

BREAD: a European coordination action for broadband for all

P. Van Daele

IMEC-Ghent University, INTEC Department,

Gaston Crommenlaan 8 box 201, B-9050 Gent-Ledeberg, BELGIUM

Tel: +32-9-331 49 06, Fax: +32-9-331 48 99, e-mail: peter.vandaele@intec.ugent.be

ABSTRACT

The BREAD - co-ordination action, funded by the European Commission through the Framework 6 Programme (FP6) aims at developing a multi-disciplinary approach for the realization of the 'Broadband for All' concept within Europe, bringing together societal, economic, regulatory and technological disciplines and presenting information from regional "success stories" of actual deployment. The EU objective of achieving "Broadband for All" will not be reached by solely a 'technology push' strategy but will need this multi-disciplinary approach and sharing of views and knowledge to develop new strategies and good practice recommendations in the area of 'Broadband for All'. As a co-ordination action the project wants to unite all players active in the field of the end-to-end broadband provisioning for all. It performs a multi-technological analysis of the current and evolving situation, starting from the roadmap information generated by different projects and IST instruments which focus on specific technological domains. The BREAD consortium simultaneously studies the techno-economic, societal and regulatory aspects of this "Broadband for All" concept. It tries to identify the impact of the EU regulatory framework on the successful implementation of new broadband communication services.

Keywords: Broadband for All

1. INTRODUCTION

The BREAD (BRoadband in Europe for All: a multi-Disciplinary approach) co-ordination action aims at developing a multi-disciplinary approach for the realization of the 'broadband for all' concept within Europe. This EU objective will not be reached by a solely 'technology push' strategy but will need a multi-disciplinary approach (societal, economic, regulatory and technological issues).



Fig. 1. BREAD-logo.

Bringing all these different disciplines together, sharing views and knowledge, developing new strategies and good practice recommendations in the area of 'broadband for all' is the major objective of the BREAD proposal.

As a co-ordination action the project wants to bring together all players active in the field of the end-to-end broadband provisioning. It performs a multi-technological analysis of the current and evolving situation taking as a starting base all the roadmap information generated by different IST instruments and projects focusing on specific technological domains. The BREAD consortium studies at the same time the techno-economic, societal and regulatory aspects of this "broadband for all" concept. It tries to cover the evolution in BroadBand in EU countries and some relevant country cases all over the world. This study includes regional "success stories" of actual deployment and the influence of government stimulus for accelerating the early rollout of broadband services.

The BREAD project is setting up an IST co-ordination and information exchange platform to enhance the interaction between the key players in the field and to invoke discussions on this multi-disciplinary approach. The Broadband cluster/Forum set up by BREAD supports the creation of the European Research Area (ERA) through the stimulation of the interaction of EU national initiatives and projects. The BREAD project has initiated a yearly “BB EUROPE” event (www.bbeurope.org) which brings together all players involved in the R&D and the implementation of Broadband for All in Europe and presents information on trials, projects and initiatives taken in the field.

The project has also organized and co-organized workshops such as: “Broadband Roadmap” (10/03/04), “Shaping the Broadband Society” (24/08/04), “QoS” (09/03/05), “Fixed-wireless/mobile-satellite convergence” (23/06/05), “Techno-Economic feasibility of Broadband for All” (23/09/05), “Universal Broadband Access in Europe: What role for photonics?” (25/09/05). Copies of the presentations are available through the BREAD-website.

1.1 The BREAD-consortium

The BREAD-consortium is made up of leading research institutes / universities and consultant companies in the relevant fields, covering as well a broad range of technological expertise as non-technological expertise in the area of socio-economic and policy issues. Many of the partners have extensive contact in- and outside Europe with relevant actors in the field. They have an excellent track record within previous research programmes / projects both on National and on EU scale.

- IMEC and more specifically the INTEC Department at Ghent University (Belgium);
- The Electronic Systems Engineering Department of the University of Essex (United Kingdom);
- COM / Center for Tele-Information at the Technical University of Denmark (Denmark);
- The Communications & Electronics Department at the GET/TELECOM PARIS-Ecole Nationale Supérieure des Télécommunications (France);
- The Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut (Germany);
- Telscom Consulting (Switzerland);
- Institute for Prospective Technological Studies, Directorate-General Joint Research Centre, European Commission (Spain);
- JCP-Consult Sarl (France).



Fig. 2. The BREAD-consortium.

The consortium is open for interaction with other consortia further strengthening the geographical impact and / or extending the multi-disciplinary knowledge covered by the consortium.

1.2 Acknowledgment

The material used in this paper is fully taken from BREAD-work carried out by all of the BREAD-partners. We therefore would like to thank all of the BREAD-partners for their work and would like to refer to the BREAD-website (www.ist-bread.org) and the BREAD-publications, available through the website, for more detailed information.

2. RECENT RESULTS FROM THE BREAD-PROJECT

2.1 BREAD deliverables

The first major result is the publication of the second deliverable “Second Report on the Multi-Technological Analysis of the ‘Broadband for All Concept with’” of this FP6-project “Broadband in Europe for all: a multi-disciplinary approach project (BREAD)”. It contains an update of the listing of multi-technological key issues, a first gap analysis and first roadmaps on how to tackle these issues. It is a combined deliverable on the multi-technological and multi-disciplinary analysis of the “broadband for all” concept. The major objective of this second deliverable (D2.2.-3.2) is to identify and outline the most important areas in relation to the multi-technological and multi-disciplinary analysis of the “broadband for all” concept. This means that an overview is given on evolutions around the world in the different technological disciplines with a first indication of trends and expected scenarios.

