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The fallacies of network neutrality regulation

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The fallacies of network neutrality regulation

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Discussion Paper

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Abstract:

In this paper, historical functionalities of the traditional Internet are contrasted with today's Internet functionalities of the "smart" Internet architecture. It is shown that network neutrality regulation prohibiting congestion management and traffic quality differentiation is contrary to economically founded allocation mechanisms. By access regulation of local loop bottleneck components the transfer of market power from the telecommunications infrastructure into the complementary Internet access service markets can be avoided. Regulation between access service providers and Internet application service providers is not only superfluous but detrimental.

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1. Introduction

Originally “network neutrality” was understood in the sense that there should be no discriminatory access, mainly to services like IP number assignment, directory services, outgoing and incoming packet routing and connectivity (O’Donnell, 2000, 15 ff.). In other words, the focus was on the functionalities of the narrowband Internet, transporting data packages on the basis of best effort principle. Even then, the inclusion of emergency calls and the exclusion of illegal content was already regarded as necessary and dealt with under the heading of technical regulation. But with respect to an increasing number of application services, the debate on “network neutrality” began to diffuse. Relating to the notion of network neutrality, it “has been used to describe a data network that assigns all transmissions equal priority as they are passed along the network” (OECD, 2006, 3). In this respect it is a “call for regulatory limitations on network owners’ ability to discriminate against particular content, applications, and devices” (Yoo, 2006, 1850). A common denominator of network neutrality definitions¹ - independent of whether the authors are proponents or opponents of network neutrality regulation – is a plea against traffic shaping within the Internet and the resultant challenge of the traditional ‘best effort’ transmission.

Moreover, the role of market power in the future Internet traffic organisation is considered of significant relevance. Internet application providers (e.g. Google, Yahoo etc.) have worried that they might face higher prices or degraded services in the absence of network neutrality (e.g. Hogendorn, 2007, section 2.1). The focus of the debate is whether Internet application providers should be protected from the abuse of market power of Internet access providers (e.g. Economides, 2007, 8). Therefore, the network neutrality debate centres on private and social incentives for traffic shaping and the impact of the supposed market power involved. What is currently being debated under the heading of “network neutrality” is the statutory prohibition of mainly the following three issues:

¹ See as well e. g. Economides, 2007, executive summary; Ganley, Allgrove, 2006, 454; Litan, Singer, 2007, 1; Kahn, 2007, executive summary; Sidak, 2006, 349; Sidak, 2007, 379.

- (1) The blockage of content or applications (“port blocking”), meaning that Internet access service providers can deny customers access even to lawful content;
- (2) Agreements between the providers of Internet access services and providers of Internet application services (e. g. Internet content delivery services) taking into account different traffic qualities and congestion management.
- (3) Vertical integration of Internet access service providers into the production of Internet content or other application services.

Within the network neutrality debate, it is argued that without network neutrality regulation a situation may arise, where customers of Internet access service provider could reach competitors of the agreement partner(s) with a guaranteed quality of service only if these competitors explicitly recompense the Internet access service provider for it. In contrast, web sites in owner- or partnership with the Internet application service provider could receive a higher traffic priority, what in the debate is called “access tiering”. The effects of competition from alternative Internet Access Service Providers are neglected, although the instability of vertical market foreclosure in case of upstream and downstream competition is widely known. In this context, the differentiation between local telecommunications infrastructure and Internet access services is typically missing. Accordingly, the localisation of a possible regulatory problem with respect to network-specific market power in the local loop is neglected.

In this paper, it is shown that the problems arising in this debate (e. g. congestion pricing, traffic quality differentiation) can be solved according to the logic of network economics without any support of sector-specific market power regulation. Section 2 illustrates the spontaneous evolution of the Internet architecture. A fundamental differentiation between the Internet, including its main functionalities, and the Internet periphery is made. Historical functionalities of the traditional Internet are contrasted with today’s Internet functionalities (“smart” Internet architecture). On the basis of this analysis, it is shown that the concepts and political agendas of the network neutrality debate have their origin

