

Broadband Access in the European Union: An Enabler for Technical Progress, Business Renewal & Social Development

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Broadband can be evaluated as a practical enabler for evolution, innovation and progress in many distinct sectors and it covers numerous activities. Under normal conditions, broadband can efficiently support market development and growth. It also strengthens competitiveness and forwards the evolution of the wider Information Society sector, especially in period where there are strong indications for market recovery, in terms of finance and investment. Broadband is at the heart of the convergence of telecommunication, information technology and broadcasting. The paper discusses a variety of possible broadband technologies/platforms. Furthermore, we investigate and discuss principal technical and business challenges related to such a potential expansion, by taking into account other relevant concerns (such as development and availability of different forms of content, trust and security options, copyright and related rights, etc.). In addition, we study specific features for the evolution of innovative, 'content-rich' broadband applications and/or novel e-Services. Broadband deployment has the potential to bring valuable new services, stimulate economic activity, improve productivity, and advance economic opportunity for societies around the globe. However, society must be able to translate the full benefits of such innovations into productivity gains, economic growth, employment and social cohesion. . The paper summarises with main concluding remarks originating from recent developments at the European level, as well as with some concerns in creating a competitive broadband access market, based on probable synergies between the public and the private sector.

Keywords

- broadband
 - interoperability
 - e-society
 - local access network
 - convergence
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1 Introductory Framework: The European Vision for Global Development via the Usage of Innovative ICT

The rapid development of new, disruptive network technologies and the ongoing convergence among the Telecommunications, Information & Communication Technology (ICT), and Electronic Mass Media industries are bringing about significant changes to economic development in the EU [1]. At the same time, all the above clearly have a significant impact on broad participation and cohesiveness, to equal communication and access to the knowledge economy ([2, 3]), with the adoption of the necessary cross-sector strategies.

Although there is still a 'crisis' in the global ICT sector, the Information Society is still viewed as a powerful source of productivity gains and of significant improvements in living standards, for both corporate and residential users [4]. In its latest report [5], the European Commission referred to the fragile state of the electronic communications market in the light of a number of factors, including the global economic slowdown and the level of debt on the part of some market players due to ill-timed investment in backbone networks, the cost of 3G licenses and the high prices paid for the acquisition of other operators in other countries. However, the situation now appears to be stabilising. As far as the wider economy is concerned, there are now signs that the EU is about to embark on a period of recovery. Both business and consumer confidence are reported to be improving as the world economy gathers momentum, while financial conditions are believed to be supportive of growth.

The current, high-tech, digitally converging environment, is strongly related to the existence of modern digital infrastructure of high capacity and of high performance. However, when rationally deployed and properly priced, it is capable of providing easy, cost-effective, secure and uninterrupted access to the international 'digital web' of knowledge and commerce, without imposing any artificial barriers and/or restrictions. The Internet is considered as a 'multi-entity' of both traditional and innovative infrastructure, services, IT and content, thus providing the basic tool for e-Commerce, public services and for the effective re-engineering of multiple business processes. Internet penetration has increased rapidly in the EU since the launch of the Lisbon strategy in 2000 [6] with more than 40% of households now connected as well as most businesses and schools [7]. The Internet is now becoming the main means for the transmission of information, communication, transactions and media in Europe and the rest of the world. The EU Governments place an increasing emphasis on the necessity of the development and diffusion of high-speed Internet from the e-society perspective. Broadband Internet access is a key factor for improving the performance of the economy, while broadband networks will form the backbone of an increasingly interconnected and integrated society.

The benefits of broadband in terms of productivity gains, growth, and employment are expected to be significant. Broadband will stimulate new businesses and improve productivity and innovation in businesses.

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The Broadband Option: A Major 'Tool' for Evolution

There is no universally accepted definition of broadband. Its key features are faster data rates, high speed, high availability, high quality, a range of new products, improved performance and 'always-on' functionality. In a generic sense, broadband equates to a minimum amount of bandwidth (above 2Mbit/s), and bandwidth indicates how fast data is transmitted. It is characterised by the interplay of technological capabilities and application requirements. Broadband access usually refers to the capability of transferring large volumes of information (i.e. large quantities of electronic signals (including data, video, text and voice) between communicating systems and users, with emphasis on the 'always-on' connectivity to the Internet and on the seamless transfer of rich multimedia content between providers and users (e.g. including the transmission of acceptable quality interactive videos over the local loop (i.e. the last mile)) and via the use of different terminals (also considering specific customers' premises equipment). Broadband allows people to access and exchange information, rich media content, video, music, community services, business applications and many more, at high speed over a variety of wired and wireless technologies.