The deliverable also includes a complete set of EU country studies on broadband development, as well as case studies of a small number of non-EU key broadband countries. (US, Japan, South Korea, Iceland and Canada). In particular, the five non-EU countries as well as five EU member states (Finland, Sweden, Germany, Denmark, UK) are examined more in-depth than the other 20 EU member states. The analysis includes an empirical account of the drivers of broadband use and diffusion, alternative policy approaches and their impacts, and social, cultural and economic factors that have shaped and that are expected to shape broadband take-up. In addition, a synthesis of the results of all country studies is provided, as well as an examination of how the issue of usability affects broadband development.

The deliverable is a public document and is available via the website <http://www.ist-bread.org> or by sending an e-mail to breadmaster@intec.ugent.be. More information on the different sections of the document are given in the following sections of this paper.

2.2 The BREAD Information exchange platform

The second major result is related to setting up the information exchange platform. As a basis for this platform served 4 elements: the BREAD-website, the BREAD-newsletter, the BB4All Cluster and its website and the BBEurope Event.

The BREAD website (www.ist-bread.org) contains much information and many links to recent results obtained not only within the FP6-community, but also regarding reports, pilot projects and worldwide news-items in the field. Besides this website, the BREAD Newsletter is also available on request. It includes 5 sections: information on the BBEurope event, the FP6 - BB4All Cluster, news from other FP6-projects, recent published reports and the BB Calendar.



Fig. 3. Screenshot of the BREAD-website: www.ist-bread.org

The BB4All cluster is also becoming the main platform for contacts with FP6-projects in the BB4All area. BREAD has been involved in the meetings and organization of the workshops in parallel to the Concertation Meetings. Interaction among the projects and multiple cluster groups is essential in order to reach the general objectives of the overall IST Workprogramme by combining fragmented efforts and strategies into a more coherent EU view and effort.

The various contacts and liaisons which have been set up with other FP6-projects and with national and regional initiatives and organizations in the field have varying success. In some cases the BREAD-project has obtained access to internal deliverables and roadmap information from projects and organizations, while in other cases the links have been one-way traffic until now

2.3 BBEurope & BREAD-workshops

A third major result is related to the organization of the workshops and the yearly BroadBand event, called "BROADBAND Europe". The first event, BBEurope – Brugge, Belgium was, despite the very short time available for organization, a success with 144 participants, coming from 25 countries and spread amongst manufacturers, R&D institutes, academia, government agencies, operators,... The program was based on invited presentations in plenary sessions and more technical oriented sessions covering a broader range of subjects. It turned out to be an event that succeeded in bringing together the different players in the area.

The 2005-edition, BBEurope 2005, held in Bordeaux, France was based on a technical program using a "Call for Papers" and paper selection based on critical review process. The number of participants was increased to 187, coming from 26 countries and again spread over manufacturers, R&D institutes, academia, government agencies, operators,... The technical program consisted of plenary presentations covering more general topics on BroadBand issues and 2 parallel sessions, totaling to over 80 presentations. In addition to this program, extra workshops were organized in parallel by projects or groups of projects to highlight specific topics of their field of interest.

More details on the current status of the organization can be found via www.ist-bread.org or on www.bbeurope.org. Preparations are now underway to BBEurope 2006 (Geneva, Switzerland) and BBEurope 2007 (Antwerp, Belgium). The BBEurope 2006 is hosted by ITU-Telecom and the event will involve ITU standards groups.

Besides this BBEurope event, the BREAD-project was and is involved in the organization of some topical workshops and the IST2004 networking event. Details can also be found on the website.

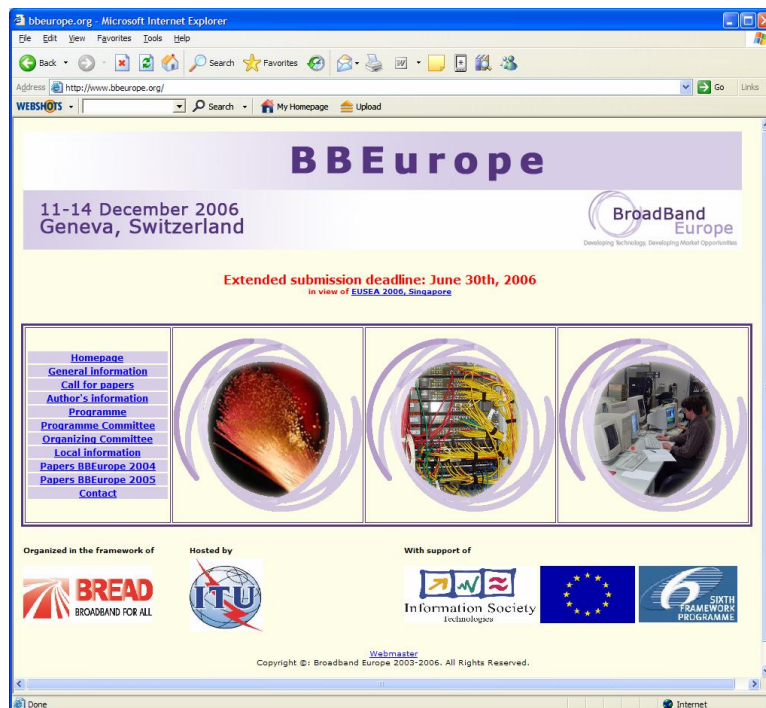


Fig. 4. Screenshot of the BBEurope-website: www.bbeurope.org

3. THE BREAD ROADMAP

In the BREAD-project and the deliverable, a summary is given of the different technologies and trends in the broadband for all areas, which considers different inputs:

- The user, market and convergence trends described in the rest of the document
- The technology state of the art and trends, which have been produced in coordination with the other involved IST project, as well as with external projects and initiatives
- The future inputs of a think tank initiative which is set-up by the project.

