Kitta Gergely • Szolnok Endre • Viszkievicz András

Network Neutrality

vs.

Network Management

A Central European Perspective

2011.

Contents

Executive summary

Network neutrality means that all content and sources of data are treated equally on the internet. In this *non-preferential system* every internet user is allowed to access any web site on equal terms. According to the concept, all corporate and individual consumers can choose several internet subscriptions with different levels of transmission speed, but *no additional type of discrimination of users or prioritisation of content* are permitted when using the internet. The neutrality of the internet allows only a FCFS (first come, first served) service policy in contrast to *network management* that favours data package tiering and an alternative pricing model for the sake of better service quality.

In the current model of the internet, the interests of *Internet Service Providers* (ISPs) and those of *Internet Content Providers* (ICPs) are sharply diverging. The representatives of the ISPs are mainly cable and telephone companies that would like the present data transmission-retrieval schemes, along with their entailing pricing, to be reconsidered, whereas the ICPs rather prefer to preserve the current model. In the heated debate on network neutrality, ICPs frequently urge legislation/regulation in protection of the open internet, while ISPs believe problem solving should be in the purview of internet market players.

Telecommunication firms and cable carriers want large content providers to be assessed more for exploiting bandwidth, while ICPs think network improvement – in a figurative and strict sense of the word – is not their business at all. As for big online companies, *a level playing field* is essential. They say infrastructural services should be offered to ICPs without unjust economic favouritism. Contrary to that, supporters of network management are inclined to regard the negligence of tremendous traffic generation to be a mere bandwidth waste that is really unfair to other users of the world wide web.

Opponents of the open internet consider net neutrality to be a pretext for large ICPs to avoid paying additional fees for their heavy load on the transmission lines deployed and maintained by service providers. On the other hand, its proponents accuse ISPs of trying to gain extra profit at the expense of online companies through the “undemocratic” violation of neutrality. In this sense, service providers call online content giants '*free-riders*' of the

internet, whereas ICPs criticise telecom Goliaths for attempting to *'rule* and *control'* the so-far independent internet.

The debate is multi-layered, there are several arguments for and against network neutrality calling issues like competition, free market, innovation, public welfare, pricing, politics, legislation, etc. into discussion; however the discussion about the neutral web among ISPs and ICPs is rooted in one important question: *who should finance the needed growth in broadband capacity and the indispensable infrastructural development of the internet*?

Currently the EU and the US have slightly different political stances to the case. The EU has a careful and unbiased approach to the neutral net. The Community considers the present set of legal safeguards to be sufficient for the protection of consumers and finds further legislation for the sake of network neutrality to be unnecessary. Neelie Kroes, EU Commission Vice-President for Digital Agenda, stated that network neutrality regulation might deter investment and an efficient use of the available resources and called traffic management practices of ISPs essential; however, she also kept the opportunity of further legislation open if it were necessary.

In the United States of America the debate on network neutrality started more than a decade ago, although the case of the open internet has not been clearly decided on yet. The legal steps of the Federal Communication Commission usually advocate net neutrality; nevertheless FCC's resolutions favouring the open internet were denied by the Federal Court which fundamentally questioned the agency's legal basis for regulating the ISPs' network management practices.

Hungary is a "blank spot" in the professional discussion on network neutrality. Neither the Strategic Plan (2010-2015) of the national regulatory board (NMHH) nor the Digital Agenda of the competent Ministry of National Development deals with the topic in detail. The Minister of State for Info-communication, Zsolt Nyitrai, chairing the TTE Telecom Council during the Hungarian EU Presidency, called network neutrality a supported issue while he also admitted that the Hungarian policy had to be adjusted to the legislative and strategic environment to theEU.

Our institution got engaged into the professional debate on network neutrality and developed an economic analysis to see the effects of a potential neutrality regulation on the

users of wired broadband services in the V4 countries. In order to elaborate a Central European perspective, we applied the approach and an updated methodology of Copenhagen Economics to reflect the recent developments of broadband market. Our analysis showed that a complete ban on network management could seriously harm public interest and the evolution of information society, and could also result in consumer welfare loss.

According to our economic calculations, if network neutrality regulation was introduced, a serious additional investment would be needed to maintain the recent level of supply quality, and this would put a significant upward pressure on prices. A 25 percent price increase would be needed, which would in turn reduce broadband internet penetration by the same ratio. The drop in broadband usage would likely cause a serious consumer welfare loss. Higher prices together withdecreasing penetration would generate an annual welfare loss of 570 million euros in the V4 region. As loss is proportionate to market size, the biggest yearly loss would fall on Poland (260 million euros), followed by the Czech Republic (130 million EUR), Hungary (120 million EUR), and Slovakia (60 million EUR). The three western countries with an eightfold market size compared to the V4 region incur an eightfold loss. Effects for three western countries (France, Germany, and Sweden) were also calculated that would incur a total loss of 4 460 million EUR per year, eightfold to that of the V4 countries,. (Detailed calculations and methodology can be found in the study).

In tandem with making an economic analysis, we reviewed researches relevant to the issue subsequent to which we recognised that nowadays internet services cannot always handle congestion caused by the multiplication of next generation applications and new media formats. Service quality failures appear both in the EU and the US , therefore leaving the problem of decreasing infrastructural capacity to be sorted out between ISPs and ICPs is a serious mistake.

As a conclusion, we state that the application of tiered services and different network management practices can be supported with certain restrictions, whereas more regulation on network neutrality could contribute to higher service prices, welfare loss and a decreasing internet penetration ratio.

Preface

The purpose of this study is to enrich the professional debate with a Central European viewpoint, the emerging findings of which may help shape relevant political activity in the EU.

First, we give a general introduction to the issue wherein we define the concept of network neutrality and identify the arguments that frame the debate on the open internet. Next, we examine the international political stance to the topic from the perspective of regulation policies in the European Union and the United States without providing detailed historical background. We then briefly describe the case in Hungary, and develop a profound economic calculation on the estimated effect of network neutrality on subscription prices and broadband penetration in the V4 region via applying the methodology of Copenhagen Economics.

In the last phase of this study we draw some final conclusions, which may differ from the official standpoint of the Hungarian Government. Information about the methodology of our economic figuring, and our institute, is found in the appendix.

General introduction to the issue

What is network neutrality?

Network neutrality means that all content and sources of data are treated equally on the internet. In this *non-preferential system* every internet user is allowed to access any web site on equal terms. According to the concept, all corporate and individual consumers can choose from among several internet subscriptions with different levels of transmission speed, but *no additional type of discrimination amongst users or prioritisation of content* are permitted. The neutrality of the internet allows only a FCFS (first come, first served) service policy in contrast to *network management* that favours the tiering of data packages for the sake of better service quality. For this reason, the principle of the neutral network is often referred to as the "*open internet*".

The core of the debate

In the current model of the internet, the interests of *Internet Service Providers* (ISPs) and those of *Internet Content Providers* (ICPs) are sharply diverging. The representatives of the ISPs are mainly[1] cable and telephone companies that would like the present data transmission-retrieval schemes, along with their entailing pricing, to be reconsidered, whereas the ICPs prefer rather to preserve the current model. In the heated debate on network neutrality, ICPs frequently urge for legislation/regulation in protection of the open internet, while ISPs believe problem solving should be in the purview of internet market players.

The discussion is multilayered; however, it can be scaled down to one key question: *Who should finance the needed growth in broadband capacity and the indispensable infrastructural development of the internet*?

[1] Of course this classification of roles is not so simple in practice, that is why we use the word "mainly" deliberately. Supporters of the idea of net neutrality might include VoIP service companies like Skype, though strictly speaking they are not an ICP.

Telecommunication firms and cable carriers want large content providers like Microsoft, Google, Netflix, Facebook. etc. to be charged more for exploiting bandwidth, while ICPs think network improvement – in a figurative and strict sense of the word – is not their business at all.

As for big online companies, *a level playing field* is essential. They say infrastructural services should be offered to ICPs without unjust economic favouritism. In the contrary, supporters of network management are inclined to regard the negligence of tremendous traffic generation to be a mere bandwidth waste that is really unfair to other users of the world wide web.

Opponents of the open internet consider net neutrality to be a pretext for large ICPs to avoid paying additional fees for their heavy load on the transmission lines deployed and maintained by service providers. On the other hand, its proponents accuse ISPs like Time Warner, Comcast, etc. of trying to gain extra profit at the expense of online companies through the “undemocratic” violation of neutrality. In this sense, service providers call online content giants '*free-riders*' of the internet, whereas ICPs criticise telecom Goliaths for attempting to *'rule* and *control'* the so-far independent internet.