The necessary pre-conditions for the successful deployment of broadband access include the availability of useful multimedia content beyond a critical mass, and the availability of ultra-high capacity core infrastructure, all user-friendly and attractively priced. It is of major importance that the overall political and economic conditions (i.e. regulatory framework, positive investment climate and socio-economic stability) encourage the extensibility, scalability and sustainability of the access to core infrastructures, as well as the overlaying services. Broadband will enhance the performance of Internet by improving its quality, by making users enjoying rich content applications and services and by improving their productivity.

3

Broadband Technologies: Current State & Future Perspectives Towards Creating an 'Efficient' Pan-European Infrastructure

Technological developments associated with the digitalisation of information have allowed dissociation of communication networks from specific types of information: voice, data, images, etc. All of them can be transported through various access platforms, and can be accessed through terminals, via appropriated interfaces. However, physical infrastructure and geography vary greatly across countries and areas, and technologies that work well in one geographic area may not be feasible in another. As no one technological solution is necessarily appropriate for an entire country or region, the variety of available technology platforms gives new and

innovative alternatives to expanding broadband access services. Suitable network architecture solutions can help to map several business models and broadband services, allowing identification of business opportunities in relation to technical and operational issues and high standards for the quality of services (QoS) offered.

The access to high-speed Internet is provided by means of existing facilities such as the telephone copper networks using the Asymmetric Digital Subscriber Line (ADSL) technology and cable TV networks using cable modems [8]. The ADSL and cable modems are driving the present transition of broadband. The ADSL is currently the dominant platform (in terms of market expansion and penetration) in the EU as it may provide immediate access via the existing copper wires. Cable modems are usually integrated with the set-top box (STB) and offer potentially higher access speeds at lower cost with bundled product including access to digital TV, telephony and Internet. However, cable access is limited by geographical coverage of the network(s). Cable access is at present the main alternative technological platform used by several operators to provide broadband access; this option is feasible only in those areas where CATV networks are already deployed.

Recent EU reports [5] and [9] have demonstrated that ADSL prices are falling, thus attracting more users. Indeed, the decline in prices for equipment and the connection of previously isolated machines have provided people with more powerful devices. The development of broadband services constitutes an important source of revenue growth for both fixed line communication companies and cable operators. Data show that greatest availability and take-up of broadband tend to occur in those countries where competition takes place between different networks or facilities [10]. When competitors are independent of each other's network, competition on the market can develop at its full extent. Nevertheless, in Europe, current alternative technologies to ADSL only count for about one third of broadband connections. Therefore, regulation remains extremely important.

The new communications platforms are emerging: interactive digital TV, third-generation mobiles (3G), satellite communications systems, fixed wireless access (FWA), R-LANs (Radio Local Area Networks or WLANs or Wi-Fi), free-space fibre optics and electric power-line access will be amongst the alternatives for full territorial coverage. These new technologies can coexist in order to ensure diversity for the complete coverage. Each separate technology provides particular capability options.

Considering the role of TV and radio (jointly referred to as 'broadcasting') in modern societies, the impact is not only economic but also social and political. Interactive digital TV (DTV) platforms can use different transmission technologies (i.e. terrestrial, satellite, cable, over VHF and UHF frequency band) to reach to the end-users. Some television receivers now use a set-top box and a connection to a telecommunications network can provide Internet access, together with short-message services (SMS) and e-mail services; moreover, digital audio-visual content can be also supported by the Internet and by a variety of networks. All these are suitable means to provide a variety of convergence-based facilities, Information Society services and Internet-like services, which combine different broadcasting and telecommunications applications. DTV covers both enhanced broadcasting and 'true interactivity', especially via the development of the Multimedia Home

Platform (MHP) [11], based either on digital video broadcasting (DVB) or digital audio broadcasting (DAB) specifications. In fact, both digital TV and radio are still growing markets.

