Developing national broadband infocommunication infrastructure Hungarian case study

Gyula Sallai, Imre Abos
Budapest University of Technology and Economics
Dept. of Telecommunications and Media Informatics
1117 Budapest, Magyar tudósok krt. 2. I.B.220
sallai@tmit.bme.hu, abos@tmit.bme.hu

Abstract

In Hungary the implementation of the broadband infocommunication infrastructure of suitable bandwidth and quality reaching all settlements of the country and the intensification of the development of the broadband coverage have been actual issues for the government and the society. For the formulation of the best solution several surveys, studies, articles and drafts were prepared.

In order to deliver broadband services optical connection of the settlements and deployment of high quality broadband access networks in the settlements are necessary. To deploy those parts of the national infocommunication infrastructure that are not realized by the market players and are not profitable for them community support (state, local government or EU) is required. Utilization of the networks deployed or upgraded by community support as open access networks can ensure the reconciliation of state intervention and competition approach.

In the first step it is advised to implement the full national optical backbone providing multiple connections for all the 174 districts of 535 km^2 *area in average. In the district network for the settlements of over a given number - e.g. 500 - of inhabitants optical, in case of smaller ones some broadband wireless connections should be used.*

In the second step the optical connectivity of all settlements can be realized. The applicant for the support must decide on the type of the applied technology and the targeted service level. The decision is supported by system selection diagrams.

Introduction

In the European Community the issue of broadband coverage plays an important topic for years [1, 2]. The Commission issued the Communication to the European Council entitled “A European Economic Recovery Plan” [3] in Brussels on 26 Nov 2008.

One of the ten action points of the document announcing the programme for solving the economic crisis situation is the action point of ‘*High-speed Internet for all’* inviting the member states to develop a harmonized broadband strategy, setting target to reach 100% broadband coverage by 2010, providing further support to finance the coverage of areas poorly supplied or requiring high deployment costs.

The government and the professional community put an emphasis on the issue how to solve the broadband coverage in Hungary. A series of conference presentations, articles deal with the development of the information and communication technologies, with the essential role of the broadband infrastructure of suitable bandwidth and quality reaching all settlements of the country in the knowledge society, with the intensification of the development of the broadband coverage. The Scientific Association for Infocommunications (HTE) in Hungary has got a request from the government to shepherd the ambitions into a perspective direction, to promote their realization and to make decisions on the network development dilemmas [4,5].

Present article gives an overview of the situation in the EU and in Hungary, the coverage in Hungary as the function of bandwidth, and at settlement categories and district level. The comparison of EU member states is based on the Broadband Performance Index (BPI) introduced by the EU, the components of BPI and their correlations will be inspected [6].

The local broadband coverage of the settlements will be examined; the opportunities and the most important development areas of the settlement groups (districts) of different size will be compared. Because no business interest exists for the upgrade of the least supplied areas, there is a need for state intervention or EU support. Its conditions will be analyzed.

The article formulates the development objectives and the design rules, specifies the structure plan of the national broadband network, the service levels provided by the local access networks.

Based on the above the broadband development strategy can be drafted, it is proposed to execute it in two steps. The selection of the broadband technologies coming into account should be done with respect to the local circumstances, for this a system selection diagram (application map) will be shown.

Present availability of broadband

Comparison at EU level

If we look at the broadband penetration rate of EU member states (Figure 1) we can see that Hungary stands at the 20th position with 14.2%, under the 20% of EU average in January 2008. (Norway is present in the diagram but not counted in the ranking.)

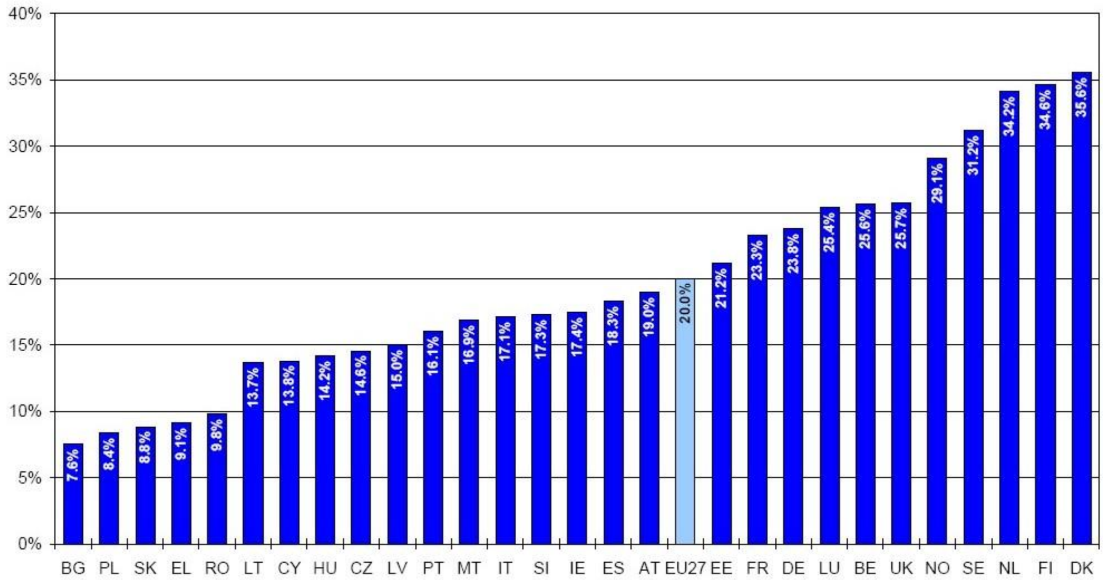

Figure 1. EU broadband penetration rate (Jan 2008)

In Figure 2 the set of Broadband Performance Indices (BPI) of EU member states are shown, based on statistical indicators from early 2008 composed by the European Committee [6]. BPI is a compound indicator taking into account broadband rural coverage, competition by coverage, prices, speeds, use of advanced services and socio-economic context. From the BPI diagram we can see that Hungary is 17th in the ranking among the EU member states.

