Jena Economic Research Papers

2008 – 080

THE ECONOMICS OF NET NEUTRALITY REVISITED

by

Gernot Pehnelt

www.jenecon.de

ISSN 1864-7057

The Jena Economic Research Papers is a joint publication of the Friedrich Schiller University and the Max Planck Institute of Economics, Jena, Germany. For editorial correspondence please contact markus.pasche@uni-jena.de.

Impressum:

Friedrich Schiller University Jena
Carl-Zeiss-Str. 3
D-07743 Jena
www.uni-jena.de

Max Planck Institute of Economics
Kahlaische Str. 10
D-07745 Jena
www.econ.mpg.de

THE ECONOMICS OF NET NEUTRALITY REVISITED*

BY GERNOT PEHNELT

Director of GlobEcon, Research Associate at ECIPE and
Research Partner at the Chair of Economic Policy, Friedrich-Schiller-University Jena
Carl-Zeiss-Str. 3, 07743 Jena, Germany
email: gp@globecon.org

October, 27 2008

Abstract

In this paper, we analyze the problem of congestion and quality loss of data transmission through the Internet from an economic perspective. We show that due to the congestion problem, quality sensitive services are likely to be crowded out by high volume but less quality sensitive applications in a strict "neutral" system. This crowding out reduces the availability of services and the development and diffusion of innovative and high value services. Not least, the congestion problem causes welfare loss. As we discuss in this paper, the differentiation of data packets according to their quality sensitivity could remedy the congestion problem. Appropriate business models that incorporate quality of service concepts could be very efficient in preventing the crowding out of high value quality sensitive services without affecting other applications and would be very convenient for Internet users at the same time. We show that any ex ante regulation in the sense of strict Net neutrality could seriously harm the development of innovative business models and discourage innovation and investment.

Key words: Net neutrality, Internet, bandwidth, quality sensitivity, crowding-out

JEL classification: O31, O32, O33, O38, L51

* I gratefully acknowledge helpful comments by Andreas Freytag and George Ou.

Introduction

In recent years, the world has seen a tremendous growth in content and applications provided via internet. Google and its YouTube subsidiary are just two examples, though probably two of the most impressive success stories. More efficient search engines, sophisticated communication technologies and many other applications have created huge benefits for millions of Internet users worldwide and – not least – enhanced productivity in many sectors and contributed to economic growth.

Broadband Internet providers are constantly working on better and faster networks. But rising traffic from video-driven Web services like YouTube and iPlayer, online gaming, P2P file sharing and social networks, continues to put a strain on even these improved networks. Live video streaming and other multimedia content offerings such as YouTube cause a massive increase in bandwidth consumption. According to comScore, nearly 26 million German Internet users viewed more than 3 billion videos online in May 2008 and 25 million French Internet users (81 percent of the total French Internet audience) viewed 2.3 billion videos online in that month, with Google sites, driven especially by the popularity of YouTube[1], being the most popular source in both countries. YouTube alone accounts for more than 10 percent of total global online traffic.

Despite a more efficient usage of the existing bandwidth and huge investments in the Net infrastructure by broadband providers and other companies, the increase in data volume is already causing congestions and threatens the quality of data transmission and therefore the development and diffusion of new, quality sensitive services.

There is no doubt that the world needs substantial further investments in the Network infrastructure. Furthermore, appropriate business models are necessary to finance these investments and to overcome the crowding out of high value, quality sensitive applications. Since different content providers and consumers have different needs and preferences regarding the quality of service, there is no “one quality fits all”.

This paper analyzes how a meaningful differentiation could remedy the problem of congestion and increase overall supply, demand and welfare.

---

[1] French users watched 629 million videos on YouTube and over 1 billion videos have been watched on YouTube by German users in May 2008 (see comScore 2008a and comScore 2008b). The impact on the network is enormous. A two-minute standard definition (480 progressive scan) video download for QuickTime requires about 50 megabytes. Higher resolution versions require roughly 80 megabytes (720p) and 130 megabytes (1080p). A two-hour video then will require up to 8-gigabytes of data, depending on the resolution. Networks built for email and web browsing will not scale sufficiently to accommodate this level of traffic burden.

Neutrality and the dynamics of markets

The system of innovation in the Internet community as in any other emerging and growing market depends both technically and economically on differences: Consumers have different preferences and different willingness and abilities to pay, suppliers possess different comparative advantages, and, as discussed below, services and data packets have different characteristics. The static, zero-sum model of neutrality fails to capture the essential living dynamics of the Internet (Crowcroft 2007). Differentiation can take into account different preferences, willingness to pay, comparative advantages, business focus and so forth. Differentiation better matches with different consumer preferences and – not least – is able to enhance economic efficiency. In fact, there have always been differential treatment, certain restrictions and – very much indeed – different quality and prices in almost every sector; for good reasons. These differences are one of the most important constitutive principles of any market driven economy. This holds also for the Internet which has never been strictly neutral. For instance, downstream connections are usually prioritized in comparison to upload connections by reserving more bandwidth for downloads than for uploads. As a consequence, every user is experiencing that uploading data takes significantly longer than to download the same amount of content. This modus operandi is not neutral at all and "discriminates" upload connections. However, hardly anybody is complaining about this "discriminatory" practice. It is quite obvious that prioritizing downloads totally makes sense as long as most users rather download than upload content. Without this non-neutral treatment of up- and downloads, the Internet connection of the ordinary user would be considerably slower and less convenient.

There might be other reasons why certain restrictions can improve the quality and security of web-based services. Wouldn't it be beneficial to the vast majority of users if specific measures prevented spamming and avoided flooding the net with viruses, phishing software and worms? Wouldn't it be comprehensible if broadband service providers (BSPs) tried to restrict the transmission of criminal and immoral content through their pipes or control and combat hacking activities? All of these measures would certainly enhance the utility of internet users worldwide but are most obviously inconsistent with strict neutrality. What about "external sharing" of one's high speed Internet access by establishing huge open Wi-Fi connections to an access point? On the one hand, it provides many users with inexpensive – if not free – access to the Internet and creates positive network effects.[2] On the other hand, as discussed

[2] This positive network effect is often referred to as bandwagon effect. It stems from a positive externality in networks where a consumer's demand for the good or service increases with the number of other consumers who have already purchased this good or service. A telephone, for instance, does not make much sense if there is just one device in the whole country. The larger the number of telephone users is, the higher is the utility for everybody who has a telephone and, therefore, the higher is the individual and aggregated demand. However, the given case is no different from a customer reselling food from an all-you-can-eat buffet which

above, bandwidth is – economically speaking – no public good since there is rivalry in consumption. "Sharing" access points with non-subscribers may lead to an overuse of the existing bandwidth and slow down the connection for everybody. Furthermore, such strategies affect the revenues of BSPs and therefore their potential to further grow and invest.

