

Broadband Technologies on Residential Access

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ABSTRACT

The diffusion of broadband technologies is a hot topic for developed and many developing countries. Although the provision of service has many similar aspects, the overall and specific penetration of broadband technologies varies significantly in these countries. This study aims to examine the place of users' perceptions in the broadband issue by studying the development of the selected technologies and national policies in the light of the general information technology diffusion aspects.

Keywords : Diffusion of Technology, Broadband Technologies,
Development of National Policies and Pricing Issues

JEL Codes : 033, L96

1. Introduction

The rapid growth of the internet combined with the increase in computer hardware and software availability to people has placed an increasing demand on the telecommunications providers to supply faster data rates to the home. As the internet becomes more information-intensive with graphics, sound, video and multimedia, the ability to take advantage of these new resources strongly depends on the speed of the internet connection. In this paper, the name of *broadband technologies* is referred to as the antonym of *narrowband* which refers to the bandwidth of simple copper pair carrying a single telephone line to the premises of the customer. This copper pair has a data speed of 64 kpbs which gets obsolete with the increasing demand on speed.

The choice of the broadband technologies reflects the behaviors of the providers and conventional attitudes of the customers rather than the cost or features of the services. The infrastructure capabilities, the standardization issues which vary significantly in different countries, the government initiatives and the marketing strategies of the providers are the key factors affecting people's perception of new technologies. The diffusion of broadband technologies will be evaluated depending on the general characteristics of technology diffusion in this study. For the aim of limiting the scope, the study emphasizes on the effects of the development, the national policies and pricing issues in terms of selected technologies. The broadband technologies in the scope are ISDN, DSL and cable modem. The other technologies, which have higher speeds and are mainly concerned by big enterprises (like fiber, satellite connections etc.) are beyond the scope as the intention is emphasizing on residential and small business access.

2. General Characteristics of Technology Diffusion

The diffusion of broadband technologies, as well as their emergence, is strongly related with the diffusion of information technologies. In this respect, explanation of the diffusion has similar basics. Reviewing the literature, it is observed that there are several studies which have focused specifically on the application of diffusion theory to the adoption of information technologies, but there is no study emphasizing on broadband diffusion. The leading reason for this might be the relatively late

emergence of broadband concept compared to issues like introduction of PC, internet and complicated software usage. Although the reviewed studies cover many issues, this paper only intensifies on user perceptions concept dealing with the place and the level of it.

When computing systems moved from giant mainframes used only by technicians or programmers to individual desktop units used by everyone in an organization, the “human side” of software and hardware became even more critical to the designers and implementers of systems. Reviewing the literature on information technology design, an important conclusion is that most information technology failures stem not from technical difficulties but from individual issues (both sociological and psychological)⁽¹⁾. It is suggested that the provision of increased efficiency from information technologies will be based on the psychology of the systems’ users.

The P3 model of Dillon and Morris (1999) is treated as the most efficient way to place the importance of perceptions in the diffusion of information technologies. They propose that use of a given information technology is driven by three main aspects; utility, usability and user attitude. Utility refers to the technical capability of the tool to actually support tasks that the user wishes to perform. Usability refers to the extent to which users can exploit the utility of the system. Thus, systems with equivalent utility may result in different levels of usability depending on how the design is implemented. While two systems may have identical utility and both prove usable, users may express a preference for a system based on personal judgment, previous experience, aesthetics, cost etc. Therefore, Dillon and Morris (1999) state that the final driver of use must be the user's attitude to the technology. To adapt these drivers to systems implementation they propose the P3 framework:

- *Power*: An objective measure of the applications capability/functionality, i.e., "what the machine can do",
- *Performance*: Behavioral measures of usability,
- *Perception*: Perceptual measures from users in terms of usability, utility, etc.