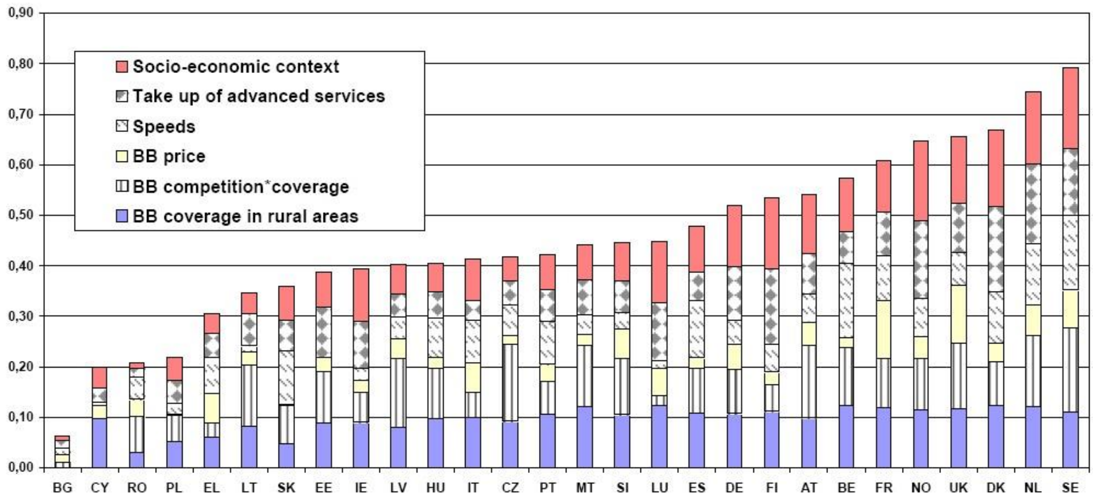

Figure 2. Broadband Performance Index (BPI) of EU member states

Evaluation of the Broadband Performance Index

From the diagram it is a bit complicated to draw conclusions for the different components. Therefore it is worth to examine the data sets separately. (Table A1 and Table A2 can be found in the Appendix. The original values are multiplied by 1000.)

Based on the data of the tables we can find out the strengths and weaknesses of Hungary:

- From the viewpoint of rural coverage Hungary is in the middle group at 15th position, competition – mostly at medium and larger settlements – is considerable (11th position).
- As far as the speed of broadband access is concerned Hungary can be found in the first group at the 8th position. It is significantly balanced by the high broadband access prices, in this respect we are ranked to the 24th position.
- As the consequence of the medium level of rural coverage and high prices, in case of use of advanced services and socio-economic context Hungary is at the 19th and 20th positions, respectively.

The components can be examined in pairs or in smaller, e.g. in triple groups. Calculation of the correlation between any two data sets (Table 1) helps discover the relationships.

Table 1. Correlation between data sets

Correlation	Rural	Compet.	Price	Speed	Advanced	Socio-ec.
Rural coverage	1,00000	0,39657	0,39207	0,38468	0,61788	0,73135
Competition	0,39657	1,00000	0,21041	0,43138	0,30782	0,37671
Price	0,39207	0,21041	1,00000	0,22010	0,32204	0,46551
Speed	0,38468	0,43138	0,22010	1,00000	0,31514	0,48004
Advanced	0,61788	0,30782	0,32204	0,31514	1,00000	0,90707
Socio-economic	0,73135	0,37671	0,46551	0,48004	0,90707	1,00000

Let us examine the diagrams of groups of considerable correlation. It can be seen that between the *"use of advanced services"* and *"socio-economic context"* there is a significant correlation (0.907), as it has been expected (Figure 3).

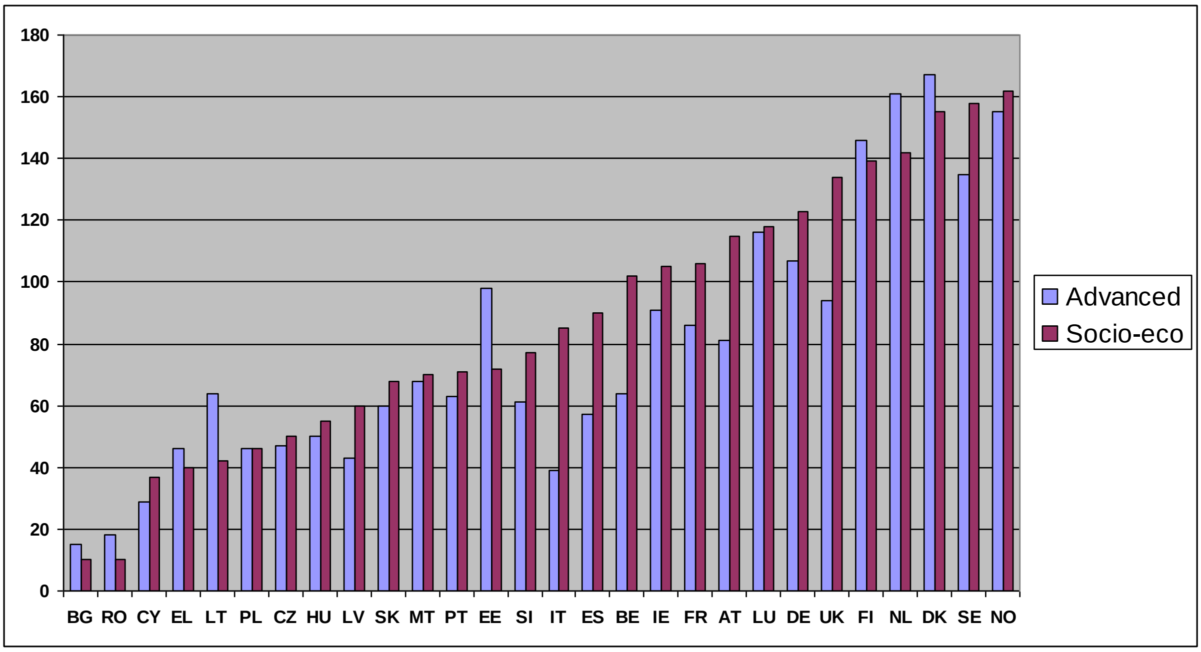

Figure 3. Data sets of Advanced services and Socio-economic context

We can also see from the table that only the *"use of advanced services"* and *"socio-economic context"* are in stronger correlation with the *"rural coverage"* (0.618 and 0.731, respectively). It means that in respect of the final objective the coverage has been the most important factor (Figure 4), the role of the competition is not significant, the existence of broadband is an imperative.