One possibility to overcome this dilemma would be an innovative pricing system that charges higher fees to those who establish huge Wi-Fi networks and, therefore, use more bandwidth than the ordinary customer. The respective revenues could be used by BSPs to further enhance the infrastructure and increase the existing bandwidth. As a consequence, accessibility *and* economic sustainability could go hand in hand. Wouldn't this be just fair to charge semi-professional providers of Wi-Fi connections more than the ordinary user? Any Net neutrality regulation bears the risk to prohibit the establishment of innovative business and pricing models that are able to combine economic sustainability with an everywhere access via Wi-Fi.

These considerations show that differentiation to a certain degree has always been the case in the Internet age and that "discriminatory" practices totally make sense and are able to enhance overall welfare. However, the most important arguments against exaggerated fears that broadband providers could discriminate ordinary users are 1) the fact that BSPs simply do not have incentives to do so, 2) their possibilities to do so are rather limited and 3) there is decent legislation and effective enforcement to prevent the abuse of market power.

First, content providers and end users are the customers of BSPs. Who does really believe that BSPs would scare away customers by disproportionate discrimination or other consumer unfriendly measures? Any business practice that does not meet consumer preferences and damnifies users will not succeed. BSPs simply cannot afford bad reputation and the loss of market shares due to inappropriate market behaviour. New business models have to be designed in a way that provides different user groups and content providers with tailor made offerings that create additional consumer surplus.

Second, users are by far more knowledgeable than some so called consumer protection agencies realize. If a BSP does not provide a bundle of services and prices that are in line with the specific preferences of a user, this user will simply find other ways to get connected to the Internet, let it be in choosing another BSP or an alternative to traditional broadband internet services.

Third, if a BSP had significant market power in a particular region and tried to abuse this market power and to exploit consumers, the European Union has a very effective antitrust authority. As recent examples like Microsoft, Bayer, sodium chlorate paper bleach producers and electricity companies show, the Directorate General for Competition under Neelie Kroes

---

would result in zero prices for any additional meal. Zero prices yield zero revenues and zero revenues inevitably lead to insolvency.

is very consistent and effective in guaranteeing and enforcing fair competition, and in preventing and punishing breaches.

Overall, offering different products, services and qualities with different pricing is one of the major drivers of any market economy and for the benefit of consumers. It contributes to the creation of new services and economic growth especially in dynamic sectors such as ICT. The fear that differentiation of broadband services could lead to an "unfair" treatment of consumer is by far exaggerated and ridiculous.[3] The opposite is true: More sophisticated business models and differential pricing would create new services and increase consumer surplus and overall welfare. To abolish such business models would be to the disadvantage of suppliers, content providers and users.

Why prioritizing makes sense

Increasing data volume and the peak load problem

The tremendous increase in data traffic and the typical peak load problem of data transfer becomes apparent when we look at the data volume that is handled by the DE-CIX, the largest German web-knot[4]. The following charts show the data traffic measured at the DE-CIX over the last 3 years (Figure 1) and on two typical days in September 2008 (Figure 2). As can be seen in Figure 1, the average data traffic has quintupled in the last 3 years.

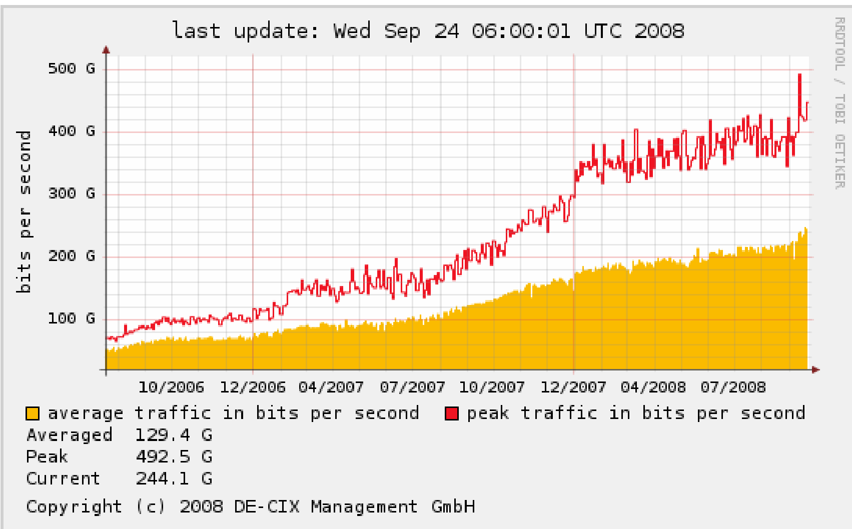

Figure □: Data traffic at the DE-CIX – 200□-2008

---

[3] Again, most applications such as email, ordinary webbrowsing and even P2P would be rather unaffected by quality of service models.

[4] Most recently, the DE-CIX got new network components and is able to guide through 1,4 Terabits per second which makes it one of the largest web-knots in the world.

Another thing that becomes apparent is the typical peak load structure (Figure 2). While data traffic is comparably low between 2:00 and 7:00, the data volume reaches a peak of up to 500 gigabits per second in the evening. Networks must be built to handle these peaks in data traffic sufficiently. However, even with huge redundancies full quality for all data packets might not be guaranteed during the peak load times. Here, the differences of services come into play.