Arguments for and against the neutral net

Pros

- Abolishment of the neutral character of the internet would result in the restriction of competition. Network management is an external intervention into the operation of the free market. Small and medium-sized enterprises (SMEs) that generate more traffic would not usually be able to pay for the same premium service as large businesses which enjoy abundant financial resources. *Therefore, a gap between smaller and larger enterprises would be inevitably and arbitrarily widened* by ISPs.
- ISPs are *against innovation*; they consider content-rich pages, flash animations, video streaming, and multimedia to be enemies. They would go back to the era of the web 1.0 for decreasing traffic if they could do so. The idea of network management is also opposed to innovation, because it forces pioneering start-up companies to spend their money on internet capacity instead of upgrading their service or product.
- Telecommunication companies are charging large content providers heavily in many particular ways, so additional fees would *equate to imposing multi-taxation* on them.
- On account of infrastructural complexity and the commingled business interests of ISPs, congestion handling would lead to non-transparency in *broadband management* techniques.
- If network management was not transparent, ISPs would be given a *possibility to favour their own content unfairly*.
- The amount of information on the web, together with the size of the internet are much bigger than the ISPs would be able to manage . At present, the internet functions according to clear and well-known protocols. The *disintegration of the net via establishing new and rarely experienced management procedures* by different ISPs is, indeed, a possible threat to the stable operation of the entire internet. Untested manners of data allocation would add uncertainty to the internet, which might cause several system errors, none of the ISPs could calculate precisely in advance.

- For all the reasons mentioned above, the internet *will be more expensive for nearly everybody* if network neutrality cannot be defended.
- In a political sense, *global authority over the worldwide internet, which is a public good, should not be transferred* to the private business sphere. "No authority should have the power to pick winners or losers on the Internet," said FCC Chairman Julius Genachowski.

Cons

- In terms of economics, it is internet neutrality that is highly restrictive to competitiveness. Large content providers *expropriate bandwidth, thusweakening the competitiveness* of SMEs. Net neutrality *means an inflexible business situation* in which scarce network capacity is engaged mostly by traffic making giants (like Facebook), rathern than by entrepreneurs for whomit has the highest innovative value.
- Start-up companies that need premium quality of service and exclusive bandwidth for completing their innovation are actually *obstructed by the unmanaged internet in* reaching their cutting-edge goals. As time passes, more sophisticated innovations require more broadband capacity; instead, the present infrastructure is going to run out of this much-needed capacity.
- ISPs have no strong incentives to recoup profit for investments of advanced network developments. In the present system of the open internet, expanded capacities *are financed by few ISPs*, while the advantages of such enlarged capabilities are really employed by huge ICPs.[2]

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[2] Content providers earn the largest share of the overall revenue in the Internet value chain. Content providers grab the largest share of the revenue earned on the Internet: in 2008, 62% of the total revenue9 was earned by content and service providers, while Internet service providers cashed only 17%.

The total revenue includes money earned by content providers and Internet service providers as well as content owners (TimeWarner, EMI, BBC), providers of enabling technology and services (Akamai, PayPal and DoubleClick) and user interface providers (Firefox, Symantec, and Apple).

See AT Kearney (2010): “Internet Value Chain Economics”, available at http://www.atkearney.com/index.php/Publications/internet-value-chain-economics.html.

- If political authorities think that ISPs cannot possess the right to manage internet traffic just because the net is a public good or a non-excludable resource, then it should not be the private businesses *that have to finance the necessary infrastructural development* of such a public commodity. The *need for additional investment is significantly higher under net neutrality* as opposed to a system where network management and pricing based on throughput consumption is allowed and the infrastructure is used efficiently. If net neutrality attained legislative confirmation, *the establishment of significant unused network capacities* would be unavoidable for ISPs, since they should guarantee the exploitation of full bandwidth at any time for all individual users. As a consequence, verified neutrality would result in higher capital investment needs that would decrease the intensity of competition in the broadband market. If this legislation was passed, ISPs would not be able to economise network usage by reducing excess bandwidth demand that currently makes the internet cheaper.
- Net neutrality leads to *a sub-optimal use of resources*. Through network management and changing *ex-ante* pricing mechanisms, the effectiveness of broadband services can be optimised while *subscription fees can be lowered*. The whole system would be more reasonable and balanced, since greater consumption demands higher fees, and minor use of traffic automatically includes the possibility of cheaper internet access.
- Legislation reinforcing network neutrality could make legally mandated data filtering, such as anti-virus programs, denial of service attacks, and spam reduction, very difficult to achieve.

The present status of the case

The European Union

Postponing definitive legal action on network neutrality, while simultaneously keeping open the opportunity to regulate it if necessary, reflects the EU'scareful, unbiased approach to the issue of network management. According to Neelie Kroes, European Commission Vice-President for the Digital Agenda, the present collection of legal safeguards seems adequate for now to protect consumers from the possibility of unfair market behaviour from ISPs. Among several earlier legal measures, the so-called "Telecoms Reform Package",which came into force in 2009, recognised internet access under European law as a fundamental right of citizens that equalled freedom of expression or access to information, and ensured that no citizen could be disconnected from the internet without a court order[3]. The Telecom Package created important tools for building a single European telecoms market and allowed Member States to set minimum quality levels for network transmission services that is a partial implementation of what net neutrality proponents struggle for. Commissioner Kroes in response to MEP Marietje Schaake and In't Veld's Parliamentary question said: "*The revised telecom framework, which had to be implemented by the Member States by 25 May 2011, contains enhanced tools for dealing with net neutrality issues. The Comission will monitor how effectively these provisions will be used by national regulatory authorites to ensure the open character of the internet.*"[4]

The legal action also promoted universal services, harmonised the activity of NRAs and established a new pan-European telecom authority (the Body of European Regulators for Electronic Communications, or BEREC), that replaced the former, less official European Regulators Group.

The law aims at preventing operators from blocking or slowing certain websites. However, the Telecoms Package is not thought to be a genuinely disciplinary step against all types of network management initiatives of European operators; thus, proponents of the open

[3] The heavily contested but finally re-adopted Amendment 138/46 in particular assures this.

[4] Answer to question E-005159/2011, http://www.europarl.europa.eu/sides/getAllAnswers.do?reference=E-2011-005159&language=EN, Brussels, July. 13, 2011.

internet keep urging for more effective measures for regulating ISPs. Although market reports of BEREC witnessed several incorrect incidences of network management in the past year, after the operators were given a warning, all the incorrect practices were brought to an end. After passing the new telecom law, the EU promised to grant a grace period to ISPs to prepare for changes in regulation, and asked governments to transpose new reforms into national legislation by June 2011.[5] As a conclusion of the changes, Commissioner Kroes said: "*The European telecoms framework provides the conditions for both network and service competition(…)We have to avoid regulation which might deter investment and an efficient use of the available resources(…)traffic management is essential, not only to optimise the provision of „best effort services" on the open Internet, but also to allow the development of special managed services, such as eLearning or eHealth applications, which are very valuable for the European society*".[6]

That is why, at present, the EU is in a wait-and-see position. It did not sanction ISPs for charging their customers additional fees for using VoIP services, but Neelie Kroes encouraged people to vote with their feet and leave mobile operators whose network management policy is discriminative or not transparent. Additionally, Kroes assumes that the telecommunication market in Europe has more room for competition than does on the other side of the Atlantic; therefore, the key solution is to make it possible for EU citizens to change their ISP from one to another swiftly, rather than to enforce stricter regulations that might reduce the competitiveness of the telecom sector and deter investment.

The United States of America

We can say the US is the "mother country" of the debate over network neutrality; a debate that started more than a decade ago. Despite the long-standing nature of this heavily disputed issue, the case of net neutrality has not been clearly decided on yet. The Federal

[5] To learn more: EU Telecoms Reform, Brussels, Nov. 20, 2009 http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/09/513&format=HTML&aged=0&language=EN&guiLanguage=fr Date of retrieval: Jan. 20, 2011

[6] Press conference at the European Commission and European Parliament Summit on "The Open Internet and Net Neutrality in Europe". Brussels, Nov. 11, 2010. http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/10/643 Date of retrieval: Jan. 20, 2011.

Communication Commission (FCC), the US media regulation authority, has not committed itself to absolute non-discrimination principles. However a gradual shift towards net neutrality is often mirrored by the legal actions of the agency.

One of the milestones in the battle between ISPs and ICPs was an FCC resolution that blamed Comcast for vastly delaying BitTorrent's data transmission on its network in August 2008 , and asked the cable carrier to cease slowing p2p file sharing.[7] The FCC order against Comcast was denied by the Federal Court in April 2010, which fundamentally questioned the agency's legal basis for regulating the ISPs' network management practices. In May 2010, new FCC Chairman Julius Genachowski declared the need to fill the emerging legislative vacuum with new rules. Therefore, the FCC passed certain further measures strongly disseminating the idea of the open internet on 21 December 2010.[8] Since then, tension and frustration in the bipolarized debate have not been smoothed away at all: net neutrality advocates condemned the FCC for capitulating to ISPs, while service providers, together with Republicans, found the regulation unacceptable.