The methodology (shown below in Figure 5) adopted to build a coherent set of requirements and roadmaps in the different areas of interest follows an hybrid top-down / bottom-up approach.

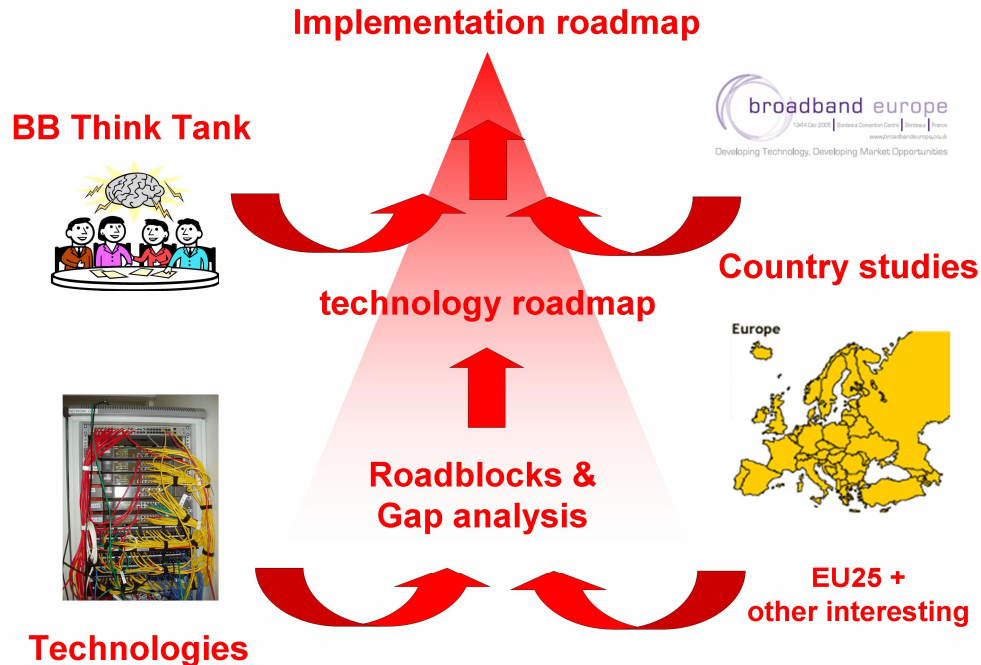


Fig. 5. Strategy followed in the BREAD-project to define roadmaps and strategic documents

Some technical requirements are well known, and a complete framework can be derived. A high level vision, and the pre-study of the state of the art analysis in the different technical domain covered by “Broadband for All” will allow to refine the gap analysis and the technology roadmap derived.

The initial set of requirements which has been considered in the analysis is being segmented between the Application/Service Provider, the Network Operator, and the User (Figure 6).

These can be translated in a set of technical requirements and trends, which are considered for the establishment of the gap analysis and roadmaps in the following chapters. The study of these technical requirements and trends require to segment the Broadband for all into technical areas which are shown in Figure 7

The breakdown between domains tries, to align to the separation between networks and actors of the broadband chain: there is a natural separation between Home network, Access technologies, Metro Network on one end, and horizontal boundaries between the network operator, service / application providers, and content providers on the other end (the latter domain being out of scope of the document).

“Home network” has its own technical and business constraints and there are complex objectives in the area of “Home network” which are not fulfilled yet (the present version focuses more on the physical aspects, and wireless issues) such as:

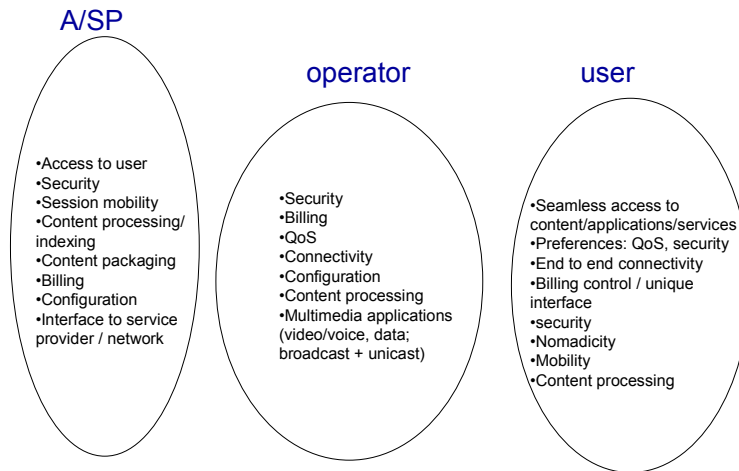


Fig. 6. The initial set of requirements which has been considered in the analysis is being segmented between the Application/Service Provider, the Network Operator, and the User