The 3G (or UMTS) mobile communications [12] will enhance network technologies and software, which will improve the range of services and applications available, particularly by increasing the speed at which services will run over the networks. The main aspects of third-generation systems and services will be consistent quality of service and coverage for voice, data, graphical and video-based information, thus allowing multimedia connections and video-conferencing. This constitutes a revolutionary perspective for the future development of the global mobile sector, which provides opportunities for enhancing services together with mobility. Because of the mobility and portability options of such technologies, 3G communications have the potential to stimulate demand and incite new ways of accessing and using the Internet. To offer high-speed, low-cost data applications, a wide variety of commercially available devices (e.g. mobile telephones, smart phones, personal digital assistants (PDAs) and laptops) make the 3G technology a reality today.

Furthermore, satellite communications may guarantee 'wide' or global area coverage but the key problem in this area is the need to develop new economically viable applications, which make optimum use of the benefits of earth and space technologies with generally different industrial cycles and capital yield profiles. The satellite communications can be considered as an 'instrument' for guaranteeing strategic, political, scientific and economic leadership. Investment in the space applications sector in general generates a 'wider' market of services. The rapid introduction of digital technologies including data compression has repositioned space communications as a competitive alternative to optical fibre to provide video/multimedia services to businesses, public authorities and individuals. Recently, there is a strong EU interest [13] for the investigation and the exploitation of the strong potential of satellite (interactive) applications, especially within a common framework in parallel with other EU activities (such as broadcasting, positioning and navigation applications, sustainable transport and mobility, weather forecasting, environmental protection, responses to emergencies, etc.).

Light via fibre optic is quite simply and provides the optimum platform for data transmission. Fibre optic does not suffer from interference, and provides reliable connections, which has significant capabilities in terms of bandwidth. However, the cost of installing completely new infrastructure is still significant. An alternative might be to promote suitable partnership schemes (e.g. between local authorities in cooperation with existing operators and/or other market players) for the deployment of 'dark fibre' infrastructure, via 'condominium fibre networks' and/or suitable carrier-neutral collocation facilities. Under certain conditions, the development of new fibre infrastructures may be a significant driver for growth. Such specific optical networking can provide advantages, in parallel with extended reliability options. In addition, optical infrastructures may be able to reduce network complexity and offer extra benefits for network management costs [14].

FWA uses radio microwave technology, and it can be rapidly installed. This is an attractive option, to support competition in the telecommunications markets, especially in terms of flexibility. It has been used successfully for point-to-multipoint telephony services in remote towns and for point-to-point, high bandwidth connections for larger businesses. FWA can be considered as an effective means to-

wards providing, in a short to a medium term basis, valid alternative options for infrastructure solutions. Current broadband fixed wireless access (BFWA) base stations are mainly located at urban areas, where a line of site is needed from the base station to a customer's premises. BFWA allows high-speed data connections using radio links between an aerial located on the user's premises and a base station. At a regional level, a growing number of groups are also developing community wireless networks in areas where ADSL and cable modems are not available, aiming to offer services to both residential and business users.

As for RLANs, these are a fast-developing, innovative and promising means for the provision of broadband wireless access to the Internet and to corporate intranet networks not only for private uses but also for the public. The RLAN can serve various categories of users (especially business users) away from their home or office location, which complement other broadband access infrastructures, and offer significant opportunities for accessing Internet in public (limited or extended) areas (such as airports, train stations, shopping centres, public spaces, libraries, schools, cafés and restaurants, hotels, etc.) via the usage of appropriate hot spots. It should be expected that the supply of wireless broadband services would facilitate more efficient use of other technologies [15]. . To meet demand in a timely and cost-effective manner, many operators are examining wireless technologies that provide high-speed data transmission without the expense of installing and maintaining traditional broadband networks, such as DSL or cable.

Power-line communications are interesting; however, there are still technical restrictions to be clarified, especially for data transmission rates and in particular technical constraints of the infrastructure.