This extremely heated discussion can be explained by noting that the issue of the open internet – in comparison with the situation in the EU– is less philosophical and involves more practical, daily problems with the use of internet capacity.

For example AT&T, which is the largest telecom company in the world by revenue, and the biggest ISP in the States, reported serious service quality breaks in New York and San Francisco caused by insufficient network capability. Its LTE spectrum can hardly have the capacity for coping with the tremendous traffic generated by the latest smart phone applications. In order to tackle such failures, the company announced its purchase of

[7] Opinion and order, FCC 08-183, http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-183A1.pdf, Date of retrieval: Jan. 17, 2011.

[8] For example: 1. Greater transparency. 2. No blocking of lawful content, applications, services or non-harmful devices. 3. No unreasonable discrimination of lawful traffic. Report and Order, FCC 10-201 http://www.fcc.gov/Daily_Releases/Daily_Business/2010/db1223/FCC-10-201A1.pdf Date of retrieval: Jan. 16, 2011.

Qualcomm's mobile TV license of 700 MHz (known as FLO TV) at the very end of 2010 that was dedicated to expanding the bandwidth of its overloaded 4G network.[9]

Proliferation of bandwidth-guzzling devices (iPads, eBooks, mobile data modems) makes growing challenges appear on the horizon. *"Networks overburdened by a data flow they were not built to handle(…)we must ensure that network congestion doesn't choke off a service that consumers clearly find so appealing or frustrate mobile broadband's ability to keep us competitive in the global broadband economy"* – said Phil Bellaria, Director of scenario planning for the federal government's Omnibus Broadband Initiative.[10]

Hungary

Hungary is a "blank spot" in the professional discussion on network neutrality. Alhough the issue is topical indeed, just a few experts are aware of the main directions and the real evolution of the diverging arguments, and know the background of the debate accurately. Professionals who get engrossed with the question of network management usually deal with the technological aspect of the problem; public policy approaches are rarely developed.

Even the national regulatory board (National Media and Info-communications Authority, NMHH)[11] speaks broadly about network neutrality. In its Strategic Plan for 2010-2015, the authority generally declares that regulation policy has to be adjusted to the strategic environment of the European Union, and that the adaption of EU priorities is fundamental in setting goals and making orders. The document also states that future activity and assignments of the authority have to be determined by ICT policy (e.g. spectrum policy, network neutrality, universal service obligations), and relevant public policy (e.g. digital economy, information society, e-commerce, e-governance) directives of the EU. In tandem

[9] Before that, AT&T already had to made other developments to cease frequent call drops by setting towers to an 850MHz spectrum or upgrading his HSPA+ (now 4G) protocols to faster 7.2Mbps.

[10] Paul McDougall: iPad Threatens Wireless Networks, Feds Warn. in. *InformationWeek.* Feb. 02, 2010. http://www.informationweek.com/news/infrastructure/management/showArticle.jhtml?articleID=222600823 Date of retrieval: Jan. 16, 2011.

[11] The document was published by the National Communications Authority (NHH) that became integrated into the new converged authority NMHH in Jan, 01, 2011.

with that, the authority underlines the importance of playing a proactive role in the forums and organisations that concern regulation, with special attention to the work of COCOM, RSC, RSPG and BEREC.[12]

The Minister of State for Info-communication, Zsolt Nyitrai, chairing the TTE Telecom Council during the Hungarian EU Presidency, called network neutrality a supported issue. On the other hand, the Digital Agenda of the new government published by the Ministry of National Development does not even mention the topic.[13]

As far as media publicity of network neutrality is concerned, the topic appears only in very few articles of sparsely-circulated periodicals and less-visited info-tech sections, blogs of news portals, and is basically missing from the programmes of broadcasters.

By writing about the issue with a massive emotional tenor, professional and citizen journalists tend to fight firmly against network management practices. There have been only four central themes the Hungarian press dealt with, but all of them remained isolated and did not create upheaval in the Hungarian audience. One of them was the news that Magyar Telekom (T-Mobile Hungary) had deployed Cisco's content service gateway solution (CSG2) by which the telecom company could personalise mobile applications and could probably filter content in its network. Rumours emerged that the "real" intention of T-Mobile was to breach the model of the open internet.

Other public criticism reached T-Mobile when it turned out that the operator had introduced an extra fee for using Skype in the UK network, or when it allowed Facebook users to join the social network gratis on its phones. Both cases were believed to be an unfair violation of network neutrality. Some articles were written in condemnation of the so-called Google-Verzion agreement that was heavily interpreted as a betrayal of the neutral net again; however those were not followed by a salient public out-cry, either.

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[12] Source: http://www.nmhh.hu/dokumentum.php?cid=22968 , the document was released in April, 2010 and made pubic only in Hungarian. Date of retrieval: Jan. 12, 2011.

[13] Digital Renewal Action Plan 2010-2014 Source: http://www.nfm.gov.hu/data/cms2089529/Digitalis_Megujulas_Cselekvesi_Terv.pdf, the document was released Dec. 23, 2010. and made public only in Hungarian. Date of retrieval: Jan. 12, 2011.

Economic analysis

In this section the effects of a potential net neutrality regulation on the users of wired broadband internet services in the V4 countries (The Czech Republic, Hungary, Poland, and Slovakia) are quantified. The approach and methodology are based on a study prepared by *Copenhagen Economics* that demonstrated the possible welfare effects of net neutrality regulation for Germany, France, and Sweden. This methodology is updated to reflect recent developments, most importantly the saturation of the fixed (wired) broadband internet market, and to mirror the growing importance of the mobile broadband technology.[14] In this section we also attempt to introduce the current trends in internet use that potentially lead to bottlenecks in the physical network infrastructure. After that, we continue with the likely negative impacts and unintended consequences of a rigorous network neutrality regulation.

Current trends in internet use

Worldwide internet penetration is growing rapidly but there are substantial differences in the geographic distribution of this significant growth. In 2009 more than 1.7 billion people had internet access and the user base increased by several hundred millions annually.[15] At the same time, per subscriber traffic and bandwidth use is also on the increase thanks to the rapid dispersion of video based applications that are especially bandwidth intensive. The high growth rate of subscriptions accompanied by more intensive use led to serious congestions in some regions of the world (especially in Asia and Latin America) where the extension of physical network capacities could not keep up with the user demands.[16]

Congestions generally arise due to the intraday fluctuations of usage. In Europe, the peak load of the network is reached between 16.30 and 21.00 when the number of online users

[14] Our methodology can be found in the Appendix.

[15] AT Kearney (2010): Internet Value Chain Economics, p. 3., Figure 1 http://www.atkearney.com/images/global/pdf/Internet-Value-Chain-Economics.pdf Date of retrieval: Jan. 11, 2011

[16] Sandvine (2010): Fall 2010 Global Internet Phenomena Report (prime time ratio for various regions) http://www.sandvine.com/downloads/documents/2010 Global Internet Phenomena Report.pdf Date of retrieval: Jan. 11, 2011

approximately doubles and the bandwidth use is more than five times higher for a few hours compared to the low usage periods.[17] To be able to cope with these extreme fluctuations every network operator establishes his network with substantial reserve capacities. Every ISP faces the same trade-off. On the one hand, the more he invests in the physical infrastructure, the better service quality he can offer, especially at peak times. A quality network that offers good user experience attracts more customers. On the other hand, excess investments put an upward pressure on access fees. To be able to offer competitive prices with the least possible loss of user experience, many ISPs circumvent this clear trade-off by using sophisticated network management applications. Although so far North American and European users rarely experienced significant deterioration in the quality of service through prime time periods, this general conclusion does not mean that local congestions do not arise on a regular basis.

This experience draws attention to the limitations of the current physical network infrastructure. No doubt that the extension of current network capacities is essential. The question is who should bear the costs of these investments and who could be charged for his more bandwidth-intensive usage patterns? These days, predominantly end users finance the infrastructural investments as, according to data from 2008, consumers generated around 80 percent of the revenue of internet service providers while business to business services were responsible for the remaining 20 percent.[18] But this business model is gradually changing as business to business (B2B) services these days already represent a much larger share of total internet revenues than the business to consumer (B2C) segment.

As the importance of B2B services grows, so does the throughput capacity they require. Therefore the new network operator and internet service provider business model would increasingly rely on the revenues coming from the B2B segment. This model is justified by the intensifying network use incurred by the B2B segment. Therefore, it seems to be logical that this segment should contribute to the investments into the extension of the existing

[17] Sandvine (2010): Fall 2010 Global Internet Phenomena Report, p. 32., Figure 26 http://www.sandvine.com/downloads/documents/2010 Global Internet Phenomena Report.pdf Date of retrieval: Jan. 11, 2011

[18] AT Kearney (2010): Internet Value Chain Economics, p. 10., Figure 5 http://www.atkearney.com/images/global/pdf/Internet-Value-Chain-Economics.pdf Date of retrieval: Jan. 11, 2011

physical infrastructure. An orthodox interpretation of network neutrality might prevent the introduction of this business model and consequently it may impose higher direct burdens on consumers. To be able to estimate these unintended consequences, in the following sections we attempt to estimate the welfare losses of consumers incurred by a potential too rigorous network neutrality regulation that would completely disable all network management practices.