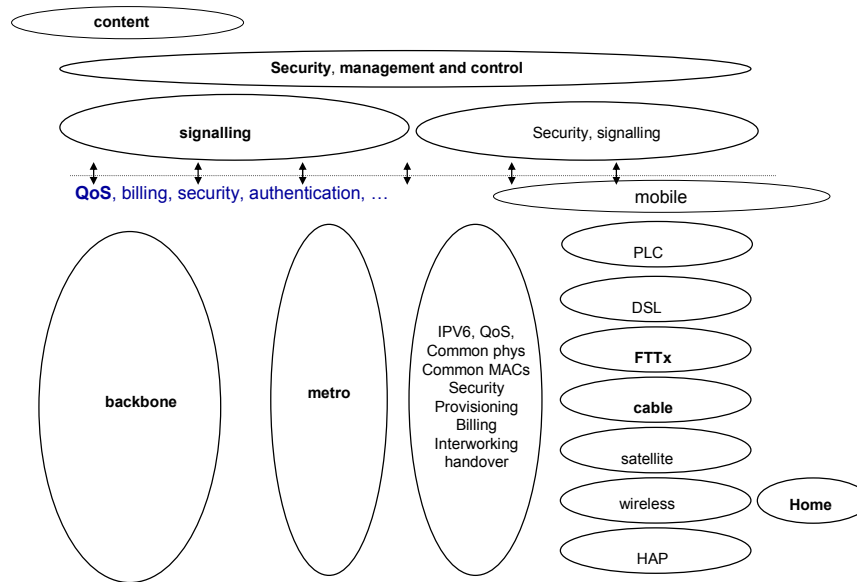


Fig. 7. Segmenting the Broadband for all into technical areas

- High bit rate transport through heterogeneous clusters (including wireless, cable, PLC) and interworking between fixed and mobile clusters; handover between networks owing to different operators
- QoS framework including in-home QoS management, and interworking with access network
- DRM framework to support multiple providers, and local storage
- Introduction of storage in the network
- Coherent content discovery and selection framework

“Access technologies” have all their own issues, common denominators being the need to increase dramatically the average capacity and upstream per user with the introduction of video in the services provided, and the increase of user created content and Peer to Peer communication. Common trends appear between access technologies like decentralized architectures and common optical transport, new physical and MAC layers, common IP architectures (including QoS, charging, device provisioning and security) between access technologies, and between fixed and mobile networks. The progressive introduction of IPv6 in the access, then in the backbone is also developed.

“Backbone and Metro” has similar trends with different constraints and roadmaps; the clear recent tendency is an evolution towards lower CAPEX & OPEX architectures with “multiple services centric” rather than “voice centric services”. A clear trend is a progressive evolution of SDH technology which remains clearly dominant in that field. Trends developed further in this chapter are dynamic networking, more efficient robust modulation and transport format, the reduction and implication of protocol stacks, multiprotocol support with GMPLS, and the progressive apparition of Ethernet in the Metro.

Interfacing between application, signaling and network layers is a natural technical requirement; the openness of these interfaces is driven by the trend of network operator, services operator and application provider being distinct.

Interworking between networks becomes an important issue for ensuring optimal end to end transmission which respects the initial QoS and security, billing and initial users’ preferences settings (e.g. preferred operator). This introduces important additional constraints like:

- Uniformity of QoS and signaling infrastructures
- Requirement for dynamic networks reconfigurability

Requirement for a ubiquitous nomadic or mobile service to the user introduces requirements for unique user identification, capabilities and preferences description; these information must be accessible on a standard way to allow terminal provisioning. The same kinds of requirements exist for the content, i.e. unique ways to identify, locate and describe the content.

On the content and applications layers, video is being aggregated with voice and data into content offers, and there is a general need for unification between data, voice and video frameworks on the different topics of content description, security, content adaptation.

Crucial topic is security, where the requirements are very dependant on the type of content and application, and where the legacy situations are very different; for example a news event and a telephone call will have significantly different protection requirements; moreover the legacy security systems have to deal with the particular environment (broadcast one way, or always on line). As security functionalities can have a major impact on service cost, and seamless access to use is required, a defined and interoperable security and content protection framework, that can rely on lower layer security mechanisms (scrambling, user and terminal authentication) is needed.

More generally there are 2 main requirements concerning content and application delivery: a requirement for standard content encoding, aggregation, description and adaptation mechanisms, and a second general requirement, driven by the separation between content, application and network providers, is the need for defined interfaces between all the actors which allows to communicate the content description, session, security, QoS characteristics, so that the service provider and the network operator can fully exploit and transmit the content.

The requirement to use terminals with different capabilities introduces additional important constraints on content scalability; this scalability can be static (i.e. signaled at the start of an application between the end user terminal and the content provider), or dynamically, i.e. the content would have to support a varying QoS legacy environment, and adapt dynamically to this environment; this is particularly critical in multicast application where the content has to be consumed simultaneously by different kind of terminals with different capabilities.

Another important requirement is for uniformity of content coding and representation, so that ideally a terminal with limited capabilities can use any content, or that affordable transcoding can be provided within the network.

4. MARKET DEVELOPMENTS & POLICY ASPECTS

4.1 Introduction

This part of the BREAD-project includes a complete set of EU country studies, as well as case studies of a few number of non-EU key broadband countries. The case studies mainly concentrate on success stories describing some of the front runners in broadband development. The idea is to analyze examples of successes and failures in a number of selected countries, which can be used as guidance in formulation of future policy initiatives in a European setting. The synthesis of all the individual country analyses is then the subject of the following chapter.