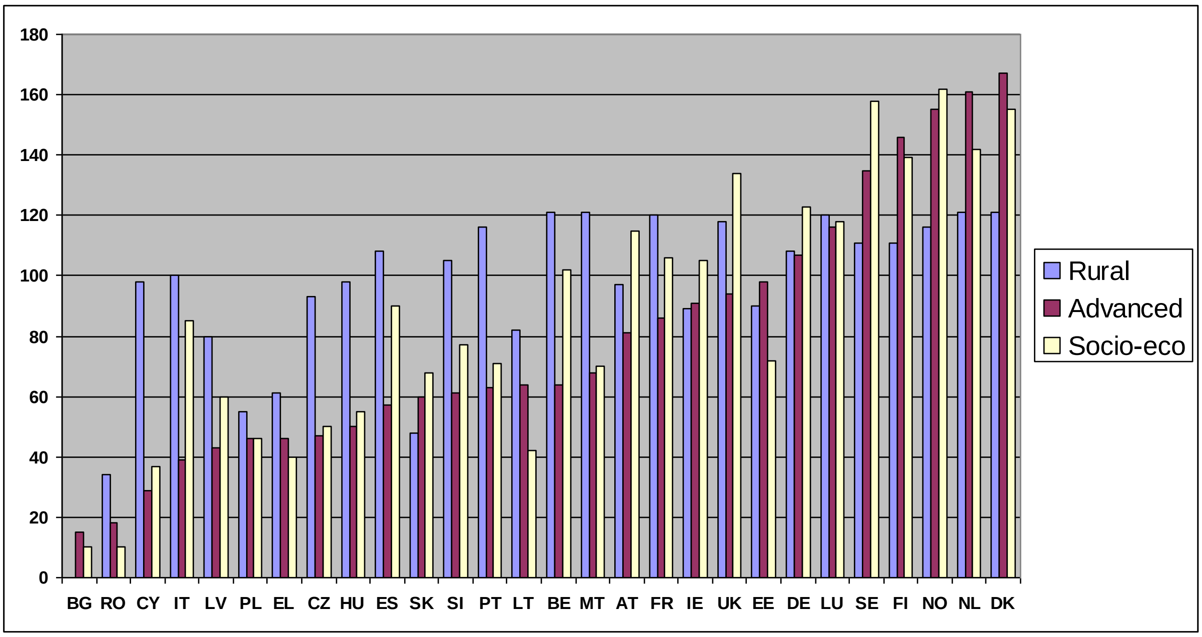

Figure 4. Data sets of Rural coverage, Advanced services and Socio-economic context

The *"price"* and *"bandwidth"* play only a secondary role (0.466 and 0.48) with respect to the *"socio-economic context"* (Figure 5).

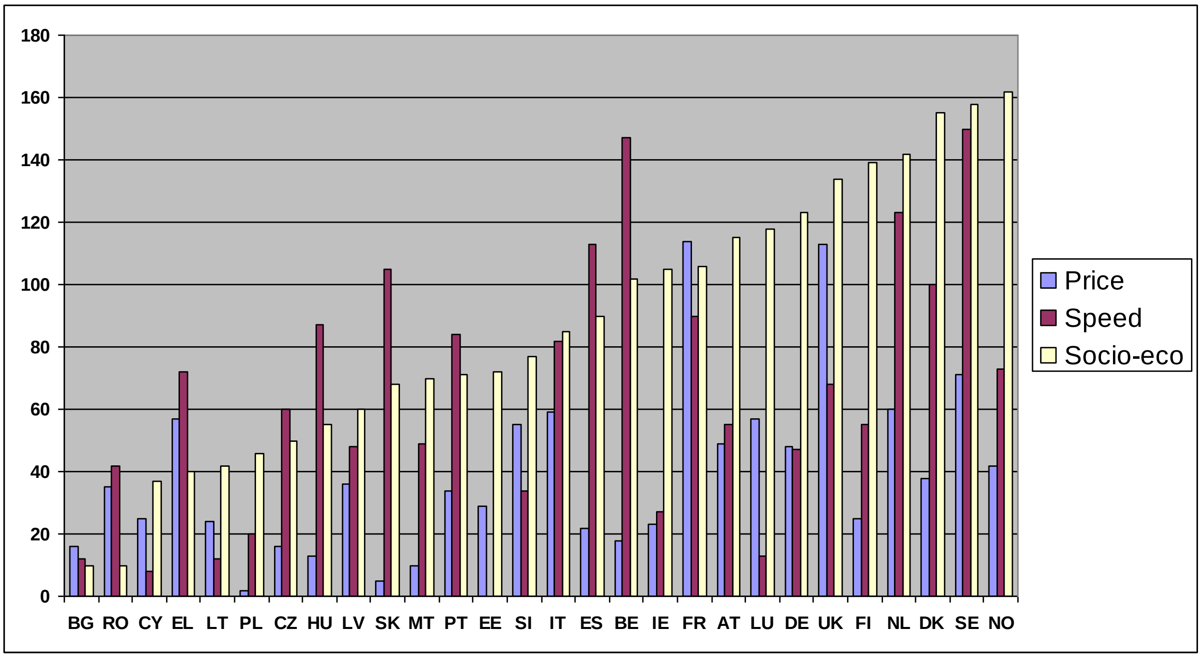

Figure 5. Data sets of Price, Speed and Socio-economic context

This analysis points out as well, that the realization of the national broadband coverage is the most significant factor in the aspect of exploitation of the advanced services and the deployment of the socio-economic context.

Broadband availability in Hungarian settlements with respect to bandwidth

The national surveys [7] show that in the settlements – if there is any access – the maximum bandwidth of the access varies between broad margins.

The results of a survey show that in 90% of the Hungarian settlements some kind of broadband service of 256-512 kbps or higher speed is available. However if we raise the minimum speed e.g. to the nominal value of 1 Mbps, then such an infrastructure capable for this higher speed is available in 84% of the settlements. In case of higher bandwidth the broadband availability will further decrease.

The results of the surveys can be misleading. At the judgement of the availability only that fact is examined whether at a given bandwidth there exists any – even a single – subscriber having access opportunity or not. It is not examined that what portion of the settlement is covered by broadband, what bandwidths are available, what kind of service levels can be provided, how many new customers can be activated in case of connecting the settlement to the national network, is it possible to meet the emerging demands, how much time is required to connect a new customer.