How to use the economic toolbar?

The starting point for the analysis is the recognition of scarcity in the broadband internet infrastructure. This recognition gave birth to various network management techniques which enabled service providers to reduce their costs and keep their prices at a relatively low level while servicing the demand in a more efficient way. For this reason, network management also served the interest of the customers and enabled a further dynamic spread to broadband services. The analysis intends to show that a complete ban on network management techniques, as propounded by the radical interpretation of network neutrality, could seriously harm public interests and the evolution of the information society. However, the goal is not to argue against network neutrality but to point out some potential threats from enforcing it through regulation.

When we raise the question of how to distribute a scarce resource in the most efficient way, economic analysis is justified. To illustrate the scarcity of broadband capacity we first will briefly describe the underlying structure of the internet. We will present the rationale behind network management and show that network neutrality can harm the interests of many subscribers if the regulation is implemented in an improper way. Finally, we will attempt to quantify the potential welfare losses of an improper regulation based on the review of the existing economic literature.

Potential welfare effects of net neutrality regulation: a Central European example

We now turn to review the broadband situation in the Visegrad countries (The Czech Republic, Hungary, Poland, and Slovakia), abbreviated as V4. In 2010, 55 percent of all

households in the V4 region had access to broadband internet, that is, 88 percent of the households with internet access. The broadband penetration of the V4 countries is 17 percentage points lower than the average of Germany, France, and Sweden. Although total fixed line internet penetration is significantly lower in the V4 countries, fixed line broadband has approximately the same share in both groups. We use these country groups to benchmark our results with the findings of Copenhagen Economics and to show the differences between the old and the new EUMember States.

The OECD broadband internet penetration statistics let us analyze the recent developments of wired broadband markets.[19] The number of subscribers relative to total population (the penetration ratio) over time fits a typical logistic trend (see Figure 1). This model is used to describe saturating markets or product life cycles, where the trend (e.g. the number of products sold) takes off fast and, after a turning point, converges to an upper limit. By modelling the saturation we are able to estimate the theoretical maximum of wired broadband penetration and to predict the remaining market growth potential for every country.

Broadband internet access spread increasingly until the end of 2006. In Hungary and Poland the growth gradually slowed down from the beginning of 2007, whereas in the Czech Republic and Slovakia the same process began in the second half of 2007. Based on the currently experienced sluggish penetration growth (the last data is from 2010 Q2), we estimate the remaining penetration growth potential to be around 2 percentage points in each V4 country (see Table 1). In other words this means that the current subscriber number is expected to increase by a maximum 9 percent in each V4 country.

Saturation began somewhat later in the V4 countries (first in Hungary) compared to the three Western European states. Among the examined EU Member States, broadband

[19] OECD fixed (wired) broadband penetration statistics use a different method than Eurostat's Broadband use of Household statistics. While Eurostat uses a questionnaire and provides figures on the share of households with broadband access to the internet, OECD provides the ratio of broadband subscriptions to the total population. Households are counted for the number of subscriptions they have, so normally the OECD statistics should be 2,5-3 times lower. However, OECD statistics do not differentiate among households or other users of broadband internet. A Eurostat figure of 55% penetration should be compared to an OECD figure of 13,25% penetration, as average penetration in the V4 countries.

diffusion was fastest in Sweden and slowest in Germany. Our model shows that Germany has the highest level of possible broadband penetration (34,8%) and this country has the highest growth potential both in relative and absolute terms.

TABLE 1: ACTUAL AND POTENTIAL WIRED BROADBAND PENETRATION RATIOS IN SELECTED COUNTRIES

country	beginning of slowing down in diffusion	penetration (2010H1)	predicted level of saturation	further growth to saturation		predicted penetration by the end of 2012	remaining growth after the end of 2012, percent	average broadband price 2010H1, EUR
				percentage points	percent			
Poland	2006H2	11,9%	12,6%	0,7	5,8	12,48%	0,6	20,47
Slovak Republic	2007H1	12,0%	13,1%	1,1	8,9	13,04%	0,2	29,45
Czech Republic	2007H1	13,7%	15,0%	1,2	8,9	14,84%	0,8	30,72
Hungary	2006H2	18,7%	20,3%	1,7	8,9	20,06%	1,3	22,10
France	2005H2	31,4%	33,5%	2,1	6,6	33,06%	1,3	29,18
Sweden	2004H2	31,7%	33,6%	1,9	6,1	33,30%	0,9	29,22
Germany	2006H1	31,2%	34,8%	3,6	11,4	33,88%	2,6	33,11

Note: Slowing down of the diffusion refers to the inflection point of the estimated logistic trend, H1 and H2 refers to half-years. Source: OECD, calculations made by Századvég Gazdaságkutató

Modelling the penetration ratios of these countries allows us to predict the evolution of the wired broadband market, given recent market conditions (prices and quality of supply). After fitting a logistic trend on the broadband penetration ratios we can say that the V4 countries are likely to reach a 12-20 percent fixed line internet penetration rate by the end of 2012. According to the fitted curves, we can assume that by the end of 2012 the wired broadband market will be nearly fully saturated with very low further growth potential (see the last but one column in Table 1).

However, wireless broadband access is also catching up to wiredbroadband technologies (DSL, Cable, Fibre, BPL, etc.). Wireless technologies include satellite, terrestrial fixed wireless and terrestrial mobile wireless broadband services. Within the V4 region, wireless

broadband penetration[20] is high in the Czech Republic, Slovakia, and Poland andlower in Hungary (see Table 2). While mobile broadband penetration is significant in Sweden and Germany, it is quite low in France.

TABLE 2: WIRED AND WIRELESS BROADBAND PENETRATION IN SELECTED COUNTRIES

Country	total wired	wireless*	total broadband*	wireless share in total broadband
Sweden	31,8	23,4	55,2	42,4%
France	31,4	0,0	31,4	0,0%
Germany	31,3	8,4	39,6	21,1%
Hungary	18,7	5,2	23,8	21,7%
Czech Republic	13,7	10,1	23,9	42,5%
Poland	13,1	8,3	21,4	38,9%
Slovakia	12,0	8,4	20,5	41,3%

Note: wireless penetration is computed excluding the penetration ratio of standard data subscriptions. The OECD figures are not fully comparable due to different data sources. Source: OECD, calculations made by Századvég Gazdaságkutató

Although mobile (wireless) broadband penetration is significant across the OECD member states, mobile broadband networks are still in their infancy in some countries. Mobile broadband is not yet a perfect substitute for wired broadband internet due to data caps and incomplete geographical coverage, but it is in a very dynamic build-up phase. Depending on the developments of the mobile broadband market, mobile broadband might become a relevant alternative to wired broadband one day. However, since historical penetration and price data is not available for the mobile broadband markets, in our analysis we can only quantify the welfare impact of net neutrality on the wired broadband markets.

[20] Wireless (mobile) broadband penetration calculated based on OECD statistics on the OECD Broadband Portal (http://www.oecd.org/document/54/0,3746,en_2649_33703_38690102_1_1_1_1,00.html). Figures exclude standard mobile data subscription penetration. Date of retrieval: Jan. 11, 2011

Results of the economic analysis

The effects of net neutrality regulation on consumers of wired broadband internet are quantified according to which a 25 percent price increase would be likely in the case of a legislated network neutrality regulation. This expected price increase is due to the additional investment needed to upgrade the physical infrastructure if network management tools and price mechanisms are disabled by the network neutrality regulation.

The own-price elasticity of demand together with the estimated price increase result in 25 percent lower potential penetration rates in every country. Consequently, following the implementation of the net neutrality regulation, penetration rates would fall below current levels. Regarding the V4 countries, the result would be a 10,65 percent penetration ratio as opposed to a 14,20 percent in the baseline, saturating market, scenario and the 13,25 percent observed in mid-2010. By 2013 wired broadband penetration would be 20,3% in Hungary in the baseline scenario, but higher prices would reduce this to 15,2%. In the case of the Czech Republic 11,2%, in Poland 9,4%, in Slovakia 9,8% would be the penetration ratio as opposed to 15,0%, 13,1%, and 12,6%, respectively.