The EU country studies come in two varieties: an in-depth approach for several countries of particular interest for broadband, and more condensed country studies for the other EU countries plus one for the EU as a whole. The EU countries selected for the in-depth approach are Finland, Denmark Germany, Sweden, and the UK.

Finland and Denmark are chosen as both countries have a high ranking with regard to penetration of broadband services. Finland provides a special case as they are hosting a very strong telecom industry. Denmark has a moderate telecom industry but has a tradition as an advanced telecom market with regard to usage and regulation. For example, it has recently been ranked 1 in IDC's information society index. Germany has been selected because it is the most important market in Europe. Sweden is not only advanced in telecommunications in general, but is also leader in fiber-to-the-home technology. Finally, the UK is the country with the lowest market share for the incumbent telecoms operator.

For the non-EU case studies we have selected the US, Japan, South Korea, Canada and Iceland. Clearly, the US is a key market for broadband development, in particular regarding the multiplicity of technologies and initiatives. Japan has been very successful at disseminating broadband access recently, while South Korea is the leading broadband country in the world. Japan and South Korea have also followed distinct telecom strategies which are very different from those applied within Europe. Canada has high broadband penetration despite low population density, an important challenge for large parts of Europe. Finally, Iceland has been included because it is successful in broadband roll-out although there is basically no infrastructure competition. All of the non-EU country studies are of the extended kind.

Altogether, therefore, there are ten in-depth and twenty-one condensed country studies. Given the large number of countries, not all aspects of markets and regulation is studied in every country. Every country study consists of a short country introduction, an update of the broadband market, an overview of the policies pursued by public authorities in the respective country, and a short conclusion. The in-depth studies have more detailed information on the market developments and on the policies, and typically have also detailed information on a number of exemplary local or regional initiatives.

4.2 European Union

The EU 25 includes both the long-established market economies of Western Europe, and the newly-reformed market economies of Eastern Europe, which acceded in May 2004. However, significant income and development differences remain, which is reflected in the broadband market.

Broadband penetration is increasing rapidly across the EU, but at varying speeds and from varying starting points. As a rule of thumb, digitally advanced Nordic countries and the highly cabled Benelux do particularly well, while the new member states and Greece lag behind. The EU-wide penetration rate nearly doubled in 2004.

In terms of technology, xDSL is the dominant technology, often because it is the only one available. Cable is a serious competitor where cable TV networks did exist, but its geographical coverage is limited. Fibre-to-the-Home deployment is significant only in Sweden and Italy, and to a lesser extent in the Netherlands and Denmark. Satellite is considered in several large countries as an alternative for rural areas, but uptake remains fairly low. 3G networks have considerable numbers of subscribers in Italy and the UK, and – relative to their small population – in Sweden, Denmark and Austria, too. Powerline communications have no significant market share anywhere. WiFi/WiMax implementation remains localized and do not yet provide wide geographical coverage.

Technology	Share
DSL	80 %
Cable	18 %
Other	2 %

Fig. 8. Share of broadband technologies in EU – December 2004 (Source of data: ECTA)

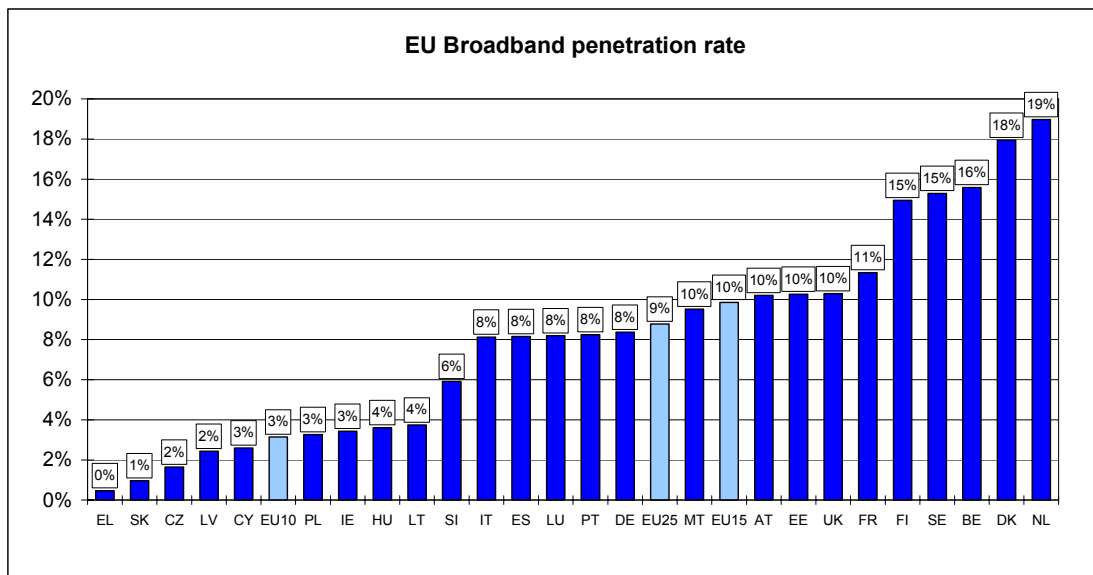


Fig. 9. Broadband penetration on 1 January 2005 (Source: EU Commission)

Broadband policy

The current regulatory framework, which dates from 2002 and, is generally pro-competitive, liberalizing service provision, facilitating market entry makes and setting up a system of independent National Regulatory Authorities (NRA). In particular, it has made local loop unbundling in the telephone network mandatory, which is a key ingredient to introduce competition in the DSL market. However, it does not require separation of the various networks; therefore, cable and telephone networks in several member states are owned by the same company, reducing facilities-based competition.