Based on the above it is simpler to define when a settlement is unsupplied, it is the smallest bandwidth where there is no service. It is represented in Figure 6 as a function of the bandwidth based on data in 2008; furthermore we estimate the changes by 2012.

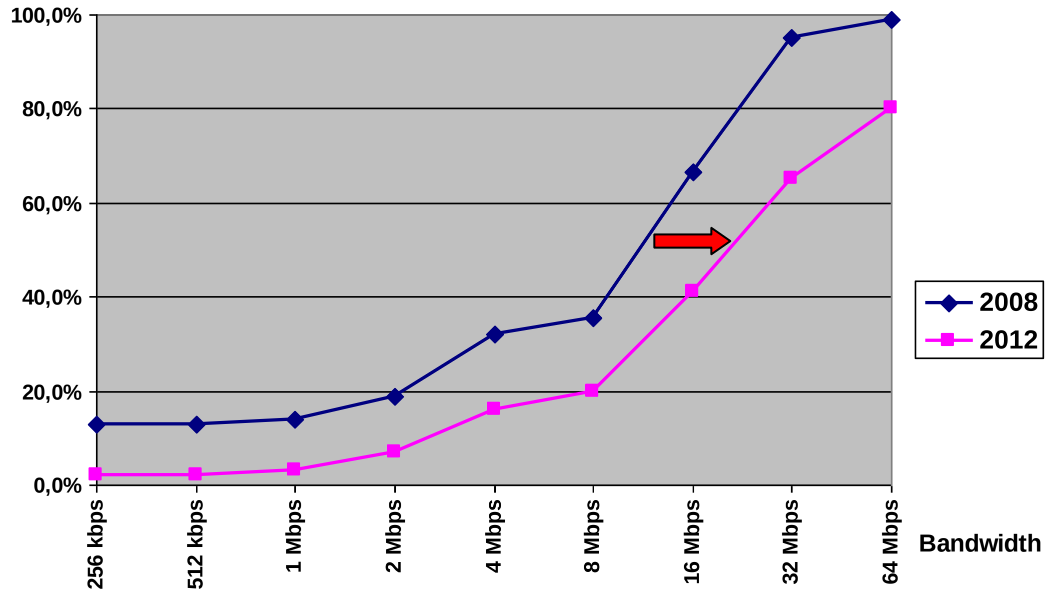

Figure 6. Ratio of unsupplied settlements in 2008 (fact) and in 2012 (plan)

In the local broadband access the ADSL and cable modem technologies are dominant technologies in Hungary. Due to the faster growth of the latter, the number of subscribers of these technologies moves to equalization. The number of wireless terminal equipment mostly working in the 2.4 GHz band (Wi-Fi) is significant; furthermore the number of customers using Ethernet connection is also increasing. Because recently the availability and quality measures of the wireless services cannot reach that of the wireline services in general, their application is only advised if they can meet the quality requirements.

Metropolitan trunk networks

The modern metropolitan trunk networks connecting local network nodes are necessarily high quality optical networks. It is known that in a lot of towns there exist optical network links connecting local network nodes. However except Budapest we cannot speak of the wholesale market of metropolitan optical trunk network, it can be considered as one of the prohibitive factor of the national broadband development. At the same time in the next few years break-through is expected: the Next Generation Network (NGN) development will basically restructure the optical parts of metropolitan networks, it will increase the demand for the wholesale market of metropolitan trunk network.

Broadband long-distance connectivity of settlements

For the upgradeable delivery of broadband services with satisfactory speed and quality, high capacity optical connections of the local access network nodes to the backbone network is required. The implementation of the optical network helps the spread of mobile broadband services. The data of the optical connectivity of settlements are shown in Table 2. (In some part of the settlements having no optical connectivity, there exists only a broadband local network with long-distance connectivity of restricted speed.)

Table 2. Settlement categories with respect to optical connections

Optical connection	Population no. category	Population (thousands)	Population subtotal (th)	Population %	Settlement no.	Settlement subtotal
0	-500	198	821	8,0%	744	1 207
0	500-50 000	623			463	
1	-500	87	1 881	18,5%	272	1 100
1	500-50 000	1 794			828	
More than 1	500-50 000	3 812	7 476	73,5%	825	845
More than 1	50 000-	3 664			20	
Total		10 178	10 178	100,0%	3 152	3 152

In Hungary 4-5 service providers have nation-wide or near nation-wide broadband infrastructure. Nevertheless, in 1207 small and medium sized settlements, for 8% of the population presently there is no optical connection. Out of them in 500 settlements there is some kind of Internet service, but in about 500 further settlements there is none Internet at all.

A quarter of the settlements (almost 850 settlements), i.e. 73.5% of the population has more than one long-distance broadband connections. However this fact does not mean that in case of this settlement category the long-distance connectivity would be solved with favourable conditions for the market players having no long-distance infrastructure. (If a settlement has more optical network connections, it does not definitely imply that they are independent connections with connectivity to the national backbone network.

The geographic coverage is shown in Figure 7.