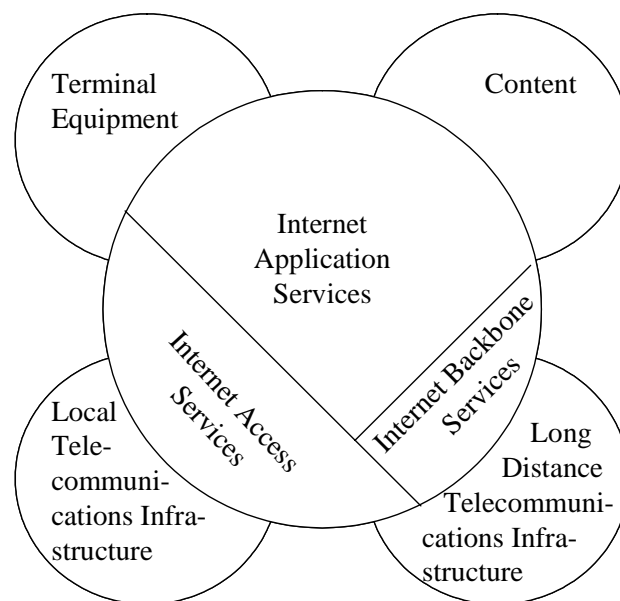
in an understanding of the current Internet as if it was still the historical Internet. Economic principles valid in the early days of the Internet are upheld by supporters of network neutrality proponents to be continued in the future, regardless of the evolutionary process the Internet has undergone since then. Section 3 finally shows that there is only a need of sector-specific market power regulation in remaining monopolistic bottleneck components of local telecommunications infrastructures and that the apprehension of a transfer of such market power into the complementary Internet access service markets is unfounded. Section 4 concludes.

2. The spontaneous evolution of the Internet architecture

2.1 Disaggregated representation of the Internet

In order to understand current regulatory debates regarding the Internet, in particular the necessity for congestion pricing and Internet traffic quality differentiation, one has to be aware of the evolution of the Internet in recent years. A fundamental distinction has to be made between the Internet and its periphery (see Figure 1).

Figure 1: Internet and Internet periphery



Source: Based on Knieps (2003, 219).

Internet application provision requires elements belonging to the Internet periphery traditionally viable on their own. Terminal equipment (e. g. personal computers) can be used either without or with access to the Internet, whereas obviously the use of the Internet is not possible without any terminal equipment². It is also important to recognise that content can be provided by Internet content service providers (e. g. customized music and video libraries) constituting digital products, but can as well be distributed by other means (e. g. cinemas, traditional video libraries). Local loop and long distance telecommunications infrastructure are also periphery to the Internet, although in the meantime, investment in telecommunications capacities is strongly motivated by Internet demand. But telecommunications networks have so far still alternative purposes, independent of the Internet. The transport of data packages takes place via Internet access services as well as Internet backbone services. In contrast to the periphery elements, Internet access service provision and Internet backbone service provision are an inalienable part of the Internet and would not exist without the Internet. In order to transport data packages from one Internet access services network to another, transmission via Internet backbone services networks is required. Both are Internet traffic services based on telecommunications capacities, combined with Internet logistics (transmission control protocol, Internet protocol etc.). Telecommunications capacities are produced by local telecommunications infrastructure as well as long-distance telecommunications infrastructure. Internet access services require not only local telecommunications infrastructure but also long distance telecommunications infrastructure capacities. Complementary to Internet traffic services, Internet application services are provided, including portals, search machines, Voice over IP and content delivery services. Internet application service providers and content firms may interact in different ways. Traffic can proceed directly between end users and any content firm or alternatively content may be mediated via an Internet application service provider. In any case the lack of openness to final content (guaranteeing property rights of content) is taken to be granted as an important component of economically viable business models (Hogendorn, 2007, section 2.1).

² Terminal equipment may also include components for the provision of Internet access services.