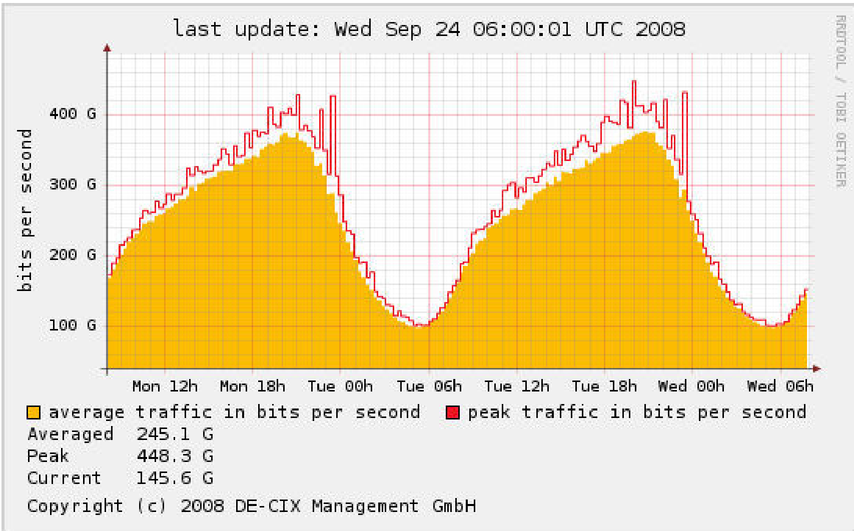

Figure 2: Data traffic at the DE-CIX – September 2008

Different characteristics of applications and data packets

There is no doubt that the various applications on the Internet transmit data packets with varying characteristics and delivery requirements. They differ in data rate and the respective bandwidth consumption, priority, quality of service (QoS) sensitivity and economic value. That is why it could be perfectly reasonable to treat these different data packets differently from an economic and technical perspective. Since the massive increase in data volume is already causing congestion[5] in the form of delays[6], jitter[7] or even data loss[8], the different characteristics of certain data packets become relevant in technical and economic terms.

5 When a packet shows up on an incoming link, the router determines on which outgoing link the packet should be forwarded. If that outgoing link is available, the packet can be sent out on it immediately. But if the outgoing link is busy transmitting another packet, the newly arrived packet will have to wait - it will be "buffered" in the router's memory, waiting its turn until the outgoing link is free. At that point, if one more packet shows up, the router has no choice but to discard a packet. It can discard the newly arriving packet, or it can make room for the new packet by discarding an older packet waiting in the buffer, but something has to be discarded.

6 If a router cannot handle and transmit the incoming data packets immediately, some data packets will be stored or "buffered". The common principle of first-in-first-out will cause a delay. A delay slows down the speed of data transmission and increases the time that it takes to transmit a data packet from the sender to the recipient. Normally, delays are not a big problem for the vast majority of services and users since they slow down the transmission by milliseconds.

Basically, one could distinguish between data packets that are very sensitive regarding the quality and speed of transmission and data packets that are rather non-sensitive and by far more elastic. There are for instance normal web browsing, email and peer-to-peer (P2P) file sharing where milliseconds of delay do not affect the quality of the service. Even data packet loss does not interfere very much with the end product since lost data packets will be delivered again by the original source so that the user may not even realize the packet loss. On the other side of the spectrum there are applications such as live broadcasting, interactive lectures, telemedicine, real-time voice conversations and online games where the quality of the service significantly suffers in case of delay and data packet loss.

Another differentiating factor of Internet applications is the varying data transmission rates these services require. The data volume of normal web browsing, email and Voice-over-IP (VoIP) services are usually comparably small. A single application of these services needs very little bandwidth. On the other hand, there are applications such as video conferencing, Internet Protocol Television (IPTV) and other media streaming, certain interactive services and P2P file sharing where huge data volumes have to be transmitted. The bandwidth consumption of such services is much higher. As a consequence, these bandwidth intensive services already consume a significant part of the existing bandwidth. Most recently, video streaming has overtaken P2P[9] file sharing as the biggest bandwidth consumer with YouTube, a website to up- and download videos, having the most significant impact on overall bandwidth consumption in many countries right now.[10] In contrast, Email and VoIP together do not even account for two percent of worldwide bandwidth consumption.

Internet services and applications also differ regarding their economic value, their economic and social utility and therefore the (potential) willingness of consumers to pay for them. Although it is always difficult and problematic to judge the (relative) social and economic value of any activity, especially in monetary terms, there can be no doubt that – not just from a normative perspective – some services provided through the Net are more valuable than

---

7 The term jitter refers to the fluctuation in delays. The consequence of these fluctuations is that the different data packets into which an information is split and sent through the Net reach the recipient in different times. Therefore, it takes longer to assemble the data packets.

8 Buffering lets the router deal with temporary surges in traffic. But if packets keep showing up faster than they can be sent out on some outgoing link, the number of buffered packets will grow and grow, and eventually the router will run out of buffer memory. If the buffer of routers is not sufficient to handle the data volume data or packet loss is inevitable. At that point, if one more packet shows up, the router has no choice but to discard a packet. It can discard the newly arriving packet, or it can make room for the new packet by discarding an older packet waiting in the buffer, but something has to be discarded. Some of the data packets will just get lost.

9 In the early 2000s, P2P by far consumed the greatest percentage of bandwidth on the Internet. Just 3 years ago, P2P applications consumed as much as 83 percent of the upstream-bandwidth and about 65 percent of the downstream-bandwidth in Germany. For quantitative data on bandwidth consumption of different services in Germany see Schulze and Mochalski (2007). In some countries with a high availability of high-speed Internet connections, such as Japan, P2P is still consuming the highest percentage of bandwidth.

10 YouTube alone accounts for more than 10 percent of worldwide data traffic on the Net and uses as much bandwidth as the entire Internet did in 2000. Among others see Lohr (2008).

others. Even the strongest supporters of Net neutrality would agree that the potential welfare gain of an online lecture reaching hundreds of students worldwide, the exchange of medical records and the improvement of medical treatments by telemedicine applications or video conferences reducing communication cost of international enterprises have a much higher economic and – most probably – social value than a 15 year old kid showing card tricks in front of his webcam and broadcasting himself on YouTube. That is why the willingness to pay for such high value and quality sensitive services might be overwhelmingly higher than the willingness to pay for low value applications that do not imply significant welfare gains for its users.