TABLE 3: MARKET AND WELFARE EFFECTS OF NETWORK NEUTRALITY REGULATION IN SELECTED COUNTRIES

	penetration		price (€/month)		market size	consumers' loss
	baseline	net neutrality	baseline	net neutrality	(mn € / year)	(mn € / year)
Poland	12,6%	9,4%	20,5	25,6	1 176	262
Slovakia	13,1%	9,8%	29,5	36,8	250	56
Czech Republic	15,0%	11,2%	30,7	38,4	581	130
Hungary	20,3%	15,2%	22,1	27,6	540	121
France	33,5%	25,1%	29,2	36,5	7 565	1 688
Sweden	33,6%	25,2%	29,2	36,5	1 101	246
Germany	34,8%	26,1%	33,1	41,4	11 311	2 524

Source: OECD, calculations made by Századvég Gazdaságkutató

Consumers' utility loss expressed in monetary terms would be a total of circa 570 million EUR per year for the V4 countries. As loss is proportionate to market size, the biggest annual loss would fall on Poland (260 million EUR), followed by the Czech Republic (130 million EUR), Hungary (120 million EUR), and Slovakia (60 million EUR). The three western countries with an eightfold market size compared to the V4 region incur an eightfold loss.

Conclusions

By tracing the whole discussion on network neutrality we can conclude that nowadays opponents and advocates of the open internet are both inclined to exploit affective argumentation substituting the inventory of hard facts and basic rationality. We believe that sheer emotional or political approach to the problem is dead-end of understanding the real background of network neutrality. In this final part of our study we summarise all the reasons end evidence that assist to recognise the following:the application of tiered services and different network management practices can be supported with certain restrictions, whereas more regulation on network neutrality could contribute to higher service prices, welfare loss and a decreasing internet penetration ratio.

Reasons

- Much as climate change is a universal problem to be solved in the next 10 years, so is the lack of internet capacity. At present, the general need for broadband capacity is growing faster than the data transmission capabilities of the internet. Without major technological advancements to support the growth of supply, other mechanisms are needed to maintain current quality of internet service.
- Internet services cannot always handle congestion caused by the multiplication of applications, new media formats, the quickly rising number of subscribers, and the decreasing price of subscriptions. Internet usage evolves new customer profiles that result in increased demand for data transmission and cause more frequent network congestions. Based on the calculations by Clarke (2009)[21], a modest video user in the future will be likely to multiply bandwidth demand by more than two factors (122x) compared to a current typical user, while a future typical user would multiply the

[21]Clarke, Richard N. (2009): Costs of Neutral/Unmanaged IP Networks. Review of Network Economics, Vol. 8, No. 1, March 2009. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=903433 Date of retrieval: Jan. 11, 2011

capacity demand almost 50 times (47x) compared to a current power user.[22] Regarding Cisco Visual Networking Index forecast: "*The sum of all forms of video (TV, video on demand, Internet, and P2P) will continue to exceed 91 percent of global consumer traffic by 2014. Internet video alone will account for 57 percent of all consumer Internet traffic in 2014. Advanced Internet video (3D and HD) will increase 23-fold between 2009 and 2014. By 2014, 3D and HD Internet video will comprise 46 percent of consumer Internet video traffic*."[23]

- Future internet usage patterns can quickly exhaust current excess broadband capacities so network management might play a key role in maintaining a satisfactory service quality without imposing relatively high financial burdens on all users. Excess bandwidth demand could be reduced by increased supply (new transmission capacity investments) or by reduced demand through the pricing of transmission capacity (network management). The combination of these two methods is likely to yield the optimal outcome both for the users and the operators.

- Service quality problems caused by low capacity do not exclusively exist in the US but appear in the EU as well. In 2010, numerous users' inconveniences, frequent dropped calls, and lost data connections were reported by users, for example on the O2 networks in the UK.

- While mobile internet suffers from more congestion problems than wired networks, estimations show that mobile internet usage is ramping up faster than fixed net usage according to the majority of relevant studies; for instance, Morgan Stanley's research forecasted a turning point in the global distribution of the different types of users after 2013.[24]

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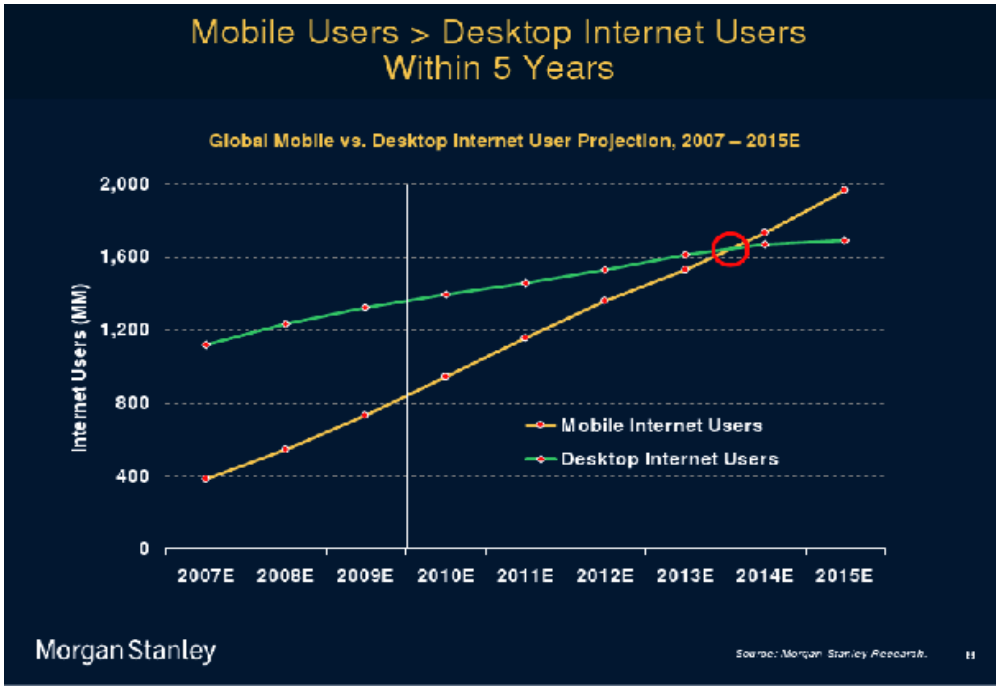
[22] Clarke estimates that a current typical user uses a 45 Kbps bandwidth to download in the busy-hour and a current power user uses 450 Kbps. In turn, a future modest video user would use 5,5 Mbps and a future typical video user would use 21,5 Mbps. Clarke (2009), p. 18, Table 1.

[23] Cisco VNI, Forecast and Methodology, 2009-2017. (June 2, 2010) Source: http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360.pdfl Date of retrieval: Jan. 11, 2011

[24] Source: Gigaom.com, http://gigaom.com/2010/04/12/mary-meeker-mobile-internet-will-soon-overtake-fixed-internet/, April. 12, 2010. Date of retrieval: Jan. 11, 2011.



- No doubt, the internet is one of the most ground-breaking inventions of humanity, indispensable for modern life and can influence worldwide economic, social, cultural, and political performance and diversity. Once we admit this, we must recognise that leaving the problem of decreasing internet capacity to be fought out between ISPs and ICPs is a serious mistake.

- The reduction of internet subscription prices is a global market trend that could be broken by growing bandwidth requirements. The next generation of internet and web applications cannot be imagined without expensive investments into network infrastructure for which somebody will have to pay the price. Considering ISPs to be exclusively responsible for financing network improvements in reference to the notion of the open internet is a false paradigm. Economic researches find that, to provide the same level of quality to new generation applications and traditional services, ISPs would need to invest 60% more into infrastructure capacity than if differentiation in quality of service is allowed.[25]

[25] See for instance Houle D. Joseph et als. (2007) The Evolving Internet – Traffic, Engineering, and Roles. http://www.cse.unr.edu/~yuksem/my-papers/2007-tprc.pdf Date of retrieval: Jan. 11, 2011.

- The internet is often said to be a public source of data or a non-excludable good that no one should be allowed to monopolise. However, the distribution of natural resources or public goods usually happens in a prioritised or managed way. When using analogies, supporters of the open net often employ the “highway” metaphor. They say somebody paying the toll is dedicated to choose between either the fast or the slow lane freely. However, in reality, heavy vehicles usually have to pay more than cars, because they cause more damage in the highway maintained by service providers. Moreover they are frequently regulated to use the slow lane to avoid traffic congestion, and forced to pay higher taxes if their engines pollute the air (which is also a public good by its nature) . In addition, we pay more to public service providers for maintenance or development of the infrastructure, if we consume more from natural resources like electricity, water, or gas.
- Network management does not necessarily mean a restriction of the frequently quoted “internet democracy”, as all users could access and upload any kind of content. The difference would manifest in the quality of access but not in the possibility of access.
- Prioritisation of data and traffic management already exists and seems to be inevitable for the efficient functioning of the internet. In this sense, the absolute non-discriminative feature of the net that many strive for cannot be secured without significant investments. Nowadays, ISPs give priority to voice calls or video streaming over other content formats so as to make these former types of services enjoyable for users.
- The internet works in the so-called *best effort* model, meaning that the present structure of the network does not have the capacity for transmitting data in a guaranteed quality of service or a given priority. In the best effort system, the bit rate might be varied while transmission time can be delayed depending on the level of the traffic load. Existing packet shaping techniques even permit retrieval interruption, if network optimisation makes it necessary. In this respect, the internet is already not neutral or equal to any content or user.
- If there was legislation on network neutrality, it might result in inefficient network capacity allocation and investment decisions. Some data packages would get high priority even though it is not necessary, and some data packages would get low priority.