2.2 Broadband convergence and the demand for a “smart” Internet architecture

The Internet as it appears today is the result of a spontaneous market evolution. In its origins, the Internet was based on narrowband local telecommunications infrastructure, and thus was basically a transport medium for e-mails. Since bits and bytes were carried forward, neither the Internet access service provider nor the Internet backbone service provider had any application awareness. Furthermore, at that time the Internet was relatively new to market players, and terminal equipment as well as content was not primarily designed for interacting with the Internet. Telecommunications networks originally also were not constructed for Internet purposes. Network Internet intelligence was basically located at the edges, not at the core of the Internet. The task of the routers was to simply forward data packages, without differentiation between services or applications. When Internet content providers began to emerge, initially their capacity use – in relation to the whole Internet traffic – rarely resulted in congestion problems. And if congestion was indeed observable, it was a temporary phenomenon. Ensuring quality of service was therefore not an issue either. Because of this, within the Internet, all traffic was treated equally, meaning non-discriminatorily, between different services and customers. The traffic principle was “first in, first out”. Therefore, today, this type of characterisation of the Internet has also become known as the “dumb” Internet (e. g. Ganley, Allgrove, 2006, 456).

In the following the transition from the “dumb” Internet to the “smart” Internet architecture is characterised as an evolutionary process. In comparison with the “dumb” Internet, today’s “smart” Internet has other premises. Whereas in the “dumb” Internet access services were often priced by dial-up, in the early period of the “smart” Internet several flat rates were applied, normally according to the chosen download speed. Neither congestion pricing nor quality differentiation has been applied. However, the logic of a “smart” Internet requires congestion management and quality differentiation with respect to providers of content delivery and other applications.

2.2.1 Congestion management

Broadband Internet traffic capacities are limited for Internet access as well as for backbone services. The bandwidth of each component of physical transmission facilities, the capacity of routers etc. are limited (Yoo, 2006, 1862). Due to the unlimited amount of data packages, created by e. g. content distribution or video streaming applications, the basic insight from transportation economics holds: An extension of capacities until all congestion disappears most probably is not a welfare optimal solution. Instead, the social benefits of decreasing congestion should be counterbalanced by the cost of additional capacity (Mohring, Harwitz, 1962). Recent developments in congestion models applying heterogeneous preferences with respect to travel time and reliability to road traffic (e. g. Small, Winston, Yan, 2006) may also be applied fruitfully to congestion in Internet traffic. Thus Lessig's demand for extension of capacity until all scarceness disappears is economically unjustified (see Lessig, 2002, 47 and its criticism by Yoo, 2006, 1883).

2.2.2 Heterogeneous needs for traffic qualities

Even if there was a complete absence of traffic congestion at all or some time intervals, demand for heterogeneous traffic qualities is a basic characteristic of the "smart" Internet. Time-sensitivity of applications like Voice over IP, video conferences, and video games needs timely and steady package delivery. These applications are jitter-sensitive.³ In contrast, other applications such as web browsers, pod casting software, video streaming, are not affected by jitters, because the user applications can buffer several seconds. Applications with high bandwidth demand for a few seconds followed by several minutes of network inactivity result in a type of Internet traffic that is referred to as "bursty". By means of traffic shaping these heterogeneous needs for traffic qualities can be taken into account (e. g. OECD, 2006, 12 f; OECD, 2007). The basic characteristics of the difference between "dumb" and "smart" Internet architecture are shown in table 1. A more detailed differentiation will be provided in the following section.

³ A jitter is a state defined by packages without a synchronized rhythm.

Table 1: Characterisation of the Internet architecture

Criteria \ Internet	“Dumb” Internet architecture	“Smart” Internet architecture
Local telecommunications infrastructure	Narrowband	Broadband
Consumer applications	<ul style="list-style-type: none"> - Basic services (e-mail etc.) - Normally no traffic time-sensitive content 	Basic services and as well as traffic time-sensitive content (Video conference, VoIP, medical applications etc.)
Application awareness	No	Yes
Network intelligence	Basically: “edge”	“Core” and “edge”
Technical feasibility of routers	No discrimination (first in, first out)	Discrimination (tiering, blocking)
Congestion management	<ul style="list-style-type: none"> - Normal case: congestion is unlikely - If congestion: “best effort” 	<ul style="list-style-type: none"> - Normal case: congestion is likely - Setting pricing signals to all actors in order to deal with congestion
Internet traffic quality variety	<p>A feeding-in and traffic price for Internet application services is inexistent because</p> <ul style="list-style-type: none"> - Internet traffic congestion normally does not occur and / or - no time-sensitivity of applications. 	<p>A feeding-in and traffic price for Internet application services is required because</p> <ul style="list-style-type: none"> - Internet traffic congestion may occur and / or - partial time-sensitivity of applications.