The Commission issues annual implementation reports to verify transposition and implementation in the member states. While the framework should have been transposed in the old member states by 2003 and in the new member states upon accession, by October 2004 five Member States (Belgium, Czech Republic, Estonia, Greece, Luxembourg) still needed to adopt primary legislation to transpose the framework, and eight Member States (Spain, France, Cyprus, Latvia, Lithuania, Poland, Slovenia, Slovakia) still needed to adopt secondary legislation . The Communications Committee (COCOM), a working group of regulators, attempts to ensure that the practical application of the rules also conforms to the pro-competitive principles of the directives.

Looking beyond purely telecommunications regulation, the European Union has started to develop a broad-based information society policy with the eEurope initiative at the end of 1999, resulting in the eEurope 2002 action plan, which focused on infrastructures, skills and content. It was subsequently extended to eEurope 2005 , and it now being revised again in the i2010 initiative , which puts the emphasis on information space, innovation and investment in research, and inclusion. Most of the specific broadband policy, which emerged as a European issue only at the end of 2002, is conducted within that policy framework.

In January 2003, the Commission hosted the European Broadband Day, followed by Broadband Content and Broadband Regional workshops later that year. After identifying broadband as a key challenge for electronic communications policy , it issued a Communication on national broadband strategies, as well as an annexed staff working document detailing strategies pursued by all old member states, in May 2004 .

A particular concern for EU policy is the roll-out of broadband across in rural areas as part of the e-inclusion strategy. An eEurope advisory work group issued recommendations including demand aggregation of services, deployment of public access points, broadband as a priority for the structural funds, encouraging eServices and eContent, private/public partnerships and called for a pan-European initiative for very sparsely populated areas .

In addition, the EU is funding a number of research projects under the 6th framework program, in order to develop technologies able to provide broadband access more efficiently and more conveniently, thus furthering uptake. In the same program, concertation actions such as the present BREAD are funded in order to create coherence between technological progress and socio-economic conditions.

Conclusion

Broadband penetration is growing very fast in the EU, but levels of deployment are very uneven, both between countries and within countries between urban and rural areas. The EU policy on broadband is currently focused on three major axes: ensuring a competitive framework, addressing broadband gaps in rural areas, and technological development. Moreover, there is a number of Internet policies, such as public access points, e-health, e-education and e-government, which continue to have an impact on broadband development.

5. HOW TO ACHIEVE BROADBAND FOR ALL

This part of the BREAD-work tries to analyze the results of the previous country studies. It looks at factors affecting broadband development first from a classical theoretical framework, which is composed of the supply/demand - infrastructure/content matrix. However, when drawing on the elements which were identified in the country studies, it then uses a framework composed of four categories, i.e. country configuration, legacy situation, competition, and public policy, where the key criterion is the susceptibility of the factors affecting broadband to be themselves influenced by broadband policy. This approach allows identifying those areas where government action can really make a difference. Finally, at the end of the paragraph we have a quick look at some potential inhibitors of broadband development.

Whilst this paragraph thus focuses on what governments can do to help broadband spread, the following paragraph will look at one key aspect which private operators could improve: usability.

5.1 Introduction

The concept of “Broadband For All” refers to a situation in which broadband is not only available to every citizen, but is actually used by all of them. In that respect it is a more demanding concept than the traditional universal service obligation in telephony, which merely stipulates the availability, at certain conditions, of a given service. The usage of information and communication technologies via broadband infrastructures by all citizens is a policy objective because it is considered to be a key component of transforming Europe into a knowledge-based society, thus enhancing economic growth and increasing employment.

For broadband there is no “universal service” obligation for companies to provide this service to all potential customers requesting it to do so at a given price; nor is there a corresponding financing mechanism in place. Therefore, operators will provide broadband only where it is profitable by itself or when specific government incentives have made it profitable. In turn, consumers will demand broadband only where they see a benefit which exceeds the prices which the operator is charging in order to make it profitable. Hence, on the market is a classical case of supply and demand. However, on a second level, supply and demand are affected by a very complex interaction between economic, technological and political/cultural factors. Technological aspects include development of new transmission technologies and development of new types of services that can be transmitted via a broadband infrastructure. Economic factors include market conditions such as the overall market size and the level of competition. Cultural/political factors include regulation and other types of policy intervention as well as differences in lifestyles or openness to new technologies.

There are several ways of classifying these factors for analytical purposes. One is to distinguish simply between factors affecting supply and factors affecting demand, which factors are of course interrelated. The demand depends on how and on what conditions broadband services are supplied. High quality services offered at low cost generate more demand than poor services offered at high costs. On the other hand, a certain level of demand is necessary to stimulate investments enabling supply of broadband services. Another obvious way of classifying factors affecting the broadband market is to distinguish between content and infrastructure. High penetration of broadband networks is only a means for the overall purpose of enabling communication and two-way interaction. Yet broadband development is normally measured by the number of connections, and not by the content delivered via the broadband infrastructure. Development of content and infrastructure may stimulate each other, but the factors influencing content and infrastructure may not be the same.