Some high profile services would not be marketable at all, given their neutral priority status (e.g. TV channels), or additional infrastructure investment would be needed in order to maintain current service quality levels.

- Without violating individual freedoms and censoring the web[26], the prioritisation of potentially harmful content should be considered. For instance, it is common knowledge that approximately 30% of web downloads include sexual or pornographic content. This type of content is already prioritised by many authorities via relevant media legislation enacted in protection of children. For example, media laws in many democratic countries make programmes including sexual content accessible on TV only for a certain period of the day or impose a complete ban on it. This is, indeed, prioritisation, however in the world of offline media. If possibly harmful web content was prioritised (but not stopped) internet traffic congestion would be at least partially relieved.

- According to economic calculations, if network neutrality regulation was introduced
    - a serious additional investment would be needed to maintain the recent level of supply quality, and this would put a significant upward pressure on prices;
    - a 25 percent price increase would be needed, that would in turn reduce broadband internet penetration by the same ratio;
    - the drop in broadband usage would likely cause a serious consumer welfare loss. Higher prices together with decreasing penetration would generate an annual 570 million euro welfare loss in the V4 region;
    - As loss is proportionate to market size, the biggest yearly loss would fall on Poland (260 million euros), followed by the Czech Republic (130 million EUR), Hungary (120 million EUR), and Slovakia (60 million EUR).

[26] Suggesting prioritisation of pornographic content is not a new idea. France's National Assembly put a law into effort allowing the government to stop porn sites without judicial control in protection of children in December 2010. Communication minister Ed Valzey went further when introduced a plan on filtering all pornographic sites in the UK in December 2010 as well. The issue is also under legal and professional consultation in the US.

- Effects for three western countries (France, Germany, and Sweden) were also calculated that would incur a total loss of 4 460 million EUR per year, eightfold to that of the V4 countries,. This result is commensurate to the findings of Copenhagen Economics, especially in the case of France and Sweden.

❖ Regulation on network neutrality should be considered with great caution. The dynamic spread of wireless broadband infrastructure and related innovations would also be slowed down by improper legislation, since it would block potential revenue from accumulating in the market of service providers. If neutrality regulation imposed a total ban on network management and QoS charging, we would possibly find residential end-users paying the price of entailing negative consequences.

Restrictions

❖ ISPs should be given less or no scope of authority to manage their networks if governments, international financial funds, or political organisations were to take over the role of infrastructural development. President Barack Obama, for instance, called for an investment of $7.2 billion in fixed and wireless network expansion via the American Recovery and Reinvestment Act of 2009.

❖ If ISPs are allowed to impose an extra charge on ICPs generating huge traffic on networks, the revenue must not be spent on anything other than upgrading broadband capacity. Network management has to serve global capacity building, not the profit maximisation of private corporations.

❖ Rules of prioritising and protocols of network management should be consistent and transparent for national and international regulation authorities.

❖ Network management practices should not result in the degradation of service quality or customers' satisfaction.

❖ The ISPs' private right for network management should not overwrite national and public interests. A new, better managed internet should not be advocated if the new model damages basic values or principals of the EU, settled in the fundamental treaties of the Community. The integration and reunification of Europe, together with solidarity,

internal cohesion, and equality, cannot be infringed by business requests or technological necessities. Network management cannot be supported if it contributes to the defragmentation of Europe and to the widening of the economic and social gap between the central and western part of the continent.

Appendix

Methodology

Following the methodology set out in the study of Copenhagen Economics, the welfare loss incurred by a radical net neutrality regulation is estimated. This welfare loss would result in higher end-user prices, decreased consumer surplus, and decreased wired broadband penetration rates. This price increase is compared to the baseline scenario where network management enables the most efficient use of the current infrastructure possible and makes the establishment of significant new capacity unnecessary. Potential price cuts are not accounted for due to more intensive competition and/or technological progress; calculation only intends to show the potential magnitude of the welfare loss related to a strict net neutrality regulation based on our current knowledge.

Imposing net neutrality in a radical form would totally ban any kind of advanced network management techniques and price differentiation based on bandwidth use. For an estimate of the possible price increase due to net neutrality, the precursor of Clarke's 2009 study was used. Clarke, in 2006, estimated a monthly $46,71 subscription fee necessary to cover additional investments, using US data. Litan - Singer (2007) concludes that this new price would mean an approximately 34% increase compared to the average $35 monthly subscription fee prevailing at that time.[27] However, we use the updated Clarke (2009) study that implies some 25% price increase on 2007 prices.[28]

Such a price increase would result in lower penetration rates and a continuous welfare loss for the consumers of broadband internet services. The demand for broadband access was modelled in order to calculate the customers' reaction to the price increase and to assess the potential welfare effects of net neutrality. The logic of the analysis can be seen in Figure 3 of the Appendix. It was assumed that the expected network neutrality regulation would come into force from 2013 and, by this time, the fixed line broadband market will have

[27] Litan, Robert and Singer, Hal (2007): The Unintended Consequences of Net Neutrality Regulation, Journal of Telecommunications and High Technology Law (2007)

[28] Clarke (2009) calculates a monthly fee of $49,75 (Table 2.) that can be compared to an average $40 monthly broadband subscription fee. The latter data was received from the author.

become saturated. Consequently, in the following equations Q_0 denotes the hypothetical maximum penetration ratio and number of subscriptions (see the calculated values for each country in Table 1). Additionally, p_0 denotes the last observed price (it is assumed that this price will remain constant until 2013, see Table 1) and p_1 stands for the expected price after the introduction of network neutrality.

We apply the same own-price elasticity of demand for broadband internet *that Copenhagen Economics* used in its study. *Copenhagen Economics* refers to Litan-Singer (2007), who estimated the own-price elasticity to be -1. This is a conservative estimate according to Litan-Singer, since the econometric literature normally predicts higher price elasticity figures for broadband and telecommunication services.[29] An elasticity of -1 would mean that the quantity demanded (*Q*, number of subscriptions) can be derived from the following demand function, where p means the monthly price of the service:

$$Q = D(p) = \frac{Ap}{}.$$

As the latest observed quantity (Q_0) and price (p_0) point also satisfies the demand equation we can derive the value of the parameter *A* as follows:[30]

$$A = Q_0 \times p_0.$$

Since the parameter *A* is independent of *Q* or *p*, the price increase results in a same percentage point decrease in the quantity demanded. Thus, *Q1* derives:

$$Q_1 = Q_0 \times \left(\frac{p_0}{p_1}\right).$$

Also, the change in consumer surplus (*ΔCS*), i.e. the lost consumer utility due to a price increase expressed in monetary terms can be calculated as follows:

$$\Delta CS = \int_{p_0}^{p_1} D(p)\,dp = \int_{p_0}^{p_1} \frac{A}{p}\,dp = \mathbf{A} \times \ln\left(\frac{p_1}{p_0}\right).$$

We calculate the backdrop in internet penetration (Q_1) and the change in consumer surplus (*ΔCS*) in the same manner for the following seven countries: the Czech Republic, Hungary,