2.3 The characteristics of “smart” Internet architecture

In the following the spontaneous evolution of the Internet architecture from its original “end-to-end” character⁴ towards multi-tiered Internet is described. In contrast to the “dumb” Internet, the “smart” Internet architecture is characterised by additional functionalities, allowing for the provision of heterogeneous Internet access services.

- (1) Additional router functionality (on top of standard protocols) by means of traffic shaping software allowing Internet access service providers flexibility to determine which packages and traffic should receive priority on a given network (OECD, 2006, 7). A provider of Internet traffic services has the possibility to “shape traffic” at the router level by installing a traffic shaping software. Within its area of control competency the Internet traffic service provider has the ability to prioritize a wide range of applications and data types, including blocking a service altogether. In particular, it can enter into a service level agreement, for example with a content provider, which provides a guaranteed minimal level of quality of service (e. g. Litan, Singer, 2007, 3). Advances in routing technologies enable a wide range of routing arrangements between different providers of Internet backbone services (Besen et al., 2001, 292). Beyond the boundaries of an Internet traffic service provider’s control area, peering and transit agreements may evolve, installing in a similar way traffic shaping mechanisms by means of border gateway protocols allowing each Internet traffic service provider to accept, forward and pass off packages using a variety of control knobs (Clark et al., 2006, 16).
- (2) Internet data centres (IDC) owned by an Internet access service provider to supply server capacity located at different locations within the Internet. Alternatively, a content provider can place its content on the access pro-

⁴ “Whatever content – messages, programs, games, search engines – is delivered to it is automatically transmitted to all broad-band subscribers by the most rapid path available, regardless of the ownership of the initiating, intermediate and terminating facilities” (Kahn, 2007, 6).

vider's servers to reach end users faster and more reliably than from the content provider's server alone (Litan, Singer, 2007, 3 and 11-14).

- (3) Routing overlay networks in order to control or modify the path of packages through the network taking into account the specific requirements of applications and the effects of the Internet traffic provider's load management (congestion etc.).

These elements are combined depending on the characteristics of the demand for traffic (Clark et al., 2006). By a combination of additional router intelligence and server capacity within the Internet a variety of "overlay" networks can be provided by Internet access service providers as well as third parties. A guaranteed level of quality of service can be contracted between the access service provider and content providers.⁵ The two "overlay" networks most worth mentioning are Virtual Private Networks (VPN) and dedicated hosting services. Within VPN, commercial customers can receive services from an access service provider which provides the attributes of a private data network within a shared publicly accessible network. The traffic of the VPN gets preferential treatment compared to standard Internet traffic. Dedicated Hosting Services are established because of services like real-time video, VoIP or online video game traffic, needing jitter-free transmission.

Incentives to minimize delay and congestions costs are supplied to content providers that distribute multiple copies of the content by setting up different servers, taking into account the proximity of each server, the load on each server and the relevant congestion of different portions of the traffic network (Yoo, 2006, 1882). Access service providers may offer enhanced quality of service to content providers in the form of managed hosting, storing content at Internet data centres and prioritisation of traffic with traffic shaping software (at the IP packet layer). The access provider can either offer a fully managed hosting solution or, alternatively, the content provider manages his own applications hosted in an IDC owned by an access service provider. Third parties (in addition to access

⁵ A systematic analysis of "overlay" networks to enhance or modify the basic functions of traffic handling within the Internet is provided by Clark et al., 2006.

service providers) may also provide quality of service hosting services.⁶ A feeding-in and traffic price for content delivery is therefore a consequent continuation of Internet pricing, a consequent dealing with the partial time-sensitivity of applications and / or Internet traffic congestion. This also includes congestion management and quality differentiation in the Internet backbone.

3. Internet access services and network-specific market power regulation

A common denominator of the proponents of network neutrality regulation is to prevent discriminatory behaviour due to market power. “Because of the unquestioned lack of market power in backbone services ... there is certainly no competitive virtue in imposing non-discrimination restrictions on backbone networks” (Litan, Singer, 2007, 4). The focus of the literature on network neutrality is therefore on traffic shaping and package blocking in the area of Internet access services.