Table 1 distinguishes certain Internet services according to their quality sensitivity, bandwidth consumption and economic value.

Service	Quality sensitivity	Bandwidth consumption	Value / willingness to pay
P2P file sharing	Low	Very high (no limit)	low
YouTube	Low (buffered)	Medium (320 or 600 Kbps)	low
NetFlix streaming	Low (buffered)	High (up to 4000 Kbps)	low
Email	Low	Very Low	low
VoIP	Medium - high	Low (30 to 80 Kbps)	medium
Online gaming	High	Low (30 to 80 Kbps)	medium
E-lectures	High	Medium	high
Telemedicine	High	High (up to 8000 Kbps)	high

Table □: Different characteristics of Net services

Why are these different characteristics of Net services important for the discussion on Net neutrality? The answer is that the transmission of data packets through physical Net infrastructure is by no means a public good: First, excludability is possible, both in technical and economic terms. Second and even more important, there is rivalry in bandwidth consumption: The bandwidth that has been used by one data packet cannot be used by another data packet at the same time. This rivalry is of technical and economic importance especially when it comes to congestion. Net neutrality in the narrower sense is likely to cause economic inefficiencies and could lead to a crowding-out of high value and quality sensitive services.

Crowding-out of quality sensitive services

Today, most users pay a flat rate for their Internet access. This means that the marginal cost of bandwidth consumption a user is facing are zero. However, in case of bandwidth congestion the social marginal cost of bandwidth consumption are not zero but strictly positive: Any additional data packet that is transmitted through the already overstrained Net infrastructure will affect the quality of other services due to longer delays and a higher probability of data packet loss. Economically speaking, any additional bandwidth consumption creates negative externalities. This problem is often referred to as the "tragedy of the commons" and causes inefficiencies if the negative externalities are not internalized by a decent pricing system or any other control mechanism. In fact, Net neutrality itself causes the tragedy of the commons because every single data packet is treated equally disregarding the different characteristics mentioned above and the negative externalities. As a consequence, low value, elastic applications such as P2P file sharing are likely to crowd out quality sensitive services because the demand for high value, quality sensitive applications will decrease if the quality of service cannot be maintained due to congestion.[11]

Figure 3 shows the crowding out of quality sensitive services. Suppose there are three different services with S^1 being a highly quality sensitive application (e.g. e-learning, telemedicine), S^2 a service with a medium quality sensitivity (e.g. VoIP) and S^3 an application that is rather elastic with respect to delays and data packet loss (e.g. P2P).

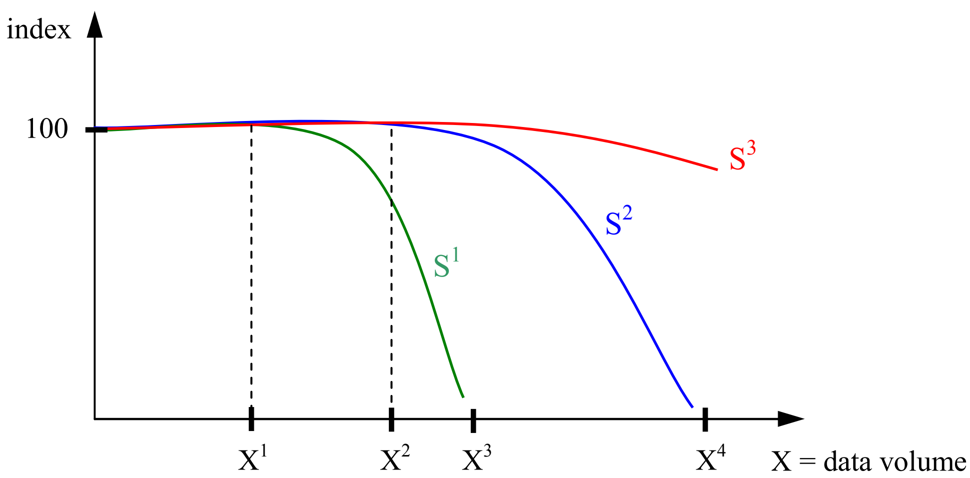

Figure 3: Crowding out of quality sensitive Net services[12]

[11] The big inter-user problem caused by P2P is the fact that it sends multiple data packets (up to 100) at the same time and that this multi-flow behavior makes it resistant to rationing. That means that non-P2P users and applications are deprived of bandwidth. Residential networks for instance are shared and therefore must be rationed in a way at busy times of the day. The big problem is that P2P breaks the rationing mechanism built in to TCP. Single-flow applications like iTunes, Netflix, and other commercial Video on Demand applications are at a huge disadvantage when competing against P2P applications and will literally suffer from the quality loss.

[12] For a similar illustration and analysis see Kruse (2007).

The Y-axis shows the individual demand or willingness to pay for the respective service given the total bandwidth consumption X. With bandwidth consumption below X^1 where no congestion occurs, the index of the demand for all three applications will be 100.[13] If the data volume exceeds X^1, some congestion in the form of delay and jitter might occur. This causes the demand for the highly quality sensitive service S^1 (e.g. telemedicine applications) to decrease. The demand for the other two services will not be affected by the slight reduction in quality of service. Beyond a bandwidth consumption of X^2, the quality of service S^2 (e.g. online gaming, VoIP) might be affected due to further congestion in the form of longer delays and even data packet loss. The respective willingness to pay will decrease. If the total bandwidth consumption exceeds X^3, the high value, quality sensitive service S^1 will be totally crowded out because the marginal (potential) consumer of this service will not accept the low quality any more. If the consumers of the quality insensitive service S^3 increase the data volume beyond X^4, the service S^2 will also disappear from the market. In the end, high value, quality sensitive services will be totally crowded out by the elastic, high volume – and maybe low value – service S^3 (e.g. P2P).