4

Specific Discussion and Assessment upon Major Technical Challenges

Advanced technologies are an essential module to achieve the goals of the Information Society [16], for the mutual benefits of users/consumers and of network and/or service providers, as well as for any other 'market players' (including governments, local and regional authorities, regulators, European Authorities, and many more). The broadband technologies will coexist, because there is no single technology able to ensure a complete coverage of the whole of the EU. Furthermore, diversity in technology will help solving access in different geographical areas, according to local needs. The two other basic options for the successful penetration of the broadband reaching technologies are substitutability and complementarity of technologies. The former implies that, in more populated areas where markets sustain more than one provider, competition in network infrastructure will be the means to lower prices, to support higher quality, to hold up innovation and to widen choices. The latter means that, in less populated areas, where provision of broadband access is not necessarily profitable, exploitation of the different characteristics of technologies will facilitate whole territory's coverage.

The openness, interactivity, interoperability, efficient interconnection and interworking between the existing multimedia platforms are crucial factors to provide a guarantee for a combination of different kinds of services offered by various delivery systems to different end-user terminals. The benefits of interoperability will be more important when platforms are based on European (and/or international) technical standards, conformant to existing market practices and aiming to well-defined policy targets. An important role to success to this effort is to be performed by the European standardisation, in particular to provide solutions 'independent' of any specific requirements imposed either by the network operator or by the terminal manufacturer. This is crucial for both industry (equipment and content) and consumers because it facilitates the creation of new and viable applications and ultimately gives consumers more choices. Open and interoperable platforms will reduce the cost and inconvenience of re-authoring content for different infrastructures. Common technical standards and specifications adopted by the market are also important to define safety options, while overall legal and technical clarity will increase industry confidence and help the necessary infrastructure deployment and/or upgrading, whenever is necessary. Operators are currently developing the next generation of services in an anticipated multi-platform environment to achieve acceptable levels of voluntary standardisation, whether in interface technology or in data format technology, to achieve interoperability of services.

In particular, the design of Internet [17] (i.e. through the new version of the IP (Internet Protocol) communication and addressing method, called IPv6, which is expected to increase the demand for bandwidth) enables broadband to run over many different types of network infrastructure. Consequently, the Internet becomes a basic platform, capable to enable users to access an extended diversity of content and applications. The usage of different technologies involves a wide range of terminal equipment and devices for end-users (either hand-held devices or more 'complex' equipment already established at 'home' or at 'work' locations), such as personal computers (PCs), PDAs, mobile terminals, digital TV sets, etc., i.e. an option which provides further motives for economic evolution and deployment of the broader telecommunications sector's industry. The broadband connections will increase the speed of transmission between digital devices and the quality of Internet access, making it: more user-friendly, convenient for consumers, enable the full scope of multi-media applications to be applied. Actions such as supporting availability of multi-platform content, encouraging digital switchover and ensuring that broadband is a priority in the wider ICT activities, are among the major initiatives to extend the reach of benefits arising from convergence and interoperability [17].

Other challenging issues, such as the development of attractive consumer services, the creation of a secure environment to inspire consumer confidence, and an environment of regulatory clarity for new electronic services, are equally important in determining whether widespread access to Information Society services will be available.

5

Broadband Services and Applications: New Opportunities for Business and Residential Users/Customers

The promise of broadband and the proliferation of broadband Internet access services are fostering the creation, adoption and use of multimedia applications that can meet consumers' broad communications, social development and economic needs. The unbundling of access networks together with the availability of new technologies, have urged telecommunications operators (and other market players as well) for new opportunities of value added services, especially for a wide broadband access to IP and data network services.

Availability can be stimulated by supply-side policies, which are based on the enhancement of competition and address existing market failures. Use of broadband can be encouraged through demand-side policies, which target the development of applications, content and services. The availability affects consumers' choice at a given price. Supply and demand-side policies are effectively interlinked. An increase in demand will improve operators' expected returns and foster investment in the deployment of infrastructure. Greater availability of infrastructure will stimulate the development of new content, services and applications, which will further impact demand.