¹ The modeling study of Al-Gahtani is an example having such findings. [2]

In this structure, power needs to be considered first, since the inability to even support task performance renders the application limited in use for the intended audience. Assuming that task support is provided by the help of the tool, the capability of the user to exploit is addressed next. Finally, given a usable tool, the ultimate question is whether people will choose to use it or not. This is the domain of perception. For the adaptation of this model to the broadband case, power and performance can be related with the infrastructure, service and deployment issues, and perception, with the choice of subscribers.

Another study by Fichman (1992), establishes a matrix to explain the adoption of information technologies. He classifies adoption as individual or organizational depending on the existence of interaction and coverage. On the vertical dimension, he classifies technologies as type-1 and type-2. Type-1 refers to the technologies which do not involve user interdependencies and necessity of substantial knowledge. On the other hand, type-2 is characterized by high-level knowledge or significant user interdependencies.

If this model is adapted to explain broadband technologies, they can be classified as “individual” and “type-1” in terms of adoption and type respectively. This classification is based on the simple facts of broadband installation which is an individual action and does not require high level of knowledge. Regarding the matrix of Fichman (1992), individual adoption or use of type-1 technologies can be explained as follows in terms of classic diffusion theory:

- Favorable perceptions of innovation characteristics are positively related to adoption,
- Adopters are differentially influenced by different information channel types and sources at different adoption decision stages,
- Early adopters/heavy users can be distinguished from later adopters/lighter users according to their personal characteristics,
- Cumulative adoption follows an S-shaped pattern.⁽²⁾

² “S-shape” implies an adoption process starting out slowly, reaching “take-off” as a growing community of adopters is established and leveling-off as the population of potential adopters becomes exhausted.

Another aspect, “managerial influence” is the case for information technologies which can be translated as “deployment influence”. Individuals rarely have complete autonomy regarding the adoption and use of innovations. Management can encourage (or discourage) adoption explicitly through expressed preferences and mandates, or implicitly through reward systems and incentives. In addition, immediate supervisors typically control access to the infrastructure supporting adoption, such as training and consulting, and may even control physical access to the hardware and software needed to use innovation. The adaptation of this definition to the “deployment influence” of broadband can be based on the coverage of the infrastructure, the necessity of investment and the intentions of the service provider.

Having introduced the basics of technology diffusion and adoption of it to the broadband issue, the next section gives basic definitions of broadband technologies within the scope of this study including historical development, advantages and disadvantages.

3. General Information on Broadband Technologies

There are various types of broadband technologies used for different purposes depending on the bandwidth and the distance to the subscriber. A wide range of bandwidth from the 64 kpbs of conventional copper pair to 155 Mbps is possible with Integrated Services Digital Network (ISDN), Digital Subscriber Line (xDSL³), Wireless Local Loop (WLL), cable modem, Local Multipoint Distribution System (LMDS), satellite etc. Regarding the bandwidth and distance parameters, residential access can be provided with ISDN, cable modem and xDSL technologies. These three have a crucial importance of that it is not a necessity to invest on the infrastructure between the customer premises and the exchanges of the provider as ISDN and DSL use the conventional copper pair and the cable modem uses the cable-TV infrastructure (Gilbert & Tobin, 2001). (⁴)

³ ‘x’ refers to various DSL technologies having different up and downstream speeds of data.

⁴ WLL is an important alternative, but it is not mentioned with the other residential access technologies as it requires a considerable investment on the infrastructure. Another drawback is the limited bandwidth which seems to be improved in the future.

The broadband technologies which have been widely accepted as the drivers of the residential access can be listed as follows depending on their basic specifications:

- ISDN provides a faster internet access by combining two channels up to 128 kbps more than four times as fast as a 28.8 kbps modem on a standard phone line. ISDN's digital technology provides a high quality connection to the internet preventing slowness because of the old analog technology of copper pair. Another method of ISDN, which is referred to as primary ISDN, provides a speed up to 2 Mbps, resulting in the considerable competency of ISDN compared to other broadband technologies.
- xDSL technology, which permits high speed data services to be provided over copper networks has been around since 1990. DSL technology has been described as the technology that is “turning copper into gold” [14] p.21] and has provided a new “life” for copper networks which not so long ago were thought to be superseded by broadband cable and wireless technology. Some xDSL varieties are widely used standards, some are proprietary and others are purely theoretical. Asymmetric Digital Subscriber Line (ADSL) is the most commonly used variety of xDSL. It is asymmetric because the downstream speed (from the service provider to the end-user) is faster than the upstream speed (from the end-user to the service provider). This makes it particularly suitable for applications such as internet access.
- A cable modem is a mechanism offering high-speed data access. It is a device that enables users to connect their computers to a cable TV network in order to access the internet. Cable TV, which has been used to bring television programs to home, becomes a popular source for interacting with the internet and other new trends in multimedia (such as voice over IP) as a broadband technology.

Table 1 General Comparison

	Advantages	Disadvantages
ISDN	<ul style="list-style-type: none">• Usage of multiple devices simultaneously• Not dependant to distance• Very high penetration levels possible due to the usage of existing PSTN infrastructure	<ul style="list-style-type: none">• Limited bandwidth of basic ISDN (128 kpbs)• Usage of dial-up connection
DSL	<ul style="list-style-type: none">• Dedicated usage of bandwidth• Very high penetration levels possible due to the usage of existing PSTN infrastructure	<ul style="list-style-type: none">• Relatively short distance between end user and provider's exchange• Absence of standards for some varieties
Cable Modem	<ul style="list-style-type: none">• Capacity up to 50 Mbps is possible	<ul style="list-style-type: none">• Shared usage of bandwidth• Cost of bi-directionality is very high (4-6 billion EUR for Germany [23])

Source: Compiled from [4], [18], [21]

Comparing the timeline of the three technologies in the scope of this study, the two crucial points are the early introduction of ISDN and the considerable similarity between DSL and cable modem technologies. DSL technology has been developed on the idea of transmitting video while thirty years had been needed for realizing that cable TV infrastructure could have been used for data transmission. The early introduction of ISDN strongly depends on the general understanding of 'inventing' a new technology for data transmission. The sliding of DSL and cable technologies from video-based domain to data transmission has been the result of exploding bandwidth demand which immoderately exceeded the demand for video services. As the standardization is a determiner factor for the improvement of a technology, it can be commented that DSL and cable modem have the same 'chance' while ISDN leads with an advantage of approximately ten years.

Table 2 Timeline of Broadband Technologies (⁵)

ISDN	Cable Modem	DSL
	~ 1980 First IEEE works on CATV standards	
1984 First ITU standardization	Universities and research institutions using the cable television infrastructure for two-way campus data networking	
~ 1990 Industry-wide discussions to establish a specific implementation for ISDN	~ 1990 LANCity and Zenith offering "symmetric LAN over cable" systems that could be deployed in specific types of cable networks	1989 First designs primarily for video (BellCore)
1992 TRIP-2 The widely accepted ISDN standard through a collective industry project	1992 Bell Laboratories cable data network project: SCAN	1993 First standardizations for primitive DSL technologies in US (for data transmission)
	1993-1996 Several Groups (DAVIC, ETSI, SCTE, IEEE) working for standardization	
1995 Introduction of Euro-ISDN by EU	1998 The first major specification was approved by ITU	1995 The ANSI standardization published 1998 First successful operation in US after some false starts in 1997
	1999 CableLabs issued two new specifications	1999 The standardization of ITU published

Source: Compiled from [4], [18], [21], ITU (www.itu.int)

Another important factor is the general policies that promote the diffusion of selected technologies. Euro-ISDN is a principal example of standardization of which the application is not limited to standardization and reviewed regularly. This approach supports the technology by the help of determining priorities, necessary changes and constructing common projects. [18]

⁵ Limited to the scope of this study and based on the standardization works.

As well as the standardization process, advantages and disadvantages, the application is important in terms of describing the broadband technologies. Therefore, the following section gives the prices and penetration levels in different countries and comments on the relationship between them.