5.2 Supply of content

Broadband enables distribution of new services that either did not exist or were only available off-line. Current examples are online music platforms, Video on Demand (VoD), Voice over IP (VoIP) and web-based software applications; for instance, Internet Protocol TV (IPTV) launched its new services in France (MaLigne tv) and Spain (Imagenio). Future applications are expected to be video-conferencing, broadcast multi-casting and increasingly interactive content. An important driver is the ability to develop new converging services combining features from services used to be distributed through separate delivery channels. There is however a number of economic and political challenges related to this. For instance, VoIP is threatening to cannibalize revenues of established (incumbent and new entrants) telecom operators and the availability of (audio)-visual content is considerably affected by intellectual property protection in form of law and technology.

Development of new business models and pricing schemes are key drivers for both generation and demand for content. One of the factors behind the success of the Internet has been a charging mechanism where the end-user pays distance independent price and where most content is free. On the other hand this model has had clear limitations with regard to content generation, as it seems difficult for users to accept payment for certain types of content.

Supply of content is difficult to quantify and compare. In theory the supply of content is the same from everywhere, as one will be able to access the same content once the infrastructure is in place. But different languages and preferences towards locally produced content imply that users may experience national differences. Relevant measures for supply of content, which can be used for international comparisons, include the number of digital broadcasting channels available, number of Internet hosts etc, but these numbers will never tell the full story and can only be used as indicators.

5.3 Supply of infrastructure

The infrastructure aspects relate to the broadband network itself. The development of supply depends on existing network facilities as well as the level of investments. Network operators are mostly commercially oriented companies that assess their investment opportunities according to the return of investments. The viability of investments in broadband depends on the level of total costs compared to expected revenues.

The most successful access technologies for broadband have so far been ADSL and cable modems. Cable modems offer generally higher bandwidth and are cheaper than ADSL services, but cable networks are not as widespread as telecom networks. Cable modems are only offered to a certain segment of users mainly in urban areas. Wireless connections such as 3G and FWA have so far a limited penetration. 3G services have today some success in Japan and South Korea and are expected to take off in other countries as well. However the bandwidth offered is limited and can hardly be a full substitute for a wired broadband connection. FWA is more expensive and is mainly used by business users, but may be an attractive solution in rural areas not served by ADSL or cable. Finally WLAN technologies may be used for providing broadband access in public spaces or in neighborhoods.

In addition to telecom and cable-TV networks other types of infrastructures provided by municipalities or power companies may be used as a basis for provision of broadband services. Local community associations may also be a driving force in provision of broadband e.g. through existing cable networks or by use of WLAN. Some of the largest of these networks are established in co-operation with the municipalities. This has been the case in e.g. Germany and in Denmark. Unlike network investments made by telecom or cable operators, these initiatives are customer driven. Pooling of demand by group of customers can be a very effective tool to decrease prices by benefiting from economies of scale. Rather than approaching the network operator individually, communities considerably strengthen the bargaining power of the customers. Incidentally, such initiatives also stimulate demand.

The extent to which these technologies can be applied by use of existing network structures affect the total cost of investments needed for supply of broadband services. The development of broadband facilities depends on the total cost of investment and on the revenues that these facilities can be expected to generate. Expected revenues depend on demand: the number of customers and the prices that can be charged for delivery of broadband services. In addition to this, the market structure – first of all, the level of competition – plays a key role in driving supply.

Infrastructure supply is also helped by standardization. Increased industry-wide commodisation of network elements and modularization of infrastructure allow easy third party interoperability. In other words, the more industry standards emerge, the more third parties investments can complement the investments by the network operator itself. This is of particular relevance in relation to the high level of debts of many network operators.

5.4 Demand for content and infrastructure services

As the demand for broadband infrastructure is driven by the demand for content, the drivers for services and infrastructure are highly interrelated although the indicators for the level of demand are different. The most important economic factor is income compared to the price for a broadband connection. Another socio-cultural factor can be termed the e-readiness of the society, a combination of skills, availability of terminal equipments and openness to new technologies.

As a general rule, households with broadband connections are using the Internet longer than those with a dial-up connection. For example, in Finland people who acquired broadband connection in 2003 increased their weekly Internet use by 4 hours. There are basically four reasons for that. Firstly, households which use or intend to use the Internet a lot are more likely to acquire broadband connections – in other words, broadband households are a self-selecting group. Secondly, the demand for services already accessible under dial-up increases because they become more comfortable – web pages appear faster, e-mail messages take less time to download. Thirdly, since broadband is usually priced at a flat-rate fee, the marginal connection price of consuming additional services is zero, which means that demand is economically unlimited (of course, it remains physically and socially limited, since it is impossible to spend 24 hours a day directed to the Internet terminal). Finally, households with broadband access can consumer certain services which are not available over dial-up access . For example, Voice over IP requires always-on connection. Some of the most important services actually require “broadband” in a stricter definition than the 256 kbps definition used for most statistics – video-on-demand needs bandwidth of at least 1 Mbps.

Although households dominate demand in the most advanced countries, the use of broadband in businesses is important in the less advanced economies. Business applications may also stimulate demand from households. Therefore, the structure of the economy is important for overall demand. An economy dominated by informational activities must be expected to generate more demand for broadband services than an economy based on agricultural production.