The broadband challenge results to significant user and consumer benefits, related to innovative areas of significant importance and of crucial business potential. Various forms of e-Services generally yield more productivity/efficiency gains and quality of work/life, when embedded in effective re-organisation of processes and service delivery. Some amongst these innovations are as follows:

e-Commerce, allowing realisation of complicated business deals in a fast and reliable manner [18], to engage in collaborative e-Business for different categories of users, thus facilitating buying and selling on-line and on-line software delivery. The steady integration of broadband ICTs into business processes has a significant impact on the economy as a whole (i.e. in terms of efficiency expected to materialise into productivity gains). However, the simultaneous development of secure mechanisms will facilitate further deployment of e-Commerce activities.

e-Learning, by stimulating distance education and learning through modern and real-time services, upgrading skills, improving human capital, and contributing to making life-long learning a reality, for people on the job market. The e-Learning requires reliable technology with high bandwidth connectivity. The connectivity to ICT infrastructures continues to rise in the education and training sector. In these sectors, there are clear opportunities for the application of broadband to reduce costs and improve quality and variety of educational materials. In the short term, some expected e-Learning applications would be the provision of 'multicast' of on-line courses and the creation of on-line libraries (probably in parallel with the creation of virtual environments equipped with navigation tools and research engines).

e-Health, as telemedicine can improve medical assistance to all patients, regardless of their geographical localisation, and improves productivity of health practitioners. Health is an area that deserves particular attention. The e-Health is now becoming a central aspect of health policy at regional, national and European level. The work of medical practitioners at all levels is becoming more information intensive as sophisticated medical equipment and computer applications are more widely used. In the health sector, 'tele-consulting' and 'home tele-monitoring' have the potential to deliver significant savings, make scarce resources more available, reduce delays in patient care, support patient mobility, avoid unnecessary duplicate examinations, increase quality standards, promote security and privacy, and help citizens to support and manage their health status. In addition, the ubiquity of patient information through electronic patient records, electronic health cards, health information networks and web-based clinical advice can speed and improve treatment and reduce costs.

e-Government, the broadband will allow the easier and faster on-line supply of existing or new public services and it facilitates contacts between citizens and administrative officials, in particular when located in distant geographical areas to avoid 'info-exclusion' and digital divide. This results in modernising communications between government departments and agencies, reducing transaction costs, improving productivity and satisfaction of the citizen. A critical factor would be the promotion of genuine interactivity between players involved. Since broadband services can be offered on different technological platforms, national and regional authorities should not discriminate between technologies when purchasing connections. A parallel significant initiative could be the development of more public Internet access points (PIAPs), especially to offer user-friendly public information for different matters (e.g. culture and tourism), as well as e-Procurement availability. It is important that e-Government is not only about implementing technologies and supplying services but that it provides solutions. The e-Government is currently a priority in most of the EU Member States. It transforms the way the public administration works, provides efficiencies to public administration, enhances the participation of citizens in public life and changes the nature of the services offered.

e-Entertainment and Applications-On-Demand, as downloading music and playing video games on-line (e-Gaming) are popular applications in the residential market. Much of the future potential is likely to come from TV-based applications, such as 'movie-on-demand' or 'news-on-demand' where user is able to select among a proposed variety of content. In parallel, radio and television broadcasters have the opportunity of providing services in innovative ways.

In open, networked societies and economies, where the rapid growth of the number of participants results to a sharp increase of the value of the overall product, new opportunities emerge for business activity and improvement in the quality of life. The end-user (either business or residential) becomes an active participant of the expected 'digital inclusion', and behaves not as a 'passive consumer' but as a 'potential provider' of services and added value. In particular, end users are expected to create, customise and share rich multimedia content with each other.

Although there are still problems in the ICT sector (i.e. investments are costly, take-up is still relatively slow and the financial situation is restricted), broadband was recently [5] a major growth factor for operators. Internet, mobile communications and digital television applications continue to show slow growth despite the onset of the global recession. However, the new global reality offers a moment of punctuated opportunity with the potential to create cross-sector strategies and turn risk into a technology leap forward.

There were 17.5 million broadband connections (i.e. connections offering capacity equal to or higher than 144 Kbit/s) in the EU at the end of June 2003 [5]. From this total, 12.46 million of such connections were DSL lines (71% of the total), while 4.1 million were cable modem access lines (24% of the total). The remaining 0.9 million lines (5%) used other technologies, mostly satellite and fibre. Broadband connections have almost doubled from the 9 million broadband lines available in July 2002. Growth has been more intensive in the period from January to July 2003, when more than 25,000 new broadband lines were being added daily.