Ways to overcome the problem of crowding-out of quality sensitive services

Massive investment in Net infrastructure and more efficient ways to use broadband capacities have already boosted the available bandwidth and are a temporary and partial remedy for the problem outlined above because it has shifted the critical data volume to the right. However, the typical peak load problem remains and congestion is still very likely to occur since there will be always certain bottlenecks – let it be the "last mile" or backbone connections that are temporarily affected by natural disasters or simply attrition. In order to guarantee a high quality at any time, broadband service providers (BSPs) would have to build and maintain huge redundant capacities. Such kind of over-provisioning would be very expensive and economically inefficient. Furthermore, even if BSPs provided huge overcapacities applications which involve file transfer could still take all of the capacity at any given moment. No amount of over provisioning could effectively guarantee full quality at any time. For some applications such as telemedicine 99,9% quality might not be enough. Such highly quality sensitive services would be still crowded out under a strict neutral first-in-first-regime. Quality and security issues are one reason for the fact that besides a high percentage of computer and broadband usage among European physicians the potentials of ICT usage in medicine are by far not exploited so far.[14] Expensive and inefficient redundant capacities do

[13] Up to a certain level of consumption, the demand for the respective services might even increase with a higher data volume because of positive network externalities.

[14] Table 2 in the appendix provides an overview on rather simple applications of ICT usage among European GPs. According to Mettler et al. (2007), certain systematic factors like data protection during exchange and

not seem to be appropriate to prevent the crowding-out of quality sensitive and high value services. Although further investments in the Net infrastructure are necessary to handle the huge increase in data volume, these investments have to be combined with business models that can guarantee 100 percent quality for very quality sensitive services.

One possibility to overcome the problem of crowding out of certain services that is used in other sectors is peak-load or volume based pricing. Such pricing models could internalize the negative externalities and reduce the crowding out effect because high volume services would be more expensive or bandwidth consumption in times of congestion would be priced higher. However, to predict congestion and to find the right price would be almost impossible and business models that incorporate peak load or volume based pricing would be rather inconvenient for the vast majority of users. Furthermore, peak load pricing could at best handle congestion on an hourly basis and is not appropriate to deal with jitter on a millisecond basis. Again, in a simple peak-load pricing system, applications that rely on 100 percent quality are very likely to be crowded out by applications that are less quality sensitive. Metered pricing or usage caps are just a second best solution for some medium quality sensitive applications and cannot control instantaneous congestion, jitter and data loss. Therefore, business models that incorporate peak-load pricing or usage caps do not seem to be appropriate to remedy the congestion problem in an efficient and user-friendly way. However, for some broadband service providers peak-load pricing for certain types of customers might be one component of their future business model. Any Net neutrality regulation would seriously hinder the development of such business model and – therefore – prematurely prevent a possible (partial) cure for the congestion problem.

The most efficient and – not least – practical way to prevent crowding out of qualitative sensitive, high value services is simply a different treatment of different data packets according to their quality sensitivity, economic value and the respective willingness to pay. High value applications that are very sensitive regarding the quality of service could be prioritized and priced differently. In such a quality-for-service[15] regime, customers and/or providers of high value services with certain characteristics would be asked to pay a higher price in order to get an interference-free transmission of their data packets through the Net. Consumers and providers of more elastic, non-sensitive services usually do not have a willingness to pay for prioritizing their data packets since the final product is rather unaffected by delay, jitter or even packet loss. That is why the consumer habits and perceived utility of these users will remain pretty much the same under the suggested regime of prioritizing high value, quality sensitive services. Consumers and providers of the latter would remain in the

---

ICT standards have been ranked as most important for the networkability in the health care sector by Swiss health care professionals.

15 For a discussion of according business models see Brenner et al. (2008).

market. BSPs could raise their revenues and increase investment in Net infrastructure. Prioritizing certain data packets would enhance the overall efficiency. The beauty of such a model is that the negative externalities caused by bandwidth congestion would not be "internalized" in the narrower sense but more or less avoided or at least significantly reduced since prioritizing quality sensitive data packets lowers the marginal social congestion cost (MSCC).

Figure 4 shows how the welfare loss due to congestion can be reduced by prioritizing quality sensitive data packets. D^{NN} is the aggregated demand under a strict neutral first-in-first out regime.[16] Because of congestion beyond a certain data volume (X^1), some quality sensitive services and the respective demand will be crowded out. That is why the aggregated demand D^{NN} is kinked. The quality loss because of delay, jitter and data packet loss is represented by the curve $MSCC^{NN}$. In other words, the congestion of the available bandwidth causes additional social cost. The marginal social congestion cost (MSCC) increase with any additional bandwidth consumption because of additional delay and a higher probability of packet loss for every user. However, the users of rather elastic and non-sensitive services are not seriously affected by the quality loss. That is why they further extend their demand up to the saturation level X'^{NN}.[17] At this point, some high value and quality sensitive services will be partially or totally crowded out. Any remaining application and their users suffer from quality loss represented by the marginal social congestion cost curve.

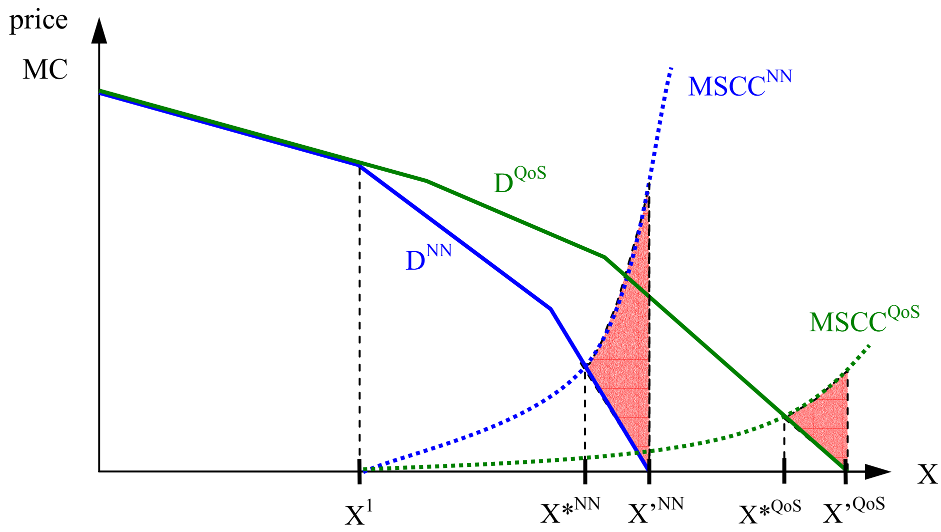

Figure 4: Reducing welfare loss by prioritizing quality sensitive data packets

16 Again, there are different services available. Some of these applications are highly quality sensitive, some are not.

17 Note that the marginal costs for any additional bandwidth consumption (data volume) are zero since the users usually pay a flatrate.