4. Pricing and Penetration of Broadband Technologies

Generally, the first issue while considering the diffusion of broadband technologies is treated as the price of the service. Regarding the DSL and cable modem services, the price is based on two components; a one-off fee for connection and a monthly rental fee (Table 3). While these two construct the full price in many countries, some countries limit the service to the amount of data in terms of megabytes and charge additional price for the exceeding part⁶. However, this part is negligible while compared to the flat monthly rate. As the ISDN connection depends on the dial-up basis, the pricing is determined in terms of usage hours. OECD has two baskets depending on usage time; for twenty and forty hours. Following the fact that the comparison is made with ‘permanent’ connections, selecting the basket for forty hours of usage is more consistent (Table 4). The basket comprises of fixed rate, usage fee and the fee for the internet service provider.

Table 3 Pricing Comparison: DSL vs. Cable (USD PPP (⁷))

	DSL		Cable	
	Connection Charge*	Monthly Rental	Connection Charge*	Monthly Rental
UK	209	56	35	28
Denmark	115	40	115	23
Korea	43	58	47	55
Japan	110	32	-	31
USA	-	50	110	44
Canada	-	35	132	44

(*) The one-off fee charged for installation

Source: OECD, 2001 [19]

⁶ For DSL services, eight of the OECD countries apply a limitation varying between 400 and 10000 megabytes. The additional cost per megabyte varies between 0.03 and 0.16 USD (PPP). There is a similar structure for the cable modem.

⁷ The tables represent the purchasing power parity adjusted values. See Annex I for the index.

Table 4 - ISDN Pricing Basket for 40 hours (USD PPP)

	Fixed	Usage	ISP*	Total
UK	14	-	13	27
Denmark	15	-	27	42
Germany	14	-	36	50
Korea	4	-	40	44
Japan	10	24	14	48
USA	14	5	5	24
Canada	20	-	15	35

() The monthly subscription fee to be paid to the internet service provider (ISP).*

Source: OECD, 2001[5]

The comparison indicates considerable differences between countries, especially for the connection charges. On the other hand, the monthly rental fees of DSL and cable modem services can be accepted to have the same level except for UK and Denmark (⁸). These two countries do not follow the general EU trend in terms of cable modem pricing as the EU average is over 40 USD (PPP), reflecting the other countries' prices listed in the Table 3. Although, comparing ISDN prices with the others does not make much sense, it can be commented that they have the same levels, regarding the EU and OECD averages, which are USD 44 and 47 respectively for the basket of 40 hours.

At this point, it has to be emphasized that ISDN is treated as a technology which had been developed as an alternative to standard dial up and will be replaced by the other broadband technologies. The replacement has been realized in many 'broadband' definitions so that ISDN is not listed as a broadband technology anymore. While, the EU Broadband Report [20] published in August 2001 defines ISDN as a broadband technology, the Seventh Implementation Report does not list it in the broadband technologies section [17]. The reason should be the hopeless future of ISDN compared to the other technologies which are expected to achieve greater speeds in

⁸ The ratio of monthly rental fees (DSL/cable) varies between 0.8 and 1.14 in the other countries unlike Denmark and UK where the DSL/cable ratios are 1.7 and 2.0 respectively.

near future. A study by FCC (⁹) forecasts that the share of DSL and cable modem in total internet usage will be 35 percent in 2005, which was under 3 percent in 1999 [13]. In the same study, it is argued that “*we may consider today's broadband to be narrowband when tomorrow's technologies are deployed and consumer demand for higher bandwidth appears on a large scale*”.

The broadband penetration rates indicate the great success of Korea, followed by Canada and USA. Germany, who has deployed one third of the ISDN platforms all over the world, has the highest rate for ISDN [22]. The high rates for ISDN cannot be determined as ‘success’ due to reasons mentioned above. The evaluation of penetration data with regards to the pricing tables points out clear oppositions. Germany has the highest penetration rate and the price for ISDN at the same time. Similarly, Korea has the highest monthly rentals for both DSL and cable modem. Although these monthly rentals are at the same level, the penetration rates differ considerably. These simply indicate that pricing is not a determinant for the users’ choice among the broadband alternatives.