The broadband access debate has been focused from the supply side to the demand side. As customers' and business communications demands are changing, opportunities to compete in these challenging markets arise. Demand aggregation is used as a tool to facilitate investment; such an option creates an essential base for customers and helps industrial sectors to reduce uncertainty on the demand side. This raises productivity, ascends the value chain and supports for trade and industry.

Broadband providers are looking to improve and differentiate their service offerings in order to increase penetration and thereby revenues from both enterprises and residential markets. Open platforms are desirable because they enhance consumer access and can offer greater user choice. Proper strategies and suitable business models are to be put in place to drive demand for innovative services and to satisfy emerging needs. Users' requests and demands as well as their feedback to the proposed facilities/services, provide fundamental guidelines either for development of technology or for market evolution. Demand derives from consumers' behaviour, and depends on users' willingness to consume and to pay for faster transmission of rich content. Thus, broadband demand also depends on the availability of new content and on the corresponding pricing policy. Within the same context, as most businesses have completed their transition to broadband access, the focus would shift on the mass market to ensure that broadband becomes available to small and medium size enterprises (SME) [19] (currently representing a sector of high prior-

ity for the EU development) as well as SOHOs (small-offices home offices) and to households on a larger scale. The wider development/penetration of broadband access has the potential to bring 'fast and always-on' communication capabilities to SMEs (and other users) that could not previously afford these capabilities via leased lines or did not have the volume of traffic to justify the cost of a leased line.

In particular, a fundamental factor is to ensure stimulation of the development of new content, applications and corresponding services by putting public services on-line, focusing on public administrations, education systems and public health, which are the areas that have the greatest leverage power. Content provision must be primarily up to the market. The successful uptake may also implicate other relevant matters such as those referred to the promotion and the potential harmonisation of digital rights management (DRM) in Member States, including certain aspects of copyright and related rights in the Information Society sector [20]. This can influence widespread access to systems as well as the ability of different service providers to sufficiently offer the same content available over different platforms in a pluralistic way. DRM systems and services are closely related to consumers' perception of freedom of choice in accessing modern broadband services. The promotion of open, flexible and interoperable DRM systems and services continues to be a priority in the market.

A determinant factor for the development of broadband take-up is user's trust and confidence in both network and service providers. Information and network security (also including awareness, best practices, codes of conducts, computer emergency response, protection of privacy and security in e-Government) is particularly important for broadband because with some technologies, 'always-on' connections increase the probability of attacks [21, 22]. Security is an enabler of e-Business and a pre-requisite for privacy.

7 The Role of the State and of Public Authorities: Probable Regulatory Challenges within the Context of Recent EU Initiatives

In such an evolving environment, the role of public authorities is significantly important. The rapid development of appropriate and affordable broadband infrastructure and the development of relevant applications and services must be set as a top priority for the government. The above infrastructure deployed at national level(s) will be coupled with international broadband connections; this is a necessary step in bridging the 'digital divide' among citizens [23], both within and between regions, thus providing opportunities and potential for regional development of local communities up to a common European standard.

The development and use of broadband services by the Public Administration, particularly in education and health, could be a major enabler in raising awareness and ensuring penetration of these services.

The convergence and broadband has improved the ability of users to select amongst different network and service options offered by different market players to find the most attractive one, in order to satisfy their needs and interests. Therefore, they are both important 'drivers' of competition, as they practically open the market(s) at the level of services and content. Public authorities and governments have to promote competition within and between different possible forms of infrastructure, while simultaneously preserving the fundamental option for technological neutrality. In order to encourage competition in providing broadband infrastructures and services, the EU has recently promoted major initiatives and other measures or programs, towards establishing suitable conditions for an effective and adequate electronic communications market's deregulation and for the full liberalisation.