It is obvious that the highest marginal congestion cost occurs in the remaining quality sensitive services. At that level of bandwidth consumption, the marginal social congestion costs exceed the marginal utility of data travel. This causes a welfare loss represented by the big red shaded triangle.

Suppose now, that the broadband service providers could prioritize quality sensitive services if the respective consumers and/or suppliers express a demand for it. This quality of service regime (QoS) would avoid congestion cost for the users that opt for the QoS model and therefore drastically reduce the marginal social congestion cost ($MSCC^{QoS}$). [18] As a consequence, some quality sensitive applications would remain in the market which increases the overall supply and availability of services and – very much indeed – the respective demand (see the new aggregated demand curve D^{QoS}). Even if there were still some congestion cost, the welfare loss due to congestion would be much lower than in the Net neutrality regime. Furthermore, under the quality of service regime that takes into account different characteristics of services, the total market volume and therefore the total welfare gain is likely to increase because 1) prioritized high quality services are not crowded out any more, 2) elastic services are pretty much unaffected by the prioritizing and – not least – 3) because of the additional revenues BSPs could invest in additional bandwidth and offer access to broadband technologies to more users. An appropriate quality of service model would not only remedy the problem of crowding out of high value, quality sensitive applications, it would also enhance the range, availability and quality of services, increase total supply and demand and – not least – increase total welfare.[19]

A business model that incorporates prioritizing of certain services would be a renunciation of the end-to-end or first-in-first out principle and is incompatible with the concept of strict Net neutrality. Any *ex ante* neutrality regulation would impede the development of innovative and sustainable business models that are able to remedy the problem of crowding out and enhance the efficiency of broadband services. Mandating Net neutrality would prevent new applications and – in the longer run – actually reduce the availability and quality of services and therefore reduce producer *and* consumer surplus. Given the fact that the vast majority of users and their consumer habits would be mostly unaffected by business models that aim at priority pricing for certain high value applications, the fear of “discrimination” or “unfairness” expressed by certain interest groups is rather odd and by far exaggerated.

---

[18] Services that opt for the quality of service model are not affected by the quality loss due to delay, jitter or data loss since they have been guaranteed 100 percent quality. However, in the whole market congestion might still appear for applications that are not covered by quality of service contracts.

[19] Note that not only the welfare loss (red shaded triangle) is much lower under a quality of service regime. Since the total demand is much higher, the total surplus (consumer and producer surplus) is higher, too. How this additional surplus is distributed between the suppliers and the consumers depends on the effective level of competition and the very business model.

Prioritizing and the welfare enhancing coexistence of different services

In fact, an intelligent business model that incorporates differentiation of services and prices according to the very needs and preferences of content providers and end users is much more "fair" than a dumb and neutral network. Some of the problems mentioned above are basically intra-user induced since the consumption pattern and behaviour of one user affects the utility of other consumers that use the same connection or "last mile". For instance, the P2P application of one user can cause severe jitter problems for the VoIP or gaming application of another housemate. This inevitably leads to conflicts because the latter, quality sensitive applications and therefore the utility of the respective user will be adversely affected. A quality of service concept that prioritizes real-time applications such as VoIP or online gaming[20] would actually allow a peaceful and welfare enhancing coexistence of different consumption patterns and users. Rather than focus on the conflict between different applications, intelligent quality of service concepts are really about giving every user and every protocol what they need and want according to their very preferences.

Net neutrality regulation, innovation, investment and competition

Interestingly, many proponents of net neutrality claim that net neutrality fosters innovation. It seems far from certain why this should be the case for internet services and, most importantly, is simply not true for the very core of the whole internet – the net infrastructure. One major driver of inventions and innovation is the possibility of innovators to conquer new markets, get a competitive edge against other suppliers and, finally, reap the fruits of their intellectual work and financial effort. Any regulation that affects the property rights of innovators and investors will discourage innovative efforts and future investment. From a dynamic perspective, ex ante regulation of innovative markets usually do not maximize consumer welfare at all but – at least in the long run – will cause less innovation, less investment and fewer services available. Proponents of regulations constantly fail to recognise that the early explosive growth of the Internet happened in a sphere largely free from government interference.

Net neutrality regulation would affect the property rights of the owners of the networks. Since most BSPs are privately owned enterprises, their shareholders bear the risk of the investment and operations.[21] Taking away the property rights from the investors would negate an

[20] According to Litan and Singer (2007), the consumer surplus of online gaming in the US alone is likely to reach values between $US 729 million and $US 1.458 billion in 2009. A strict regulation in the sense of Net neutrality could seriously hamper growth and innovation in this market.

[21] It is true, indeed, that a significant part of the existing Net infrastructure has been built in highly regulated or even government-run settings. However, this fact does not justify a rigid interference in the property rights

important underlying principle of every private activity in a market oriented economic system. Any rigid regulation will inevitably lead to unforeseeable and unintended consequences and, in fact, discourage investment and innovation in broadband technologies and net infrastructure (Ganley and Allgrove 2006). The problem is that if property rights are assigned in access to users rather than suppliers, resulting in an efficient price of access, there will be less investment and long run supply of Internet services. "Net neutrality" is actually a friendly-sounding name for price regulation since it implicitly states that broadband providers must charge content providers a price of zero and must charge users only in certain, prescribed ways (Hahn and Wallsten 2006). Regulatory regimes or "business models" that incorporate zero pricing usually lead to an inefficient allocation and are not sustainable. A zero price yields zero revenues – a lesson many dotcoms learned too late. While the benefits of the Internet can be made available to a particular user at zero cost, they cannot be made available to all users at zero cost (Owen and Rosston 2003). Proponents of Net neutrality pretend to be very concerned about a "fair" treatment of users and the innovative potential of the Internet. If they really are, they should rather think about the question of how the networks of the future are going to be built and funded. In fact, any *ex ante* neutrality regulation actually threatens the innovative potential of the whole Internet since it weakens the incentives to invest in one of the most crucial components of the "system" Internet.

