) and selected U.S. CLECs. The full case studies are included in Annex II.
- Chapter 5 analyses the appropriate market definition for broadband and assesses the relative merits of facilities and access-based competition, in light of the evidence presented in chapters 3 and 4. This includes the results of empirical analysis testing for a relationship between broadband penetration and one or both of platform competition and access-based competition.
- Chapter 6 addresses the strengths and weaknesses of the EU NRF and appropriate policies for broadband going forward.
- Chapter 7 provides our conclusions.

2 Broadband and why it matters

2.1 What is broadband?

Broadband provides users with always-on, high-speed connections to access the internet and transfer data. The term 'broadband' has outgrown original narrow definitions based on specific data transmission speeds and is now widely used "*simply as shorthand for high speed Internet access*"[1]. The extensive and growing variety of broadband products available in EU member states – for example, in terms of transmission speeds – demonstrates the need to maintain a flexible definition of broadband in any market analysis. This should be based on the notions of 'high-speed' and 'always on', which differentiate broadband services from narrowband dial-up access to the internet, rather than specific minimum thresholds for transmission speed. Any definition should reflect the fact that it is possible to offer fundamentally identical products from the perspective of the end user over different delivery platforms.

As observed in the Commission's eEurope 2005 Action Plan, there is no universally recognised definition of broadband.[2] The technical term 'broadband' was originally defined by the ITU as transmission capacity that is *faster* than primary rate ISDN (*i.e.* 1.5 or 2 Mbps)[3]. However, it is now widely used by network operators marketing DSL, cable modem and other access services to users starting at speeds of 256 Kbps or even 128 Kbps. OECD governments have attached "*a wide variety of meanings*" to broadband in particular policy discussions.[4] For example, in a 2001 task force report, the Italian government drew a distinction "*between those, such as the FCC in the United States, who have defined broadband exclusively in terms of transmission capacity (number of kbit/s) and those, as in Canada, who have primarily based their definition on the type of services that can be provided.*"[5]

For the purposes of benchmarking comparisons, Paltridge (OECD, 2001) defines a minimum threshold for broadband of 256 Kbps for downstream (i.e. data transmissions *to* the user) and 64 Kbps for upstream (*from* the user). This definition has become widely used in statistical exercises and forms the basis for much of the data referenced in this book. Paltridge's downstream threshold is loosely related to an earlier FCC definition, which set a threshold of 200 Kbps, or (in the agency's view) roughly enough to allow users to transmit full-motion video or change web pages as if they were turning the pages of

[1] OECD (2001), page 6.

[2] European Commission (2002a), page 7.

[3] ITU-T (1997).

[4] OECD (2001), page 6.

[5] Italian Government (2001), page 10.

a book. The much lower upstream threshold reflects the commercial reality of many residential services supplied by asymmetric digital subscriber line (ADSL). However, as Paltridge points out, defining a "... *minimum threshold for 'broadband' only really takes on importance if a government has a specific service in mind that requires a certain level of network performance.*"[6]

There has been significant discussion as to whether there is a distinct market for broadband services that is separate from narrowband internet access. In Box I, we argue that although there is evidence of one-way substitution from narrowband to broadband and some linkages in pricing, there is a distinct market for broadband. This reflects the fact that broadband offers users significant benefits not available via narrowband; in particular: faster access to the Internet; access to high bandwidth applications, such as music, video and games; an always-on connection; and the ability to use the Internet without tying up a voice line. Regulators across OCED countries have adopted similar positions; for example:

- In the United States, the Federal Communications Commission (FCC), Federal Trade Commission (FTC) and Department of Justice (DOJ) have all made independent rulings that the provision of residential high-speed Internet access services is a distinct market in its own right.[7]
- In its 2002 annual report, Spanish regulator CMT stated: "*la CMT ha* considerado *la existencia de un mercado de servicios de acceso de banda ancha claramente diferenciado del de la banda estrecha*" ["the CMT considers that there is a market for broadband access clearly different to that of narrowband"].[8]

Since 2002, there has been a significant expansion of broadband product portfolios by operators in most European broadband markets, which is consistent with the maturing of the market and movement along the standard product life cycle. By differentiating products on the basis of transmission speed and/or capacity, pricing and other characteristics, operators are able to serve residential and business customers with differing needs at the low and high-ends of the market. Such differentiation can be expected to stimulate further growth in demand for broadband services; a 2003 report by IDC identified this trend as a "*key driver for the European broadband market*"[9]. Therefore, it is important

---

[6]OECD (2001), page 6.