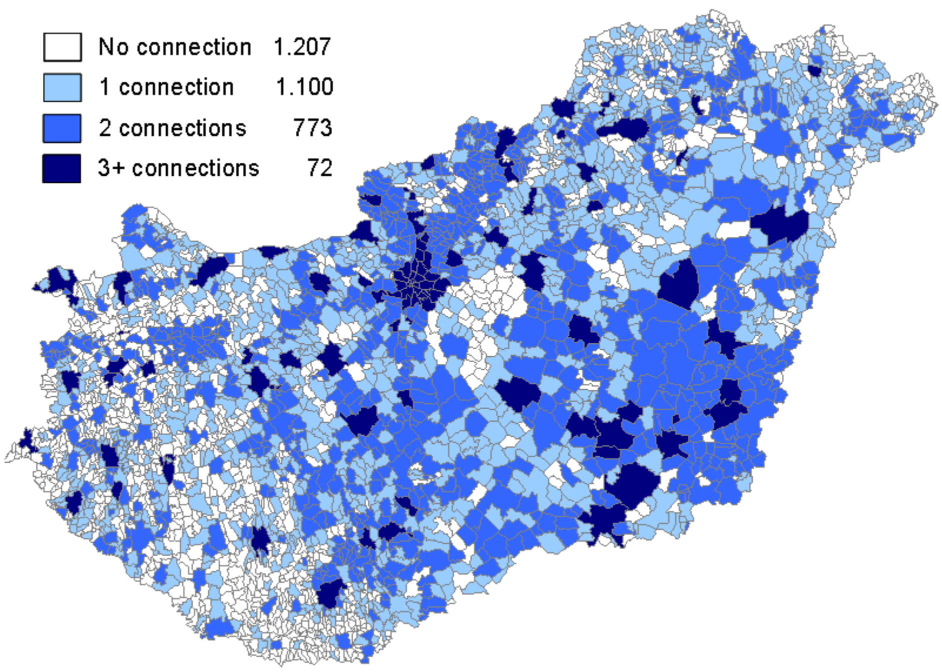

Figure 7. Optical connectivity of settlements

Further conditions of the spread of high-speed Internet

The implementation of the full national broadband coverage cannot be certainly reached on a commercial basis within a foreseeable time frame. In Hungary state support, in particular usage of community resource is required to deploy broadband infocommunication infrastructure enabling high speed Internet access in all settlements of the country. This is detailed by the conferences [8, 9] forming the concept of the development of the broadband infrastructure, the *'National Digital Utility'*.

As it is supported by the use of the compound BPI indicator in the EU, the broadband infocommunication infrastructure (including the suitable physical transmission medium, electronic communication networks and services) is only one condition of the spread of the Internet. We have to give positive answers for further questions, e.g. are there suitable devices in the households, is there solvent demand for the devices, can people pay for the Internet, are there valuable important and attractive applications on the Internet for the consumers [10, 11]. It is necessary to resolve the negative feeling of the people (motivation is necessary to generate demand for the use of the Internet), the natural expectations for information security must be solved, the digital literacy and technical knowledge must be broadened. All these aspects should be satisfied for the successful, society level penetration of the Internet. Our progress is determined by the weakest chain link.

The conditions of state intervention and EU support

The European Union has been encouraging the spread of the broadband services for a long time [1]. However, it cannot be expected from the competitive market to deploy the infrastructure required at society level and to provide service availability if the investors' expectations cannot be satisfied. State intervention, community support (state, local government or EU) is required to resolve the profitability gap problem in such a way that public financing must be reconcilable with the competition related provisions of the founding treaty of the EC, the Rome Treaty.

With respect to the European policy on broadband communications:

- public financing must be used only if the deployment of the broadband infrastructure is not feasible for private enterprises in commercial point of view;
- public financing cannot serve the duplication of existing infrastructures providing broadband services of appropriate level;
- it is necessary to allow such use of European funds, which aim the modernization or replacement of existing broadband networks, if they cannot provide connections of sufficient bandwidth and quality;
- the state support given to the builder of the broadband infrastructure must be compliant with the principle of technology neutrality;
- in a support system based on tendering the drawer must take into account to avoid breaking up the infrastructure, or its opposite, monopolization of market power (e.g. with the regulation of owner structure);
- a future proof, upgradeable, expandable, secure, good quality infrastructure with capacity reserves must come into existence.

Paradigm shift: Open access network instead of Universal service

The EU doesn't see the universal service to be the suitable and effective means in solving the broadband access availability problem. The requirements of the universal service and the support of the competition cannot be unified within the same policy. According to the standpoint of the EU in the field of broadband communications the conditions of social justice can be satisfied by the deployment of open access networks.

The open access network means the provision of non-discriminatory access opportunity to the scarce resources necessary to service provisioning.

The EU position on open access networks can be summarized as follows [2]:

- The state intervention based on public financing and other forms can accelerate the implementation of broadband infrastructure in non-profitable or less profitable areas.
- The competition neutrality and market conformity of the state intervention can be ensured by the utilization of the networks deployed or upgraded as open access networks.
- The networks deployed or upgraded by public financing must be reachable for all market players with suitable conditions meeting the principles of open access and non-discrimination. In case of networks built by public financing the open access is the guarantee of competition conformity.
- The enforcement of the requirement of openness cannot be restricted by the fulfilment of other requirement (e.g. technology neutrality).

Development objectives and design considerations

The main objective of the broadband infocommunications infrastructure development is to provide full coverage for Hungary as soon as possible by a network system, which is

- designed for the provisioning of the planned services,
- deployed and operated with respect to the plans,
- the existing, upgraded and newly installed access and long-distance networks form together a uniformly steady network structure.

The broadband Internet access should be available in the presently unsupplied or not properly supplied areas as well.

The digital broadband network is composed of several, independently built sub-networks, using different technologies and equipment sets. In order to guarantee the service quality on the network, i.e. on the joint interconnected sub-networks, it is necessary to prescribe requirements for the whole network and to all of its parts and it is also important to check the fulfilment of the requirements during network planning, implementation and operation.

The structure of the national broadband network

Presently Hungary is divided into 174 area development units, so called districts [12]. In average each of them (without Budapest as district) consists of 18 settlements with 48 thousand inhabitants in an area of 535 km^2. The proposed national optical backbone will connect the district centres.

District networks of basically optical technology will be built in all districts connecting all the settlements within the districts. In case of certain circumstances when there are difficulties in establishing optical connection to given settlements or it could require too long time, the solution could be the microwave point-to-point or bidirectional satellite connection.

At the terminals of all open access long-distance connections in the settlements it is necessary to establish open access co-location places in order to reduce the non-avoidable fixed costs of open access, in such a way to support the competition and to decrease subscription fees.

Figure 8 represents the structure of the national broadband network and the technologies used.

National backbone plane: In each district there is at least one optical node. In the optical backbone network the open access services can be the followings: SDH, optical wavelength (lambda) in the DWDM system, Fast Ethernet, Gigabit Ethernet, dark fibre.

District network plane: There are network nodes in all settlements, the network is basically optical but exceptionally or provisionally other, e.g. microwave technology can be used, too.

Local network plane: In the local networks technologies satisfying the requirements could be chosen, e.g. wireline, wireless or mixed solutions.