The new innovative European Telecommunications framework promotes neutrality of technology and takes full account of the convergent nature of broadband. In addition, major market initiatives (such as Local Loop Unbundling (LLU) and line sharing) have stimulated competition and have accelerated multiple investment procedures and incentives. Various EU policy measures, especially those imposing an obligation for market 'players' having 'significant market power' (SMP) to provide special network access facilities and information to others, under the same conditions and of the same quality as they provide for their own services or those of their subsidiaries or partners. Such measures aimed at facilitating market entry and developing competition in the high-speed access markets. The European Commission has stressed the complementary role of full unbundling, shared access and bit-stream access in the process of overcoming the limited competition in local access and developing broadband access [24, 25].

At the local level, there is a lot of activity, but sometimes contradictory. Rights of ways or sharing facilities such as ducts and antennas are in a key role. The European governments need to adequately implement EU legislation, support local initiatives, promote multilingual contents, exchange best practices, and possibly to develop financial instruments to foster investment (such as fiscal incentives by applying lower VAT rates to broadband to encourage take up and use by consumers, or applying tax relief on equity investments to attract prospective investors or applying tax breaks on the purchase and use of broadband access platforms; another alternative could be to apply conditional low interest financing to support investment in under-developed areas via different funding models). The State, by actively promoting the development of broadband infrastructures and services can be a catalyst towards the targets laid down in the European Initiative eEurope 2005.

The eEurope-2005 Action Plan [16] recognises the specific importance of broadband to rollout the next generation of on-line services and the social potential of multi-platform access. There is a double-natured strategy to be implemented by the EU Member States, i.e. to promote widespread deployment and use of innovative electronic services and applications in parallel with the deployment of a secure broadband infrastructure to support market needs and offerings. More specifically, there is an intention to achieve effective broadband access for some market domains (e.g. public administrations, schools, hospitals, libraries, etc.). This can promote disposal of public services on-line and creates a critical mass of users, helping to reduce uncertainty on the demand side.

Market experiences and related development information demonstrate that extended availability, accessibility and take up of broadband seem to occur in cases where competition practically exists. In particular cases where network operators are owners of different types of network infrastructure, competitiveness can be further promoted. However, in Europe, current alternative technologies to xDSL (Digital Subscriber Loop) have still a limited nation-wide expansion therefore, in order to support appropriate deployment of new alternatives, it should be necessary to promote suitable regulatory conditions and options. Regulation remains extremely important, to guarantee an adequate framework for the market deployment, creating a level-playing field [9, 26, 27].

Another important initiative will be to create an efficient environment to support possible investment incentives (however without prejudice to competition rules), so that interested parties should be able to obtain an adequate return of their investment in the light of probable risk factors [28]. Upgrading legacy infrastructures and rolling out new networks is primarily a task for the market. Encouraging efficient investment in infrastructure and promoting innovation are objectives for regulators next to promoting competition, protecting citizens and cooperating to consolidate the European single market. However, public policy has to exploit the potential of broadband to secure digital inclusion. This could be a major requirement, especially to focus attention for (and to facilitate) broadband deployment in remote or rural areas and to contribute to regional development. Public support may be needed when the markets do not deliver alone [29]. If broadband networks are to have a wide geographic coverage, the expense of this investment may render public-private cooperation essential in many cases.

In fact, the competitive development of new fixed wireless access and satellite technologies (as well as for optical-fibre infrastructure, also including dark fibre options) provide both the commercial potential and the technical feasibility for private and public investments or even for co-operation by favouring public/private partnerships [30].

8 R&D and Pan-European Research Networks: A Module for Broadband Development and Exploitation

The role of research and academic networks is crucial to boost further introduction and penetration of the relevant broadband services and to promote innovation. Traditionally, such networks have been the forerunners for the development, deployment and use of cutting edge telematics networks as exemplified by the early development of the Internet in the USA. Similarly, 'Next Generation Internet' technologies have been tested and deployed in advanced optical broadband research networks in the USA (Abilene), Canada (Canarie), Japan (APAN) and Europe (TEN-34, TEN-155, GEANT and Global Terabit Research Networking (GTRN) Initiative). In particular, GEANT has become the fastest research network backbone in the world, offering the widest geographic coverage. These networks are considered to be of high priority since, in addition to serving their users

(researchers, professors and students) and promoting collaborative research and education, they provide ideal platforms for developing and testing new, super-high speed network technologies, while they propose new business models in the broadband service market. In the wider context of the European Research Area project, the European Commission supports the full exploitation of broadband networks by the research community, especially by various initiatives [17] within the context of the 6th Framework Program [7]. In addition, high-speed telecommunication trans-European networks (eTENs) seek to deploy electronic services based on telecommunication networks; strongly focused on public services. Such initiatives also focus on key investment areas—especially networks and knowledge—that will enhance the comprehensive package of economic, social and environmental reforms of the EU [10].