[7]See for example: FCC – Memorandum Opinion & Order, Applications for Consent to the Transfer of Control of Licenses and Section 214 Authorizations by Time Warner Inc. and America Online, Inc., Transferors, to AOL Time Warner Inc., Transferee, 16 F.C.C. Rcd. 6547, 56 (2001); FTC – Complaint, America Online, Inc. v. Time Warner, Inc., Dkt. No. C-3989 (FTC filed Dec. 14, 2000) 21; DOJ – Competitive Impact Statement at 9, United States v. AT&T Corp., Civil No. 00-CV-1176 (D.D.C. filed May 25, 2000).

[8]CMT Annual Report, 2002, page 50.

[9]IDC (2003).

from a regulatory perspective that any definition of broadband is flexible enough to accommodate the full variety of products available.

Any definition of broadband should also be platform-neutral to the extent that it is possible to offer a variety of broadband products over different delivery platforms that offer users very similar experiences. For example, although the technologies associated with DSL and cable are quite different from one another, both offer comparable bandwidth and always-on connectivity, and are thus largely functionally equivalent from the perspective of users of data services. Although PSTN and cable networks have historically offered quite different services, there is now increasing convergence with similar service bundles being offered over different underlying networks. A platform-neutral approach is consistent with the framework adopted for the *e*Europe 2005 Action Plan, which "*promotes a multi-platform approach to broadband deployment, driven by strong competition between services and networks.*"[10]

Box I: Is broadband distinct from narrowband?

The substitutability between narrowband access and broadband access depends on the value that broadband users place on the advantages of broadband access. If enough consumers value broadband's unique advantages sufficiently that they would not switch in large numbers to narrowband access in the face of a small but significant increase in the price of broadband, then the two types of access are not demand substitutes.[11]

Broadband offers three main advantages over narrowband access:

- it decreases time costs, as an 'always on' connection provides instant access to the Internet (whereas dial-up requires wait time and lines may occasionally be engaged) and higher bandwidth enables faster download of webpages and files;
- it enables access to high bandwidth applications, such as streaming video and real-time radio, home networking, customised Internet video and audio libraries (such as Yahoo's LaunchCast), interactive gaming and high-speed telecommuting; and
- unlike narrowband, a broadband connection does not tie up a consumer's phone line, allowing inbound and outbound voice calls.

We consider the value that consumers place on each of these broad attributes in turn:

1. *Time costs*. Consumer surveys suggest that consumers do attach significant benefits to time savings provided by broadband. For example, a survey

[10] European Commission (February 2003a), page 6.

[11] See Annex III for a brief introduction to demand substitutability and market definition.

by Enders (2003) found that 41% of UK internet users considered "faster Internet experience" to be the main advantage of broadband. There is little empirical evidence on how much users value this extra speed. A study by Varian (1999) observed a "*very low willingness-to-pay for broadband and very low values for time*" (the average user exhibited a time cost of less than 1 US cent per minute).[12] However, this study is now somewhat out of date and, as Varian acknowledged, the survey sample may have been skewed by the reliance on volunteers (many were students) who may be individuals with a relatively low opportunity cost of time and therefore non-representative of Internet users in general. It is reasonable to expect that those consumers with the highest time cost of money will be among the most likely to purchase broadband services. Roughly 17% of the subjects exhibited a time cost of five US cents per minute ($3 per hour) or greater.[13]

2. *Access to additional content*. Consumer demand for much of the additional content and services available over broadband remains unproven in most OECD countries. In the Enders (2003) survey, just 2% of Internet users cited interactive content to be the main advantage. However, demand for such applications appears to be 'sticky' in that once consumers adopt broadband and begin using advanced functionalities (such as web browsing at speeds equivalent to turning a page of a book), they value broadband more than they did when they first adopted.[14]

3. *Phone line usage*. A consumer who uses narrowband service cannot make or receive telephone calls from her residence while she is connected to the Internet unless she also purchases a second telephone line. A survey by the Yankee Group found that 70% of U.S. households with two or more telephone lines subscribed to a second line to accommodate Internet access.[15] Costs for a second telephone line can be high. For example, in the United States, the cost of a second line in 1999 varied from US$7.70 to US$47.62 per month, plus installation charges.[16] For the United Kingdom, Enders points out that the cost of an additional line plus the cost of dial up access is approximately the same as getting a broadband connection.[17] Of course, not all narrowband customers choose to purchase a second line; many use a mobile telephone for voice communications while connected to the Internet or simply go without telephone services. Nonetheless, the use of narrowband service imposes a cost on consumers by tying up a residential landline phone line. Enders (2003) found that 41% of consumers considered the ability to use the phone and be online at the same time to be the main advantage of broadband.