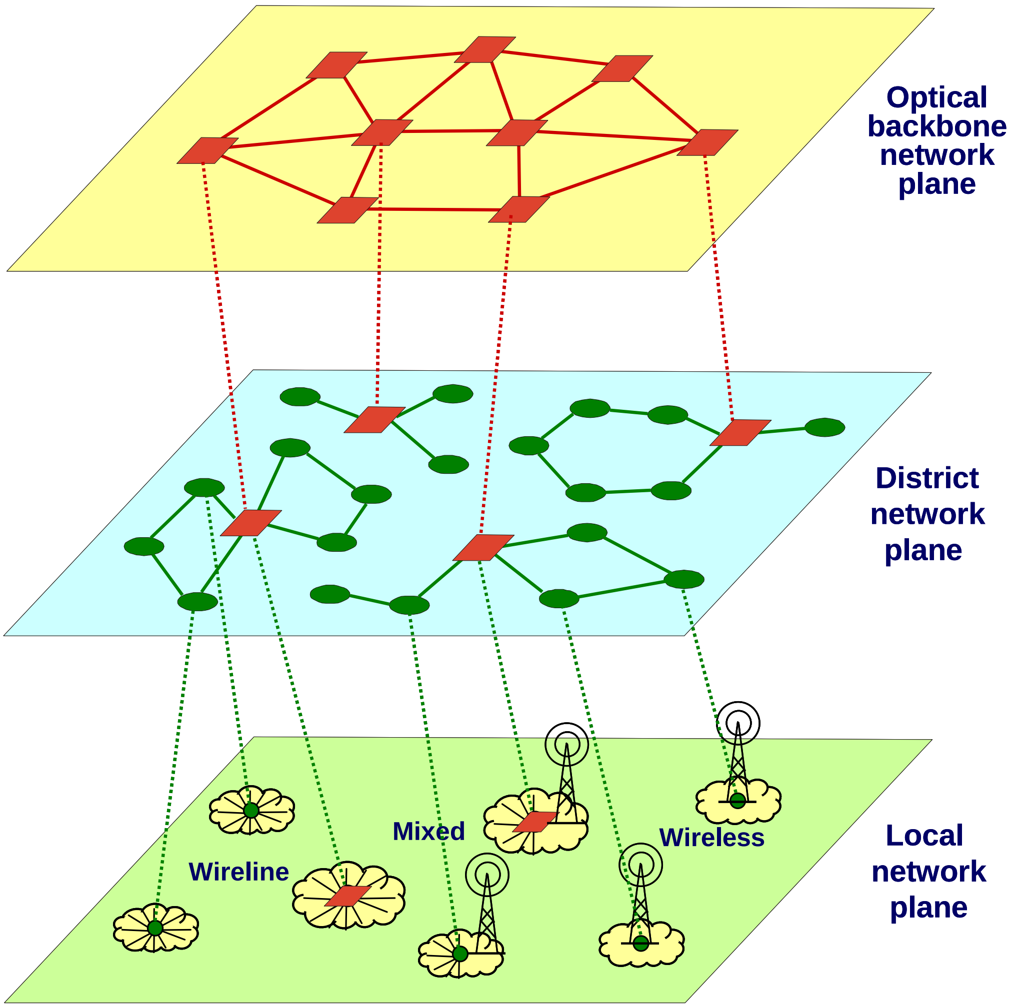

Figure 8. Proposed structure of the national broadband network

The service levels in the local access networks

Local access networks can be designed for different service levels. It is reasonable to distinguish at least two service levels:

1. *Basic service level:* The access network is suitable for the provision of broadband Internet access. It is reasonable to design basic level service to those areas where the coverage meets real social demand, but the deployment of access infrastructure enabling multimedia service capabilities cannot be realized within the available expenditure limit of public financing.
   - At the basic service level the target speed is at least 2 Mbps.
   - The features and price of the basic level broadband services must be set in such a way that the service should be reachable for the low solvent social groups as well.
2. *Multimedia service level:* The access network is suitable for the provision of phone calls, Internet access, and streaming video (Triple Play) at the same time. It is reasonable to design multimedia level access networks to the areas where this service level can be realized without public financing or within the available limited public financing.

- The minimum speed of the multimedia service level access is at least 6 Mbps.
- The multimedia level access network must have guaranteed parameters for the continuous transfer of video, audio signals and data.

It is necessary to count with the tendency that in increasing number of settlements the broadband Internet service providers will realize the Internet access of suitable bandwidth and affordable price without public finance using UMTS (3G) and CDMA 450 technologies.

The development strategy

The strategic objectives can be set as optical connection of appropriate bandwidth of settlements and the deployment of suitable local access networks. During the realization it is necessary to deal separately with:

A) the connection of unsupplied settlements, districts consisting of sparse small settlements to the optical backbone or district networks;

B) the deployment of broadband local access networks and upgrading of existing access networks in settlements and in districts of sparse settlements.

Based on the above the strategic steps of the technical development can be the following.

A) In point of the district and backbone networks:

In the first step:

- let all the 174 district centres be connected to the national optical backbone by open access of multimedia level available for any player of the competitive market;
- let all the settlements of over 500 inhabitants have nodes providing multiple access to the optical district network for the service providers;
- to the settlements of up to 500 inhabitants (with respect of Figure 2 their number is 744, it is 23,5% of all settlements, but they represent only 2% of the population), where in the first phase the optical connection cannot reach to, as a temporary solution microwave point-to-point or bidirectional satellite connection can be established to the national broadband network.

In the second step let all the settlements are accessible by optical fibres connecting to the national optical network.

B) In point of the local access networks:

- in the unsupplied or not properly supplied settlements it is necessary to conduct a series of procedures of local assessment, design, tendering and network deployment taking into account the local specialities and the timing of the implementation of the national optical network;
- the service provider (or consortium) applying for support must decide on the applied technology of the access network, which can be in general some wireline technology (e.g. ADSL, cable modem or optical) in medium and bigger settlements, some wireless technology in smaller settlements or sparse settlement structures (e.g. CDMA 450, LMDS, WiMAX, Wi-Fi, satellite);
- the smallest reasonable unit of tendering is the district, but it can be imagined at region level as well (Hungary consists of 7 regions).