Furthermore, the creation of a world-class education, life-long learning and R&D capabilities, in partnership schemes with the cooperation of the States and of the industry sector, can ensure adaptation to the current needs.

9

Conclusions

The EU recognises the importance of exploiting the broadband potential, especially for the future of the wider ICT in European markets. Broadband networks are essential for the competitiveness of the European economy. In addition, broadband ensures the appropriate infrastructure for the delivery of services necessary for the re-organisation of working and production processes and is extremely important for the health of the European economy.

Broadband deployment has the potential to bring valuable new services, stimulate economic activity, improve productivity, and advance economic opportunity in the EU and around the world. Technological choice must result from a proper assessment of regional or local needs on the basis of a cost-benefit analysis, because of the variation in geography and population density throughout the European territory, various technologies are expected to coexist. At current costs, there is no single technology able to ensure a complete coverage of the whole of the EU.

Apart from the multiple possible benefits arising from the broadband infrastructure deployment and the widespread penetration (and use) of innovative services, access to different forms of information has also significant social implications to the achievement of an inclusive Information Society. Furthermore, broadband has the potential to stimulate the creation of new high quality jobs as well as to transform the way public services are organised and delivered.

Broadband will change radically the use of the Internet. It will deliver most of its economic and social benefits through innovative applications such as e-Commerce, e-Learning, e-Government, e-Entertainment, healthcare, videoconferencing and many more, in the form of productivity, innovation, economic growth,

employment and social cohesion via the promotion of both quality and features of services. In addition, broadband has the ability to create a global innovative Information Society, irrespective of the geographical location of the user.

Convergence of digital technologies via multi-platform access becomes a factor to support competitiveness between networks, which creates new competitive level of services and content. In particular, broadband makes new forms of content accessible to users, thus contributing to the widespread of innovation.

Such a market development carries important social implications, as it facilitates widespread access to information. It finally transforms the way companies operate, individuals behave, and interact with each other.

Joint action by national and local authorities and the private sector in public-private co-operation is needed in critical areas; this is necessary in order to minimise risks and to support further market development perspectives.

The deployment of low-cost, open access, 'always-on' and national broadband reaching facilities, available to all citizens is a major target to be achieved.

The full transposition of the new EU regulatory framework will provide significant support to all relevant activities, especially for the promotion of public/private partnerships for advanced broadband applications and technologies. Regulation remains a necessary 'tool' to stimulate competition in the broadband sector, especially in the short to medium term. Competition is expected to drive investment, generate innovation and lower prices. Therefore, public policy should focus on issues where competition is either distorted or is not effective or where political objectives, e.g. territorial coverage with a view to cohesion, need to be established. EU Member States are so developing national broadband strategies, necessary to sustain the growth of the market.

Broadband communications and the new services that such infrastructure makes possible will be a major source for job creation in industry and services, will give a thrust to accelerate technological innovation, and will be a physical backbone for the knowledge economy. Widespread availability of broadband infrastructure will also impact on growth by improving the performance of services that change the way companies and public administrations work.

A broadband strategy will have a complex task as it is affected by many different policies: town and country planning, research policy, taxation and regulation. They are carried out at all levels: international, European, national, regional and local, and by a range of different actors, private sector as well as public sector.

If fully exploited, broadband technologies will advance the efficient use of networks, and consequently will increase productivity and employment (Having any-time, anywhere access to information will contribute to greater effectiveness) The success of broadband technology depends upon the legacy of existing technologies, current scientific boundaries, socio-economics (i.e. economic health, cultural context, political will, education, etc.) and socio-geographic factors (i.e. population density and dispersion, topography, etc.).

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