[12] Varian (1999).

[13] Varian notes that his methodology provides only a "*rough-and-ready, nonparametric estimate.*"

[14] Office of Technology Policy, U.S. Dept. of Commerce (2002).

[15] Yankee Group (2002).

[16] Hausman, Sidak and Singer (2001).

[17] Enders (2003).

Overall, the benefits to users of broadband relative to narrowband appear substantial, and are likely to increase for many users once they subscribe to broadband. It thus seems unlikely that a hypothetical monopolist of broadband service in a particular local market would need to control narrowband services to benefit from a small but significant and non-transitory price increase above cost. This implies that broadband and narrowband are distinct markets. This conclusion is supported by academic analysis of U.S. internet access prices. For example, Hausman et. al (2001) notes that data on the price variations of narrowband in different U.S. geographical markets demonstrates that narrowband service is a separate relevant market from broadband service: "*[t]he straightforward observation is that narrowband access prices differ by a factor of over 300 percent, while broadband access prices do not vary in any way with these differences.*"[18]

This conclusion does not deny that potential substitution from narrowband to broadband exists. There is a vertical relationship between the two markets such that all consumers can be expected to view broadband as superior but vary in the amount that they are willing to pay for the higher quality good; hence, broadband prices act as a constraint on narrowband prices in the sense that many narrowband users might switch to broadband if the price differential between the services were small enough. However, narrowband pricing constrains broadband pricing only to the extent that the size of the price gap acts as an initial constraint on take-up of broadband. Forrester Research argue convincingly that the decline in the broadband premium over dial-up – the European average fell from 178% in 2001 to 101% at end-2002 – has been a key factor spurring take-up in Europe in 2002.[19] Various consultants have talked about threshold prices at which broadband becomes a viable mass-market alternative to dial-up; according to Forrester, this point was reached when the lowest prices available fell to around 30 euros.

Arguably, the distinction between narrowband and broadband is becoming less clear with the emergence of new entry-level broadband products, which feature low-bit-rates or usage restrictions. The objective of these products appears to be "*to tempt consumers away from dial-up, aiming to convert them to pricier, faster products later.*"[20] Examples (taken in August 2003) include: KPN's 256 Kbps ADSL product, an ADSL offer from Telecom Italia's tin.it ISP at 27.95 euros per month which has a 20-hour usage cap, and UK cable company ntl's 150 Kbps low-end offer. The presence of these entry level broadband products might increase interaction between the pricing of broadband and narrowband to the extent that this leads to a chain of substitutable products, but this is yet to be seen.

[18] Hausman (2001) page 6-7.

[19] Forrester (June 2003a).

[20] Forrester (June 2003a).

Table 1: Broadband forecasts for Western Europe

Forecaster	Year	Broadband subscribers	Broadband revenues per annum
Datamonitor[21]	2006	41 million	US$ 16bn +
IDATE[22]	2007	65-75 million	Euro 22.4bn
IDC[23]	2007	62 million	US$ 27bn
Forrester[24]	2008	49.7 million	na
Strategy Analytics[25]	2008	63 million	na

2.2 The importance of broadband to the EU economy

According to many industry reports, broadband access will be one of the key sectors underpinning productivity and economic growth in the EU over the next five years. The sector is both important in its own right and, as a facilitator of faster and more efficient data transmission and internet access, a key input into other economic sectors.

Independent forecasters project rapid growth for broadband subscribers and revenues over the next five years. In Table 1, we provide a snapshot of forecasts for subscribers and revenues across Western Europe, made in 2003 and 2004. The most conservative, from Forrester and Datamonitor, predict that there will be 38 million and 41 million European households, respectively, using broadband by 2006, up from 10.3 million at end-2002. Forecasts for direct revenues range from at least 14 billion euros in 2006 up to 24 billion euros by 2007. Revenues for direct access and content will be dwarfed by the indirect benefits of faster internet access, for example through greater use of e-commerce and spread of e-government.