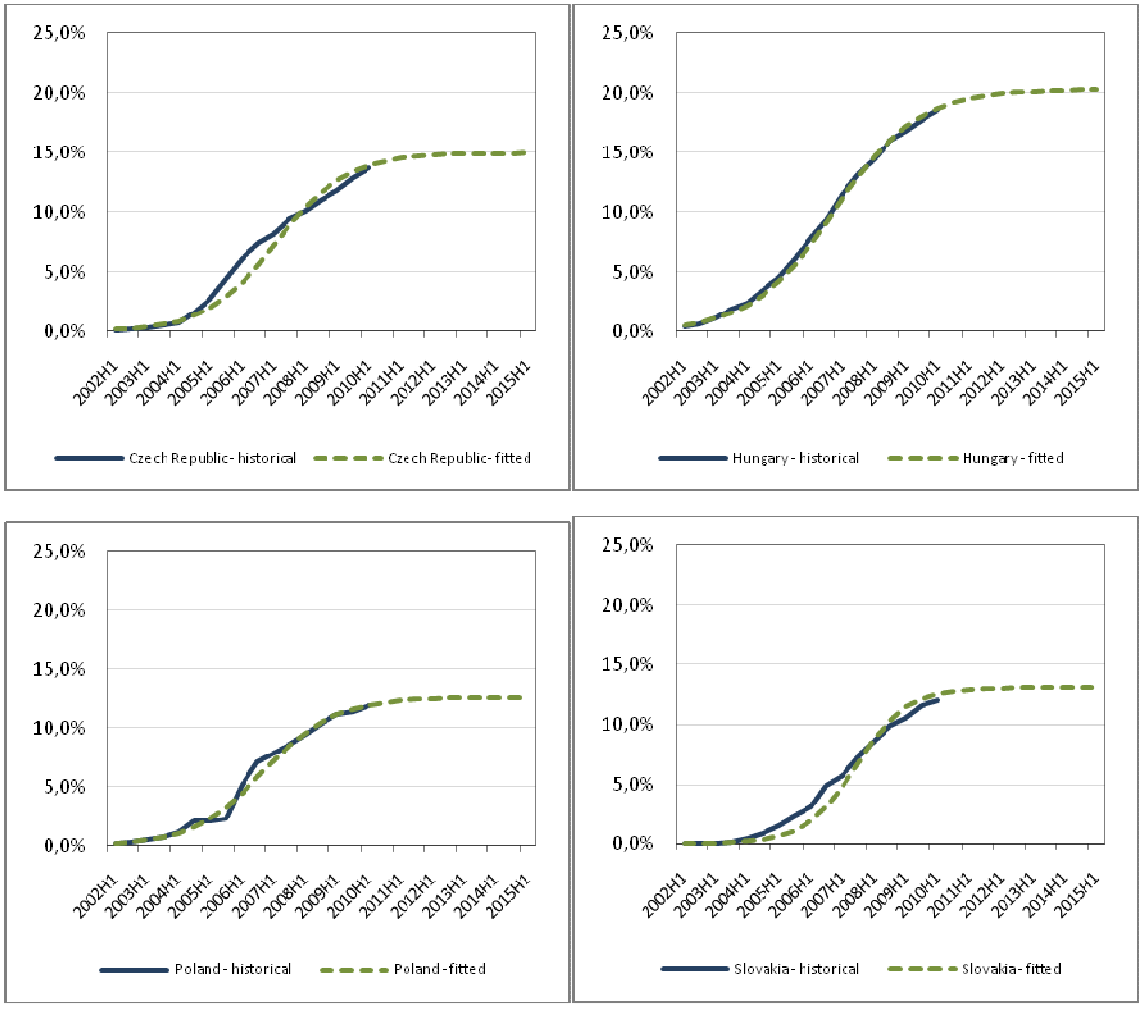
[29] Litan-Singer refers to four empirical studies that estimate own-price elasticities in the range of -1,2 and -3,1.

[30] To illustrate the market sizes in the Visegrad countries, figure 4 in the Appendix shows modelled demand functions.

Poland, Slovakia, France, Germany, and Sweden. Only the initial quantity (Q_0, hypothetical maximum penetration) and price (p_0) is country specific, the price increase (p_1/p_0-1) is common for the analysed countries (25%), as we assumed the -1 own-price elasticity to be universal for this country group.

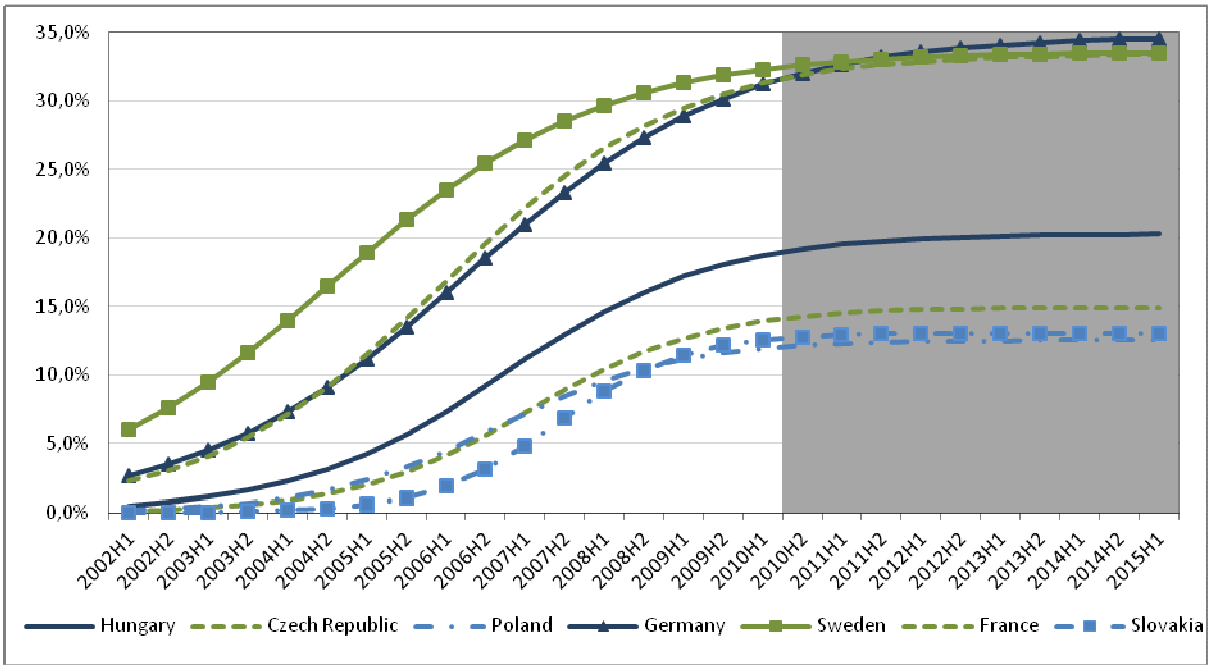
Graphs and diagrams

FIGURE 1: SEMI-ANNUAL HISTORICAL AND FITTED PENETRATION RATIOS IN THE VISEGRAD COUNTRIES



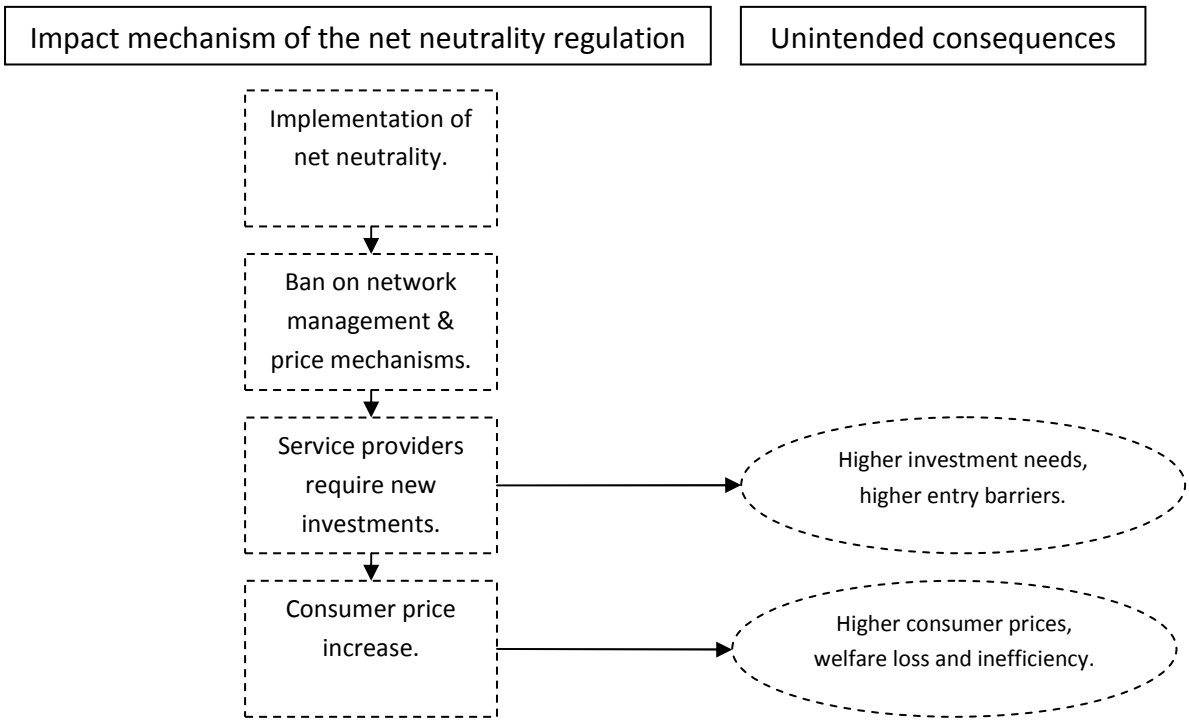
Source of figures for calculations: OECD

FIGURE 2: WIRED BROADBAND PENETRATION RATES IN SELECTED COUNTRIES. FITTED LOGISTIC TRENDS. THE SHADED AREA SHOWS PROJECTIONS FOR EACH COUNTRY.