5.5 Factors influencing broadband development

However, for analyzing potential policies based on the country studies, it would appear to be more useful to classify the factors impacting on broadband development according to how much they are subject to influence by policy makers. Therefore, we have grouped them into four large groups, which we call the configuration of the country, the legacy situation, competition and policies, going from those factors least susceptible o change to those most susceptible to change. Strictly speaking, the competitive situation is not a set of factors in itself, but the result of a combination of the legacy situation and policies, but we have given it its own chapter before the chapter on policies, because understanding policies requires understanding the nature of broadband competition. Interestingly, the country configuration is mostly composed of factors affecting demand, while the legacy situation is mostly contains factors affecting supply; public policies affect both, but with demand as the ultimate objective. The influence of these factors is described in more detail in the BREAD-work.

5.6 Inhibitors

Despite all the advantages of broadband, there are also some problems which broadband users have to overcome. The first relates to intellectual property. Currently, a large part of the network traffic is peer-to-peer file sharing, some of which concerns collaborative working and other legitimate uses, but most of which is downloading music, and, increasingly, movies over the Internet. For example, in Sweden up to 85% of a typical ISP's capacity was recently estimated to be used for peer-to-peer file sharing. As the intellectual property holders are getting ever more aggressive in pursuing unauthorized downloading, this may reduce the attractiveness of broadband. At least the music industry has, after much resistance, recognized the potential of the Internet as a legitimate channel of distribution and set up its own offers, while the movie industry is not yet that advanced. In theory, paid music downloading should mean that peer-to-peer could continue its growth, but while respecting copyright. However, in practice the digital rights management systems tend to be very restrictive and are likely to reduce consumption unnecessarily. In any case, the payments to copyright holder will naturally reduce demand by increasing the cost of downloading.

A second problem is security. The always-on character of broadband connections makes end-user machines visible to the Internet. According to some estimates, most spam mail is now sent by broadband-connected consumer machines that have been converted to mail generators and gateways using security holes. Automated scanning tools enable systematic search of vulnerabilities in broadband-connected end-user machines, and several viruses have been created that do this without human intervention. As the number of broadband users grows, there is no guarantee that their computer security

competences would quickly improve. If end users realize that machines in their homes are used to send spam and viruses across the world, they may start to view broadband connections as harmful and dangerous. The psychological effect of finding out that one's personal computer has been maliciously converted into unknown and perhaps illegal uses, and that outsiders have gained perhaps complete access to files in the machine, is probably quite damaging. Potential users may delay their decisions to acquire broadband connections and existing users may unplug the network when not in use, effectively giving up the always-on benefit.

A related issue is that one important new use of broadband is the regular downloading of security patches for operating systems and application software. In the theoretical point where broadband is mainly used to download security updates that are needed because the connection is broadband (i.e. the end-user machine is continuously connected to the net), the benefits of broadband could relatively easily become negative.

5.7 Conclusion

Broadband development, as seen in the country studies, is very uneven. Some countries are already advanced and continue to grow fast (e.g. the Netherlands), others have barely started (Greece), yet others are fairly advanced but are experiencing a sharp slow-down in growth (South Korea). These differences can be explained by many factors, ranging from GDP per capita to broadband strategies. We have separated those factors which cannot directly be influenced by governments (e. g. population density, demographics) from those which can only be influenced in the long run (e.g. educating people to use broadband services) and those which can easily be influenced (e.g. setting of interconnection and access regulations by the NRA, funding for connecting remote areas). Once the most effective levers of government action are identified, the main issue is how best to use these levers.

Given the variety of country configurations and legacy situations in the countries we have looked at, it was not surprising to find that public policies have equaled varied enormously, even within the EU, where a certain coordination exists. Clearly, a rich inner city with multiple networks needs a different approach from a rural area with not even generalized telephone coverage. Countries which have many inner cities therefore have other needs from countries which have many remote areas. Public broadband policy needs to be tailor-made for each country.

If there is any common lesson, it is that strong competition is the foundation upon which complementary public measures can build. Ensuring the right regulation for competition, is therefore the first step, which can then be followed by facilitation measures, both to intensify competition and to facilitate demand, and by direct intervention, where this is necessary. However, as always the key question is "where is this necessary", for which there is unfortunately no single universally-valid answer.

6. BROADBAND APPLICATIONS AND USER NEEDS

The intention of the country studies was to identify socioeconomic factors that have an impact on supply and demand, to describe their country specific extension and to recommend measures that appear helpful to accomplish a BB4All System.

However, one group of socioeconomic factors - also important for demand – is not taken in account within the country studies. These factors concern end user criteria, particularly the adaptation of broadband applications to end user needs in terms of usability and usefulness. To describe the extent to which these criteria are fulfilled within any European country would be far beyond the scope of the project: There would be no end to describe country specific extensions of shortcomings with regard to usefulness and usability.

On that basis it appears reasonable to provide a cross sectional chapter on end user criteria that complements the country studies and is focused on the following questions:

- Why should end users benefit from broadband applications? Without convincing answers to that question a necessary condition for sufficient demand is missing.
- To what extent are broadband applications already available or may be expected in the future? Answers to that question might help persons in charge to find out which type of broadband applications will probably cause demand and should therefore be offered
- What reasons might threaten usability and usefulness of broadband applications?
- What measures are appropriate to avoid or eliminate obstacles to a BB4All system from end users perspectives?

Again these factors are just summarized here and are explained in more detail in the BREAD-work.