Net neutrality regulation would also affect the freedom of contract and the development of new business models. Mandating an equal treatment of every data packet or requiring certain "standards" would be another, maybe even prohibitive barrier for partnerships between providers of broadband technologies and other firms such as content providers that could help to reach new customers and offer a broader range of services via cross-promotion, bundling or other business models. In fact, many content providers are desperately seeking such partnerships in order to better promote their products and services. It seems quite paradoxical that some of these content providers are among the protagonists of Net neutrality regulation since their partnerships and cross-promotion contracts with BSPs have a discriminatory component, indeed. However, bundling and cross-promotion contracts have been used quite often and very few consumers complain about it since these business models create new services and are able to reduce the cost of these services. Net neutrality regulation would most definitely affect such partnerships especially when it comes to disputes between competing content providers. That means that Net neutrality regulation would actually impede one of the most promising distribution channels that bring new services to the very customers. Therefore, net neutrality regulation not only discourages investment in net infrastructure but also impairs the diffusion of new applications into the market and therefore the transition of an idea to an

of the successors of former state-monopolies and their private investors. Things have changed and almost every investment in the maintenance and upgrading of networks is financed by private investors.

innovation. Since progress depends on innovation, not just ideas, by both access providers and content providers, eliminating an effective distribution channel for new internet applications, net neutrality regulation would reduce overall market growth and consumer welfare.

It has never been the idea as such that made an internet application successful. It has always been a combination of many components such as a good – more or less unique – idea, technical innovation, effective marketing and distribution, adequate pricing and billing and so on. In other words, it is the whole business model that decides about the success of an innovation. It is probably not the smartest idea in the world to sell books over the internet, to develop a web-based auction platform, to sell MP3 music files online or to code an effective search algorithm. However, together with efficient logistics, aggressive marketing, one-click-buy applications, review and recension systems, fancy devices, cross-promotion and bundling, innovative (and often "discriminatory") pricing models, etc. such services can be (and have been) very successful. The Amazons, eBays, iTunes and Googles of the world have introduced innovations that became extremely successful because of good ideas, innovative technologies *and* their very business models. Interestingly, most of these business models imply (potentially) discriminatory components: Amazon's and eBay's online reviews and recensions are likely (and intended) to produce discriminatory results, iTunes uses an internationally "discriminating" pricing model, Google is by nature not neutral in finding and listing websites and placing adverts. A strict non-discriminatory ex ante regulation in the sense of pure neutrality would have prevented some of the business models mentioned above.

Summary

As has been shown, different applications and services have different characteristics regarding bandwidth consumption and – most important – the quality of data transmission. In a strictly neutral and "dumb" first-in-first-out regime, quality sensitive applications and services are likely to be crowded if congestion in the form of delay, jitter or data loss occurs. In times of a massive growth in data traffic due to P2P and video applications like YouTube, the probability and scope of congestion is likely to increase. Intelligent business models that take into account the specific needs of different applications, content providers and user groups by offering distinguished quality of service could be very efficient in overcoming the congestion problem and would be very convenient for the vast majority of users at the same time.

Any ex ante regulation in the sense of net neutrality or certain "standards" regarding the quality of service would add another chapter of ridiculous over-regulation and would open a Pandora's box of endless and expensive disputes and lawsuits. Who is going to define the minimum standards and on what basis? Who is going to monitor these standards? How shall such standards be adapted to the tremendous technological and economic change in a dynamic sector as ICT? An ex ante net neutrality regulation would be nothing else than a huge job-creation measure for hundreds of bureaucrats and lawyers. That might be the reason why some politicians and bureaucrats are in favour of a regulatory framework that would increase their budget and power. The costs of this kind of regulation would be huge and the economic and social benefits would be – in the short run – at best zero and – from a dynamic perspective – most definitely negative.

The freedom to invest and incentives to innovate, to provide sophisticated products and services and to develop successful business models together with the freedom of consumers to decide what suits their preferences and needs best has always been a major driver of growth and welfare in modern societies. The role of the state is to set and enforce certain rules of this complex game and to intervene if markets fail but not to unnecessarily restrict the basic freedoms mentioned above and to distort markets, to discourage investments and to incapacitate consumers by over regulating markets that are working very well and have produced tremendous welfare gains in recent years.

It seems that the potential harms of rigid net neutrality regulation have been recognized by some politicians. Viviane Reding, the Commissioner for information society and media has been very clear at a conference on Network Neutrality held in Copenhagen on 30 September 2008: “Some proponents of Net Neutrality would like to see equal treatment for everyone cast in the Stone Tables of the Telecoms Reform. But we must recognise that openness for innovation sometimes cannot exclude legitimate network management practices. For instance, traffic prioritisation can sometimes be an important driver of value and growth for operators. The Commission's vision of an open and competitive digital market does allow for traffic prioritisation, especially for providing more innovative services or managing networks effectively. We have to allow network providers to experiment with different consumer offerings. In the end, it will be up to the consumers to decide to change to a provider that offers them what they would like.” (Reding 2008)

However, the IMCO Telecoms-Package Compromise-Amendment discussed in the first reading in the European Parliament in September 2008 stipulates that national regulatory authorities “may issue guidelines setting minimum quality of service requirements”. Though the amendment Article 22(3) - Directive 2002/22/EC does not refer to net neutrality explicitly, this rather vague formulation could pave the way for confusing and harmful national regulations. Such regulations that could discourage and prevent the development of appropriate business models could be to the disadvantage of service providers and consumers and actually jeopardize the EU’s goal to become the most competitive knowledge based economy.