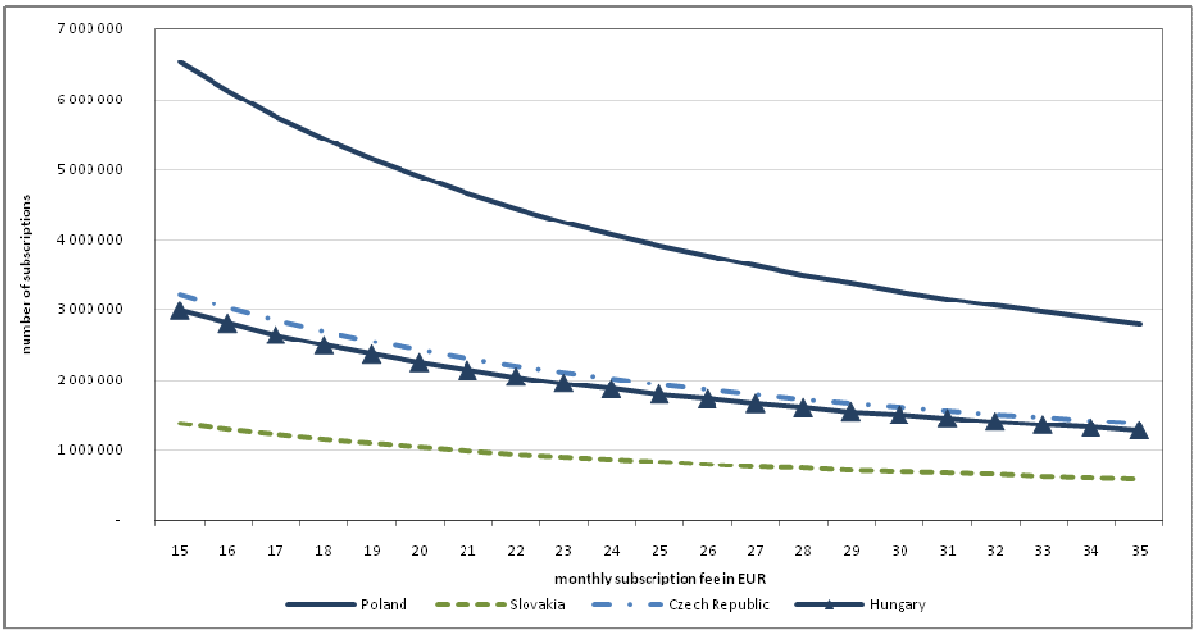
Source of figures for calculations: OECD

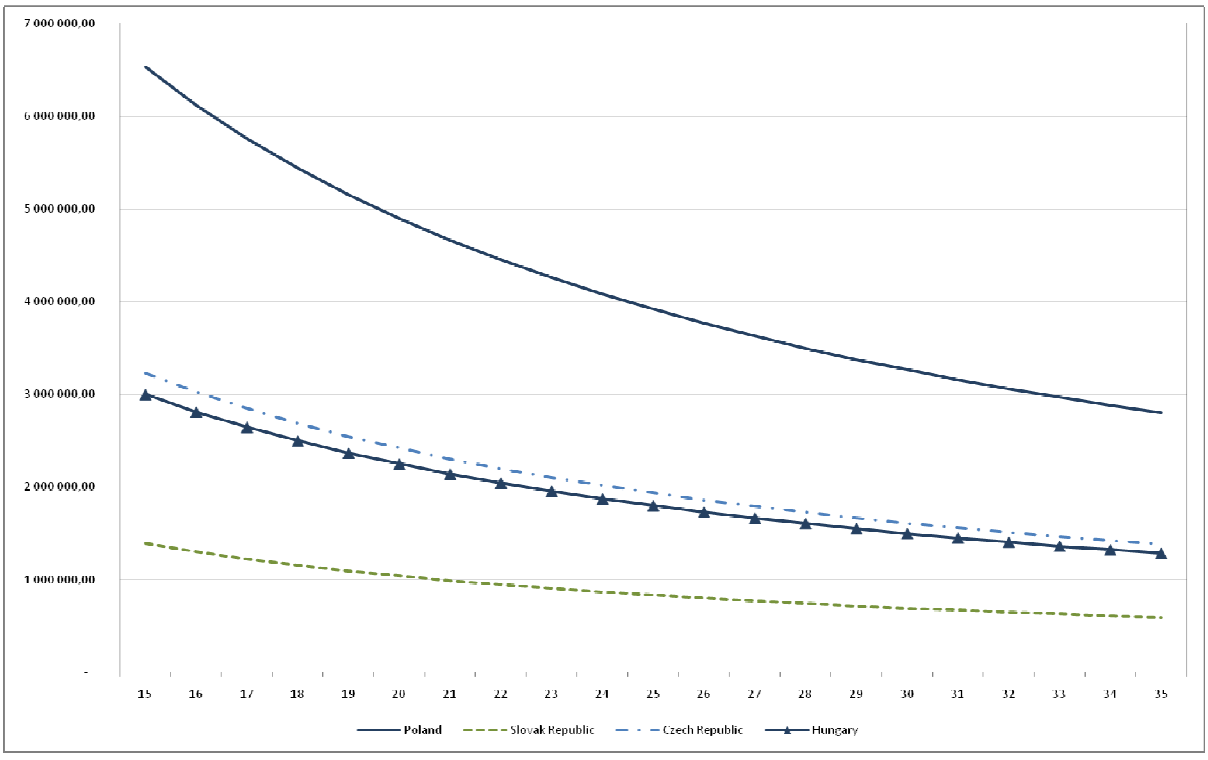
FIGURE 3: IMPACT MECHANISMS AND UNINTENDED CONSEQUENCES OF THE NET NEUTRALITY REGULATION



Note: Századvég Gazdaságkutató based on Copenhagen Economics

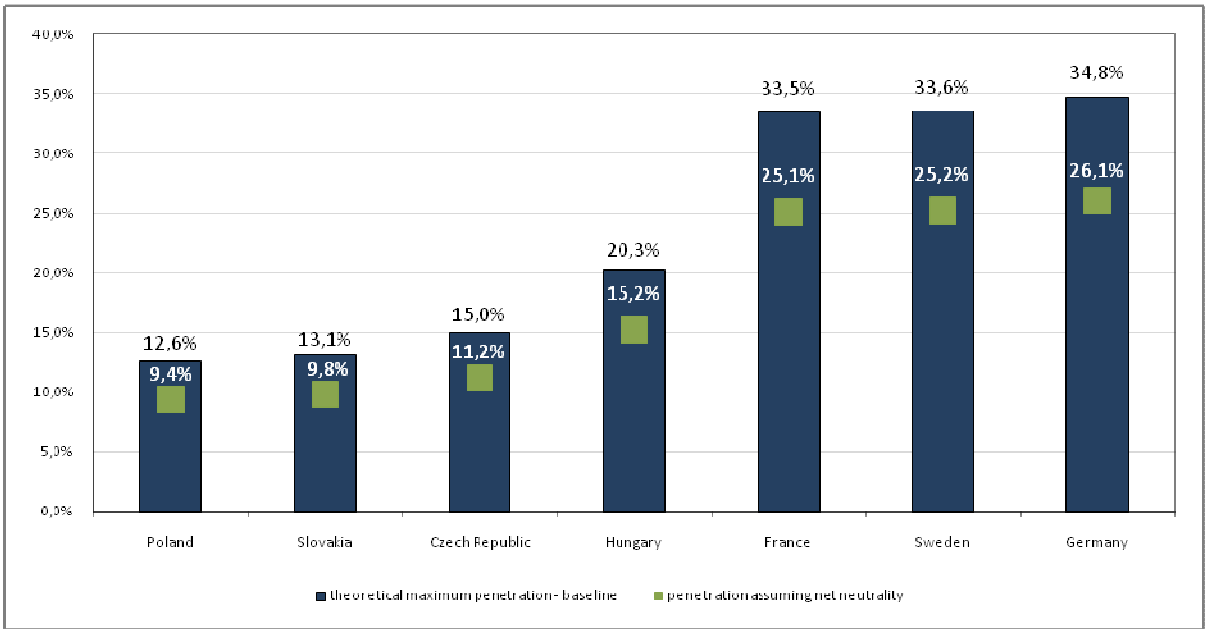
FIGURE 4: ESTIMATED DEMAND CURVE FOR WIRED BROADBAND INTERNET





Source: based on OECD data, modelling made by Századvég Gazdaságkutató

FIGURE 5: NETWORK NEUTRALITY REGULATION'S EFFECT ON WIRED BROADBAND PENETRATION RATIOS



Source of figures for calculations: OECD