The low level penetration of cable modem and DSL in many of the countries reflects the take-off period of diffusion process. Generally, the diffusion process starts out slowly among pioneering adopters, reaches "take-off" as a growing community of adopters is established and the effects of peer influence kick-in, and levels-off as the population of potential adopters becomes exhausted, thus leading to an "S-shaped" cumulative adoption curve.

⁹ FCC (Federal Communications Commission) is the regulatory body for telecommunications and broadcasting in USA.

Table 5 - Broadband Penetration (¹⁰) (%)

	ISDN	DSL	Cable
UK	2.4	0.13	0.15
Germany	17.6	0.93	0.1
Denmark	13.3	1.32	1.0
EU Average	6.3	0.51	0.31
Korea	-	9.0	4.9
Japan	7.9	0.3	0.6
USA	-	1.2	2.0
Canada	-	2.3	3.9
OECD Average	-	0.96	1.00

Source: OECD, 2001[19], EU, June 2001[10]

The national broadband policies, which seem to be the most significant determinant of the diffusion of broadband technologies after examining the technology, the price and penetration levels, are reviewed in the next section.

5. National Broadband Policies

Although the private sector takes a leadership role in the development of broadband networks and services, the role of governments should not be underestimated especially in terms of penetration. Korea and Canada lead the world in terms of broadband penetration, and one of the major reasons for their leadership has been the active role played by the respective governments have played. The role of the government can be played through the implementation of the following policies:

- Avoid redundant infrastructure and optimize the use of resources by combining the various technologies available,
- Complement competition with selective action in areas that are not covered and cannot be covered by the market,

¹⁰ The ISDN data for Japan is obtained from NTT (Japan Telecom Operator) for January 2001. The other ISDN rates are not available for year 2001. The reason is that USA, Korea and Canada do not foster ISDN

- Promote the selection and use of the best available technologies, depending on the socio-economic characteristics of the areas requiring coverage and their level of technological development,
- Use Structural Funds to finance regional projects for the realization of local broadband access and transport connection infrastructure in areas where private sector investment is unattractive. [15]

As it is evident that pricing and technical specifications are quietly insufficient to explain the diffusion of broadband technologies, the emphasis has to be made on national policies. Rather than a specific broadband policy, all governments treat this issue as a part of general knowledge society policies. The core strategies of the programs aiming to reach the construction the knowledge society are similar and in this respect, all the programs involve an item of “diffusion of broadband technologies”.

As an example, in Germany, the government applies a comprehensive program that targets all citizens, including groups such as small and medium size enterprises (SMEs), libraries, women, youth, and seniors. Germany’s core strategy elements represent an example for the general view of all developed or developing countries, which have a pre-defined program:

- Meeting the goal of access to underserved groups
- Expanding and improve IT education and training
- Expanding R&D
- Expanding the diffusion of broadband infrastructure
- Migrating all government services on-line
- Increasing the speed of broadband technology with the aim of being world-leading by 2005 [3]

The final item listed above indicates the target of Germany about the broadband issue. Rather than pretentious statements like “aim of being world-leading by ...”,

deployment. For example, in USA, people mostly prefer a second telephone line rather than upgrading to ISDN line for dial-up internet access.

governments use general ones like “increasing broadband penetration by funds” (¹¹). Although, all have similar intentions, the implementations and the results vary significantly, so that the penetration rates represented in the Table 5 come out. Therefore, the high levels of penetration can be explained by the successful implementation in countries like Korea and Canada.