The comparison of broadband network technologies taken into account

During the elaboration of the development strategy, presently or in the near future available broadband network technologies were taken into account:

Broadband backbone and district network technologies

- SDH – Synchronous Digital Hierarchy (optical or microwave transmission)
- DWDM – Dense Wavelength Division Multiplexing (optical transmission)
- Optical Ethernet links (100 Mbps Fast Ethernet, 1 and 10 Gbps Gigabit Ethernet)
- Point-to-point microwave connection
- VSAT – bidirectional satellite connection

In Hungary SDH as backbone network technology is countrywide in use, but DWDM is continuously spreading, too. A tremendous number of point-to-point microwave connections are used in the service providers' networks. Bidirectional satellite Internet can also be a solution for connecting settlements, the service prices will decide whether only temporarily or for a longer time frame.

Wireline broadband access network technologies

- DSL – Digital Subscriber Line technologies (ADSL, VDSL)
- CATV – Cable modem technologies
- FTTx – Fibre-to-the-… technologies (FTTH – Fibre-to-the-Home)
- Ethernet access technologies

Hungary, within the EU is in an exceptional situation. Although 50% of broadband accesses are DSL, the ratio of cable modem accesses is 44%, within a few years equalization is expected. Deployment of optical accesses has already stated dynamically, at a long term the spread of optical access is anticipated in wide range, even in small settlements as well.

Wireless broadband access network technologies

- 2G (GSM), 3G (UMTS) and 3,5G (HSPA) mobile technologies
- CDMA 450 (revA, revB) mobile technologies
- FWA (Fixed Wireless Access) technologies (e.g. LMDS, WiMAX)
- WLAN (Wireless Local Access Network) technologies (e.g. Wi-Fi).

Presently the 3G mobile services can be used as complementary or partially substitute services in densely populated areas of bigger settlements where there is good 3G coverage. The growing coverage will continuously pass the service to the smaller and smaller settlements as well. Broadband wireless service over 6 Mbps can only be presently provided only with HSPA technology. WLAN technologies have been widely used also in Hungary, taking into account their limited range. In Hungary recently there is only a single WiMAX service provider, CDMA 450 and LMDS service providers have not entered the market still now.

System selection: application tables and maps

The different access technologies shown in Table 3 can advantageously be applied at distinct settlement sizes in general circumstances, of course not with an obligatory manner.

Table 3. Application table of broadband access technologies

Inhabitants of settlements	Wi-Fi CDMA 450	LMDS WiMAX	KTV	ADSL	FTTx + VDSL	FTTH
1-500	xxx	xxxxx				
501-1000	xx	xxxx				
1001-1500	x	xxx		x		
1501-3000		xx		xx		
3001-5000		x	x	xxx		
5001-10000			xx	xxxx		
10001-20000			xxx	xxxxx		
20001-35000			xxxx	xxxxx	x	
35001-50000			xxxxx	xxxxx	xxx	x
50001-500000			xxxxx	xxxxx	xxxxx	xxx
Budapest			xxxxx	xxxxx	xxxxx	xxxxx

More complex (two-dimensional) technology application maps can represent the access technologies utilized at the most economic way in general circumstances as a function of the required bandwidth from the access network and the geographic extension of the access network (Figure 9).

Along the axes the distance L from the switch or wireless access point and the bandwidth V of the access can be seen. At a given L,V pair let the usage cost of technology i be $C_i(L,V)$.

For the satisfaction of the demand defined by the L,V pair we consider the technology as most advantageous, for which the cost is minimal, i.e.:

$$C_{min}(L,V) = min_{\ i=1,N}\ C_i(L,V).$$

To each point of the map defining the function $M(L,V)$ it is possible to determine the technology of minimum cost, if M gives everywhere the serial number of the optimal technology or technologies:

$$M(L,V) = i, \text{ if } C_i = C_{min}.$$

The function $M(L,V)$ can be multi-valued, because along the border curve of the interfacing areas the costs of the technologies can be the same, thus:

$$C_i = C_j = C_{min}.$$

At given points 3 or 4 areas can meet, in this case:

$$C_i = C_j = C_k\ ... = C_{min}.$$

The usage cost of the different technologies can be determined in several ways. We consider to the most appropriate method when the present value discounted for $t = 0$ at a given interest rate r of the deployment cost (emerged at t_0) and the annual operational costs for a given, e.g. 3-5 year time period is calculated (Figure 10).

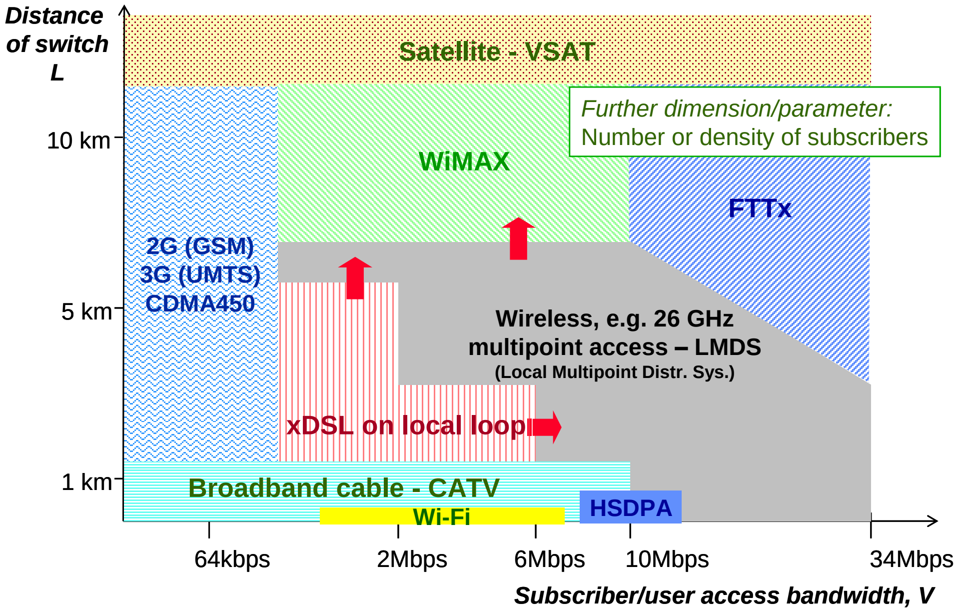

Figure 9. Application map: two-dimensional system selection diagram
of broadband access technologies

The application areas of DSL, cable modem, optical, mobile and wireless technologies are bordered by the system selection diagram. We can see that where these solutions are not suitable, satellite technology can still be used.