Academic research provides strong backing for this assertion that new communication services can lead to very large increases in consumer welfare, through meeting needs that would otherwise go entirely unmet. For example, Hausman (1997) estimated that the consumer welfare gain from voice messaging services introduced in the United States in 1990 would have been 1.27 billion US dollars by 1994 if the FCC had not delayed in authorising such service. He further estimated the gains from the introduction of cellular telephone services at 50 billion dollars a year.[26] Goolsbee (2001) estimates pre-tax consumer surplus

[21] Datamonitor (2003), page 5-7.
[22] Idate (2002).
[23] IDC (2003).
[24] Forrester (2003a).
[25] Strategy Analytics (2003).
[26] Hausman (1997), page 2.

from the introduction of broadband in the United States at 700 million dollars per year as of mid-1999, even though penetration at that point was only 2-3% of on-line users. Unfortunately, there are no recent studies estimating the direct contribution of broadband to consumer welfare and none for EU countries. However, inferring from the results of these studies, one would expect a value already in the many billions of euros.

These estimates of the value of broadband services are based on adding together individual consumers' willingness to pay for services. Various external benefits may also arise that are not reflected in end-customers' willingness to pay, particularly if there are network effects, which would not be privately valued. For example, consumers' decisions to use e-commerce to buy goods and services may lead to benefits for suppliers in terms of reduced cost and greater efficiency. The adoption of new technologies and their faster diffusion also benefits equipment manufacturers, via increased demand. Taking all these potential gains into account, Crandall, Jackson and Singer (2003) estimated that the total annual consumer benefit from broadband in the United States would be between 64 and 97 billion US dollars per year if 50% of U.S. households adopted broadband, and could be more than 300 billion US dollars per year if broadband were to achieve universal diffusion in the United States. The authors also found that the ubiquitous adoption of current broadband technology would increase total U.S. GDP by 180 billion US dollars and create 61,000 new jobs per year, and that the ubiquitous adoption of more advanced access technologies (such as FTTH or VDSL) would sustain 140,000 new jobs per year.[27] Given the similar size of the U.S. and EU economies, it is plausible to assume that the benefits to Europe could be of a similar magnitude.

Given the substantial benefits available from broadband development, it also follows that delays in broadband deployment and thus take-up could have significant opportunity costs. In particular, poorly designed regulation can have a detrimental impact on investment and competition, with direct negative implications for consumer welfare and even larger indirect effects for the wider economy. For example, Hausman (1997) estimates the total cost of FCC regulatory delay on the U.S. mobile phone market at around 100 billion US dollars.

The importance of the broadband market has been recognised in numerous documents and speeches made by governments and international bodies in recent years, reflecting not just the utility of services to end-users, but also broader social benefits. For example:

- **ITU:** "*Broadband has been referred to as the infrastructure of the knowledge economy. Countries around the world have nominated broadband networks as crucial infrastructure for achieving their social, economic and scientific goals.*"[28]

[27] Crandall, Jackson and Singer (2003).

[28] ITU (2003), page 3.

- **OECD:** "*If, as many believe, new communication tools such as the Internet and wireless networks boosted growth in the latter half of the 1990s, and softened the current cyclical downturn, then the next steps toward broadband access are of critical importance that go beyond the communications sector.*"[29]
- **European Commission:** "*Distance education (using e-learning), access to government services (e-government), healthcare (e-health), entertainment, videoconferencing, e-commerce, etc. become more practical and often feasible only through the high speed provided by broadband access. . . . The adoption of these services into our daily life, and the opening of new markets, can improve quality of life, increase productivity and stimulate innovation.*"[30]
- **Ireland, ODTR:** "*[T]he development of a vibrant broadband sector has the potential to not only stimulate growth in a new set of higher-value industries, but to open up new possibilities for all citizens, irrespective of geographic location.*"[31]
- **UK government:** "*The rapid roll out of high bandwidth technology is clearly a prerequisite to a successful UK e-commerce sector.*"[32]
- **U.S. FCC:** "*The widespread deployment of broadband infrastructure has become the central communications policy objective today.*"[33]
- **Canadian Minister of Industry:** "*Broadband can stimulate innovation and improve the quality of life for all Canadians, especially those in First Nations, northern, rural and remote communities. It is applications in areas like distance education, telemedicine and e-business that will touch the everyday lives of communities and advance economic development.*"[34]
- **South Korea, Ministry of Information and Communication:** "*Broadband Internet, which is 32 times faster than that of the dial-up modem on average, can not only utilize the idle facility of the backbone network, but also promote the related equipment and component industries, nurturing a positive economic cycle in the future. In addition, the high-speed broadband Internet service will pave the way for multimedia contents, application services and e-commerce to prosper.*"[35]

At a minimum, EU governments should provide a framework for broadband that does not impede rollout. There may also be a case for more active government promotion of broadband, given the scope for realising positive externalities for the economy at large not reflected in customers' willingness to pay for services. However, the impact of any regulatory intervention on incentives for

[29] OECD (2001), page 4.
[30] European Commission (February 2003a), page 6.
[31] ODTR (2002).
[32] PIU (1999), page 63.
[33] Powell (2001).
[34] Industry Canada (2003).
[35] IT Korea (2002).

both industry players and consumers need to be carefully thought through. Measures that impede or slow the development of broadband services may have very large costs, even if these are not immediately evident.