The Korean Government launched Cyber Korea 21 as the national vision behind the creation of the Korean Information Infrastructure (KII) in 1997. The goal of the KII is to “construct a creative, knowledge-based society” through four central strategies, of which one is the “upgrading telecommunications networks to broadband standards”. [16] The provision of high-level competition is the tool to be used for this “upgrade” since there are seven major infrastructure providers including the incumbent operator Korean Telecom. [11]

In Korea, the universal service obligation for basic telephone services is regarded as a first step toward universal access to information infrastructure. It is considered that, at least in the short term, the incumbent is able to shoulder the responsibility of providing universal service. In the longer term, the universal service compensation fund should be competitively and technologically neutral.

The Korean government has also encouraged working from home resulting in a sharp increase in the home usage of networked PCs. What has contributed to the popularity of working from home has been the availability of cheaper PCs resulting from a government-initiated internet PC project that boosted the sales of PCs and notebook computers. The government’s role in this has been one of promotion and not funding. To achieve the aim of having 75% of homes using high-speed internet access by 2005, the government has earmarked USD 1.5 billion for network upgrades while companies from the private sector will put in USD 30 billion. [12]

The Canadian government, through its National Broadband Task Force, released a report that outlines the guiding principles the government can play in fostering broadband penetration. The principle of the report is that all Canadians should have

¹¹ This claim brings out Germany’s different and intensive investment program related to the broadband technologies, which can be treated as an effective usage of public procurement tool. As this study aims to

equitable and affordable access to broadband networks and to the widest possible range of content and service providers. [9]

The Canadian Radio-Television and Telecommunications Commission (CRTC), who is famous for its efficient usage of public consultation and task forces, directs all incumbent local carriers to file service improvement plans for Commission approval, or to demonstrate that the basic service objective has been and will continue to be achieved in their territory. Plans filed are required to indicate how incumbent local carriers will reinforce their existing networks where necessary to improve service or extend service to un-served areas.

Multi-year plans to improve service, developed by incumbent local carriers and filed for approval with the CRTC, aim to be administratively simple to implement and allow for comment by the public. It is considered that such programs can also allow communities or regions to participate in proposed service upgrades. For instance, if a telephone company begins construction in an area, it may be able to offer inexpensive service improvements beyond the basic service objective to other nearby homes or communities. Knowing in advance the timetable for construction projects near their area, individuals, communities or regions may choose to take advantage of any cost-saving opportunities. They may be able to budget their own resources or obtain government grants to enhance services.

The adaptation of P3 model which had been explained in Section 2 can now be evaluated depending on the national policies. It can be concluded that all countries reviewed in this study have completed the power and performance issues in a considerable degree. They have allocated huge amounts for finance, developed a well-organized public procurement system and provided the private sector's efficient contribution by the help of competition. Additionally, they have made serious efforts in the works for standardization at both local and global level. However, regarding the perception side of the model, they have varied significantly and in fact; this has been the reason of the leading of countries like Korea and Canada.

emphasize on 'user side', this topic is held out of the scope.

The success of Canada can be explained with “localization”. In the system of Canada, where CRTC works as a coordinator and the local carriers make the decisions, the broadband penetration program seems to be successful due to the local level interest rather than a national perspective. On the other hand, Korea’s success depends on the intensive education programs and the high level promotion of PC distribution which have significantly contributed to the awareness of public. Thus, combining the main aspects of the policies adopted in Canada and Korea, “localization” and “awareness” can be considered as key factors of a successful national broadband policy, regarding the user perceptions.

The next section aims to evaluate the situation in Turkey in parallel to the issues covered in this and previous sections.

6. Remarks for Turkey

The debate of broadband is quite a new issue for Turkey. As the residential and SMEs’ access to internet is at early levels, the penetration levels are considerably below the OECD and EU averages. Considering the P3 model of Dillon and Morris, perception is not the discussion issue in Turkey, as the power and performance criteria indicate serious problems.

Because of the confusion of the definitions, the liberalization and privatization in telecommunications market have been treated as the same issue. This, combining with Turk Telekom’s resistance to new models, prevented introducing the competition in value added services. Turk Telekom’s model was based on revenue sharing agreements (RSA) of which failures have been approved (¹²).