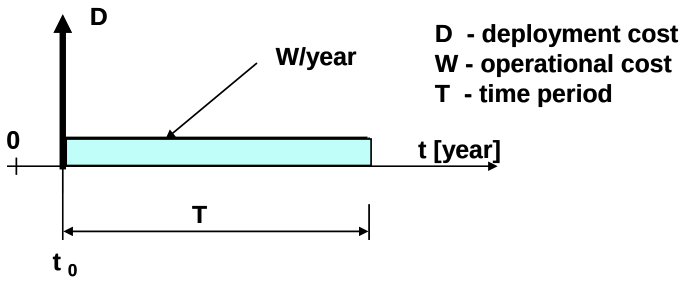

Figure 10. Deployment and operational costs

Summary

In order to deliver upgradeable broadband services of suitable speed and quality the high capacity optical connectivity of the settlements and deployment of good quality broadband access networks are to be provided. In our country presently there are about 1200 such settlements which are not reached by optical network and it is sure that there are almost no settlements without the requirement of further development. To deploy those parts of the national infocommunication infrastructure that are not realized by the market players and are not profitable for them community support (state, local government or EU) is required. The state intervention may accelerate the deployment of broadband coverage in less profitable areas. Utilization of the networks deployed or upgraded by community support as open access networks can ensure the reconciliation of state intervention and competition approach.

In order to implement full coverage in the first step let all the 174 district centres be connected to the national optical backbone by open access of multimedia level and let it be available with multiple access for any player of the competitive market.

All the settlements of over a given number of inhabitants (practically over 500) should have optical connection; the smaller ones – temporarily – can be connected to the national broadband network by some wireless (terrestrial or satellite) district network solution. In the second step the optical connection of all the settlements should be realized.

As regards the access networks the service provider applying for support must decide on the applied technology and the targeted service level (basic or multimedia) taking into account local specialities and the call for tender.

Acknowledgement

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[12] Districts, settlements belonging to districts and district seats (in Hungarian), Appendix of the Act CVII of 2007.

Appendix

Table A1. Data sets of BPI

	Rural coverage	Competi-tion	Price	Speed	Advanced services	Socio-economic context
BG	0	10	16	12	15	10
CY	98	0	25	8	29	37
RO	34	69	35	42	18	10
PL	55	51	2	20	46	46
EL	61	29	57	72	46	40
LT	82	123	24	12	64	42
SK	48	72	5	105	60	68
EE	90	99	29	0	98	72
IE	89	59	23	27	91	105
LV	80	136	36	48	43	60
HU	98	100	13	87	50	55
IT	100	50	59	82	39	85
CZ	93	151	16	60	47	50
PT	116	54	34	84	63	71
MT	121	122	10	49	68	70
SI	105	112	55	34	61	77
LU	120	20	57	13	116	118
ES	108	87	22	113	57	90
DE	108	87	48	47	107	123
FI	111	54	25	55	146	139
AT	97	143	49	55	81	115
BE	121	119	18	147	64	102
FR	120	94	114	90	86	106
NO	116	102	42	73	155	162
UK	118	129	113	68	94	134
DK	121	89	38	100	167	155
NL	121	139	60	123	161	142
SE	111	168	71	150	135	158

Table A2. Ordered data sets of BPI

		Rural coverage
1	NL	121
2	MT	121
3	DK	121
4	BE	121
5	LU	120
6	FR	120
7	UK	118
8	PT	116
9	SE	111
10	FI	111
11	ES	108
12	DE	108

		Competi-tion
1	SE	168
2	CZ	151
3	AT	143
4	NL	139
5	LV	136
6	UK	129
7	LT	123
8	MT	122
9	BE	119
10	SI	112
11	HU	100
12	EE	99

		Price
1	FR	114
2	UK	113
3	SE	71
4	NL	60
5	IT	59
6	EL	57
7	LU	57
8	SI	55
9	AT	49
10	DE	48
11	DK	38
12	LV	36

13	SI	105	13	FR	94	13	RO	35
14	IT	100	14	DK	89	14	PT	34
15	HU	98	15	ES	87	15	EE	29
16	CY	98	16	DE	87	16	CY	25
17	AT	97	17	SK	72	17	FI	25
18	CZ	93	18	RO	69	18	LT	24
19	EE	90	19	IE	59	19	IE	23
20	IE	89	20	PT	54	20	ES	22
21	LT	82	21	FI	54	21	BE	18
22	LV	80	22	PL	51	22	BG	16
23	EL	61	23	IT	50	23	CZ	16
24	PL	55	24	EL	29	24	HU	13
25	SK	48	25	LU	20	25	MT	10
26	RO	34	26	BG	10	26	SK	5
27	BG	0	27	CY	0	27	PL	2

		Speed			Advanced services			Socio-economic context
1	SE	150	1	DK	167	1	SE	158
2	BE	147	2	NL	161	2	DK	155
3	NL	123	3	FI	146	3	NL	142
4	ES	113	4	SE	135	4	FI	139
5	SK	105	5	LU	116	5	UK	134
6	DK	100	6	DE	107	6	DE	123
7	FR	90	7	EE	98	7	LU	118
8	HU	87	8	UK	94	8	AT	115
9	PT	84	9	IE	91	9	FR	106
10	IT	82	10	FR	86	10	IE	105
11	EL	72	11	AT	81	11	BE	102
12	UK	68	12	MT	68	12	ES	90
13	CZ	60	13	LT	64	13	IT	85
14	FI	55	14	BE	64	14	SI	77
15	AT	55	15	PT	63	15	EE	72
16	MT	49	16	SI	61	16	PT	71
17	LV	48	17	SK	60	17	MT	70
18	DE	47	18	ES	57	18	SK	68
19	RO	42	19	HU	50	19	LV	60
20	SI	34	20	CZ	47	20	HU	55
21	IE	27	21	PL	46	21	CZ	50
22	PL	20	22	EL	46	22	PL	46
23	LU	13	23	LV	43	23	LT	42
24	BG	12	24	IT	39	24	EL	40
25	LT	12	25	CY	29	25	CY	37
26	CY	8	26	RO	18	26	BG	10
27	EE	0	27	BG	15	27	RO	10