2.3 Broadband delivery technologies

There are many different technologies currently available that can be used for delivering broadband to both residential customers and businesses. These include DSL, cable, fibre, satellites, fixed wireless access, electrical power lines, mobile communications, wireless LAN and free-space optics. All these technologies have relative strengths and weaknesses, for example, in relation to maximum transmission speeds or vulnerability to interference and capacity constraints. Nevertheless, the types of user experience that they offer – once infrastructure is in place – are sufficiently similar that significant numbers of customers are likely to find services delivered by these different technologies closely substitutable.[36]

In the remainder of this subsection, we describe the various technologies for delivering broadband, highlight their strengths and weaknesses and discuss their potential development over the medium term. Our main observations are as follows:

- The current prevalence of ***DSL*** and ***cable*** is based on their use of existing infrastructure and first-to-market status, rather than any technological superiority. Actual transmission speeds are often quite low relative to some other platforms, although they may improve as technological advances are implemented.
- ***Fibre-to-the-home (FTTH)*** offers far superior speeds to standard DSL or cable. Although expensive to deploy if new trenches need to be dug, it can be cost effective in urban areas, especially if consumer use of bandwidth-hungry applications takes off. However, the distinction between fibre, and cable and DSL technologies is becoming blurred, as the latter undertake increasing deployment of fibre closer to the end customer and upgrade their distribution capacity.
- High deployment costs and problems with upstream connectivity mean that ***satellite*** is currently not cost effective as a mass market alternative to DSL and cable, except for rural areas, where the cost of building fixed infrastructure is prohibitive.
- ***Fixed wireless access (FWA)*** has now been available for several years in many European countries but as yet has only found a market as a niche solution for businesses. It still has potential to become a mass market technology, particularly if the costs of equipment were to fall. Over such a timescale, it faces being overtaken by more flexible WLAN and mobile technologies.

[36] For further discussion of this point, see Section 3.2, which compares broadband offers available in EU markets on different platforms.

- Owing to their ubiquity, electric ***power lines*** have potential as a mass market alternative to DSL or, more likely, a cost-effective way of extending broadband to rural areas. However, some technical and regulatory obstacles apparently need to be overcome. The longer the delay in the mass market deployment in European countries, the less likely that it will gain critical mass.
- ***WiFi*** (wireless LAN) technology currently provides hotspot internet access services, and is starting to be used to provide broad coverage public access networks in both urban and rural areas. This is a mature, cost effective and low risk technology. Many laptop computers are sold with wireless LAN functionality already built in.
- ***3G mobile*** is being deployed by MNOs across Europe. This will ultimately give the mobile telephone customer base an alternative means of broadband access;
- ***'new mobile'*** technologies can provide mobile broadband services, for example, bringing cell structure and cell handover to wireless LANs that currently permit only nomadic use. They can use a variety of different radio spectrum, including unused spectrum that many European 3G licensees hold. Commercial services are already being rolled out (e.g. in Australia) with bandwidth and pricing comparable to DSL services.

Table 2 provides a rough visual summary of the relative strengths and weaknesses of these technologies.

2.3.1 Digital subscriber line (DSL)

DSL technologies make use of existing telephone lines to deliver voice, data, and video traffic simultaneously at high speed. An 'always-on' connection is established between a modem at the user end and a DSL access multiplexer (DSLAM) at the local exchange. Using advanced modulation and signal processing techniques, data is carried over existing twisted pair copper wire at frequencies significantly higher than those used for voice traffic. Both upstream (from the user to the exchange) and downstream transmission is possible. Voice and data signals are separated using a line splitter, allowing simultaneous use of lines for narrowband voice telephony and broadband access for PCs or television set-top boxes.

DSL can be deployed in a number of different ways, for example:

- *Asymmetric DSL (ADSL)*. This is the most common form of DSL and is primarily targeted at the residential market. With an ADSL connection, the data channel is split into a number of sub-channels, creating flexibility in the way that data is allocated across the breadth of the connection. Much higher speeds are achievable for downstream (up to 8 Mbps) than for upstream (up to 1 Mbps), which is convenient for most common uses of the Internet, such as web surfing and file downloading.