Cable TV infrastructure is operated under RSAs. The ownership structures of the firms which build up the infrastructure and register subscribers reflect the misunderstanding of the service provider concept. As the majority of shares are owned by construction firms, the cable TV work is treated as a trenching, cabling and building issue rather than providing a service. In this manner, using cable TV as a

¹² The impressive example is in the GSM sector. After granting licenses, total number of subscribers have exceeded 3,3 millions in eight months time while it had reached 1,7 millions in four years under RSAs. [8]

broadband infrastructure has been carried to the agenda recently by some zealous ISPs.

The successful provision of DSL services is dependent to local loop unbundling (LLU) which aims the rental of the copper pairs from the premises of the customer to the local exchange by new entrants. LLU is on the regulatory agenda of Turkey and will be available not earlier than 2004 since the Telecommunications Law stipulates the monopoly right of Turk Telekom on infrastructure until the end of 2003. In current situation, Turk Telekom provides DSL with a seven times higher price (in terms of PPP) compared to Korea's monthly rental.

Regarding the national policy of being a knowledge society, Turkey has not made considerable progress up to now. The countries reviewed in this study prove that there must be a clearly defined national policy and a national campaign to put it into practice. The government should define the issue as a top priority and the policy must be managed directly by the political authority, i.e. Council of Ministers, since a high level of cooperation is needed in all fields such as education, health etc. Another aspect is that private sector intervention orientated by the state is a key factor considering the huge amounts of investments for achieving the structural changes brought out by the national policy. So, neither a realistic framework policy nor a broadband policy as being a part of knowledge society program is on the agenda of Turkey. The leading initiative of e-Europe+ seems to be treated as a compulsory action for EU membership rather than an opportunity.

7. Conclusion

The review of broadband technologies indicates that none of the technologies can be named as the leader or the most promising one for the future. However, there is a strong tendency towards higher bandwidths so that the definition of broadband is to be updated by nations and international organizations. Regarding the technologies within the scope of this paper, DSL and cable modem have a high potential of development and strong competition among each other. ISDN, especially the basic one, seems to be 'history' in near future in the developed countries.

Examining the relationship between price and penetration levels and bearing in mind that there is a high-level of competition between the providers and also between the technologies, it can be argued that there is not a direct relation between these parameters. Therefore, the diffusion of broadband technologies cannot be explained with price or technologic advantages.

The determining factor for the diffusion level of broadband technologies is the national policies. All of the reviewed countries have national knowledge society policies with similar core strategies which include a specific item for broadband deployment. Broadband technologies are considered as the infrastructure of knowledge society to be deployed all over the country, not limited to ‘professional’ users such as academic units, but including schools, governmental organizations, SMEs, and also residential users.

However, the implementations of the national policies vary significantly in the examined countries, causing different levels of penetration. Depending on the success of Korea and Canada, it can be concluded that higher penetration rates can be obtained by dealing with the issue at local level, providing intensive education and promoting access and usage. The ‘localization’ refers to allowing and promoting communities and regional organizations to participate in proposed services. Education is the tool to develop computer literacy and the way to promote access and usage, basically, is the distribution of PCs and extending the usage areas by e-government and similar applications.

It is clear that the diffusion of broadband technologies has a ‘broad’ range of examination. Any aspect of the topic (like standardization works, investment programs etc.) has to be studied in detail. Furthermore, similar to the information technology related ones, modeling studies (concerning the technology, users’ attitudes, market conditions etc.) specific for broadband technologies have to be done for the complete evaluation.

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ANNEX

Purchasing Power Parity Index for Table 3 and Table 4

Price in USD=1.00

	Price in USD PPP
UK	0.98
Denmark	0.92
Korea	1.79
Japan	0.72
USA	1.00
Canada	1.26

Source: OECD, 2001[5]