Appendix

	Use of Computers	Use of Broadband Internet	Electronic Exchange of Patient Data by Purpose in Detail				
			Lab Results from Laboratories	Medical Data to Care Providers	Admin Data to Other Care Providers	Prescription to Pharmacies	Medical Data Cross Border
Belgium	86,1	79,5	73,5	12,9	12,9	1,6	0,9
Bulgaria	97,1	23,0	5,3	3,4	5,8	2,4	1,0
Czech Republic	82,2	38,5	24,7	5,6	5,9	0,0	0,7
Denmark	98,9	91,0	96,2	73,6	74,0	97,3	1,9
Germany	98,8	40,0	63,2	4,0	3,2	0,0	0,0
Estonia	100,0	72,0	39,3	1,3	1,3	0,7	0,0
Greece	79,4	43,8	3,5	4,4	4,4	1,6	1,9
Spain	77,2	35,8	29,8	12,6	5,5	3,1	0,9
France	82,8	59,1	32,8	4,6	3,6	1,3	1,7
Ireland	73,4	44,3	40,4	1,9	4,4	0,5	0,5
Italy	86,2	48,8	7,6	7,2	2,8	0,7	0,3
Cyprus	69,4	31,9	9,7	2,8	2,8	0,0	2,8
Latvia	88,1	58,3	1,1	0,0	0,0	0,0	0,0
Lithuania	57,4	32,7	7,6	2,7	9,5	1,1	0,4
Luxembourg	79,7	61,5	27,1	0,0	0,0	0,0	0,0
Hungary	100,0	35,7	12,4	2,4	0,8	0,8	0,0
Malta	65,2	50,6	10,9	6,5	6,5	0,0	3,3
Netherlands	98,5	81,6	83,8	26,0	27,5	71,0	4,7
Austria	83,6	36,8	37,1	12,4	7,4	2,0	0,7
Poland	71,5	32,1	10,0	2,3	6,3	0,3	0,0
Portugal	88,0	32,1	1,4	7,7	6,3	2,1	0,4
Romania	65,8	5,3	4,3	2,0	6,3	0,0	0,0
Slovenia	97,1	54,0	9,7	0,0	2,9	1,9	0,0
Slovakia	95,8	15,3	4,6	1,1	1,5	0,4	0,0
Finland	100,0	92,7	90,0	54,8	20,8	0,4	0,4
Sweden	99,6	88,1	82,4	13,1	15,7	80,9	1,5
United Kingdom	97,3	72,6	84,9	26,5	31,5	5,1	0,4
Iceland	99,0	85,7	52,4	17,5	11,7	18,4	0,0
Norway	98,0	73,8	88,2	34,8	25,5	2,9	0,5
EU27	87,4	47,9	39,8	10,3	9,7	6,3	0,7
EU27+2	87,5	48,1	40,2	10,5	9,8	6,3	0,7

Source: European Commission and Empirica, 2008

Table 2: ICT Usage by European GPs/ Physicians

References

comScore (2008a): “26 Million People Watched More Than 3 Billion Videos Online in Germany in May 2008” Press Release [http://www.comscore.com/press/release.asp?press=2332]

comScore (2008b): “25 million People Watched 2.3 Billion Videos Online in France in May 2008” Press Release [http://www.comscore.com/press/release.asp?press=2412]

Crowcroft, Jon (2007): “Net Neutrality: The Technical Side of the Debate: A White Paper” ACM SIGCOMM Computer Communication Review, Vol. 37(1), January 2007.

Brenner, W.; Kruse, J.; Zarnekow, R. and Sidler, A. (2008): „Qualität im Internet“ e&i Elektrotechnik und Informationstechnik, Spezialausgabe „Dynamik der Kommunikationsnetze“ Heft 7/8 (2008).

Felten, Edward W. (2006): "Nuts and Bolts of Network Neutrality” AEI-Brookings Joint Center for Regulatory Studies, Related Publication 06-23, August 2006.

Ganley, Paul and Allgrove, Ben (2006): “Regulating the Internet – Net neutrality: A user’s guide” Computer Law & Security Report, Vol. 22(2006), pp. 454-463.

Hahn, Robert and Wallsten, Scott (2006): “The Economics of Net Neutrality” AEI-Brookings Joint Center for Regulatory Studies, Related Publication 06-13, April 2006.

Kruse, J. (2008): “Internet-Überlast, Netzneutralität und Service-Qualität“ Wirtschaftsdienst Vol. 88(3), pp. 188-194.

Kruse, J. (2007): “Crowding-Out bei Überlast im Internet” University of the Federal Armed Forces Hamburg, Diskussionspapier Nr. 72, November 2007.

Litan, Robert E. and Singer, Hal J. (2007): “Unintended Consequences of Net Neutrality Regulation”, Journal on Telecommunications and High Technology Law, March 2007.

Lohr, Steven (2008): „Video Road Hogs Stir Fear of Internet Traffic Jam” The New York Times, March 13, 2008.

Mettler, T.; Rohner, P. and Winter, R. (2007): “Factors Influencing Networkability in the Health Care Sector - Derivation and Empirical Validation” Proceedings of the 12th International Symposium on Health Information Management Research – ISHIMR 2007.

Ou, George (2008): „Why BitTorrent causes so much latency and how to fix it” Technology for Mortals Blog. [http://www.formortals.com/Home/tabid/36/EntryID/57/Default.aspx]

Owen, Bruce M. and Rosston, Gregory L. (2003): “Local Broadband Access: Primum Non Nocere or Primum Processi? A Property Rights Approach” Stanford Law and Economics Olin Working Paper No. 263.

Reding, Viviane (2008): “Net Neutrality and Open Networks – Towards a European Approach” Conference 'Network Neutrality - Implications for Innovation and Business Online' Copenhagen, 30 September 2008.

Schulze, K. and Mochalski (2007): The Impact of P2P File Sharing, Voice over IP, Skype, Joost, Instant Messaging, One-Click Hosting and Media Streaming such as YouTube on the Internet, Ipoque Internet Study 2007.

Thierer, Adam D. (2004): “Net Neutrality” Digital Discrimination or Regulatory Gamesmanship in Cyberspace? Cato Policy Analysis No. 507, January 2004. Cato Intitute.

Wu, Tim (2003) “Network Neutrality and Broadband Discrimination,” Journal of Telecommunications & High Technology (forthcoming 2003): 26, http://faculty.virginia.edu/timwu/bbd.pdf.