3.1 Localisation of network-specific market power

Network neutrality regulation would be characterised by an ex ante intervention into the markets for Internet access services. Irrespective of how network neutrality would be implemented in detail, it would limit the entrepreneurial flexibility with respect to the design of the Internet architecture, transport quality differentiation, and flexible transportation pricing. From a network economic point of view the first question is whether network-specific market power can be localised in the markets for Internet access services. Only if network-specific market power can be localised market power regulation may be justified. Of course, this would not imply that network neutrality regulation would be the adequate intervention from a welfare economic point of view.

⁶ For a more detailed explanation of the development of content delivery networks, see Yoo, 2006, 1880; Litan, Singer, 2007, 11-14.

From a competition economics point of view, the use of ex-ante, sector-specific regulatory intervention constitutes massive interference with the market process and thus always requires a particularly well-founded justification based on modern network economics. Obviously, the development of an ex-ante regulatory criterion creates a need for a more clear-cut definition of market power. It is necessary to differentiate between those areas in which active and potential competition can work and other areas, where a natural monopoly situation in combination with irreversible costs (monopolistic bottlenecks) exists (e.g. Knieps, 2006a, pp. 53 ff.). Sunk costs are no longer decision relevant for the incumbent monopoly, whereas the potential entrant is confronted with the decision whether to build network infrastructure and thus spend the irreversible costs. The incumbent firms therefore have lower decision relevant costs than the potential entrants. This creates scope for strategic behaviour of the incumbent firms, so that inefficient production and monopoly profits will not necessarily result in market entry. Access regulation is only justified in monopolistic bottleneck areas. In all other cases, the existence of active and potential competition will lead to efficient bargaining.

Market power involved in network infrastructures with the characteristics of a monopolistic bottleneck fundamentally disturbs private bargaining on network access. One extreme alternative could be (vertical) foreclosure of competitors on a complementary service market. Another way of abusing market power within the bargaining process on access conditions is to provide insufficient network access quality or demand excessive access charges.

The problems associated with market power due to monopolistic bottlenecks, and in particular the problems of network access, are frequent topics of discussion in the context of network economics (Baumol, Willig, 1999, 44; Knieps, 1997, 327 ff.; Laffont, Tirole, 2000, 98). It is important to note that ex ante regulation imposes the remedy before abuse of market power actually occurs. The rationale for this approach is in particular a high probability of anticompetitive behaviour in the absence of regulatory constraints (Geradin, Sidak, 2005, 519).

3.2 Competition on the markets for transport services

The transport of data packages takes place via Internet access services as well as Internet backbone services. Both Internet traffic services are based on telecommunications capacities, combined with Internet logistics. Telecommunications capacities are produced by local telecommunications infrastructure (DSL, CATV, wireless access) as well as long-distance telecommunications infrastructure. Complementary to Internet traffic services several application services are provided, including portals, search machines, Voice over IP, content delivery.

The relevance of differentiation between traffic services and access to the complementary infrastructure is well known from transportation economics. Indeed, one of the essential features of the ability of competition to operate on the free markets for transport services is that corporate strategies such as product and price differentiation, the build-up of goodwill and the development of an efficient distribution network, etc. are also part of competitive strategies. Information problems (search costs, asymmetric information, etc.) can also play a role.

Both active and potential competition operates on transport markets. The very fact that transport services are on offer in the form of a network with their associated bundling effects implies that there is no monopolistic control where transport undertakings have free access to the market, since high profits recorded by one undertaking have the immediate effect of attracting others. There is no danger of preventing competitors from entering the market insofar as the decision-relevant costs with respect to transport services are similar for established undertakings and for potential rivals. Often a newcomer enters the market with no intention of duplicating the established undertaking. Important is active competition achieved by means of technological and product differentiation, and the introduction of new products and processes. As a direct consequence of this, it is misleading to assume that newcomers have as their reference point the belief that ideally there can only be one transport network on the markets for transport services (e. g. Knieps, 2006b).

Insofar as there are monopolistic bottleneck areas in network sectors, they require sector-specific regulation, in order to discipline the remaining market power. To the extent that transportation infrastructures fulfil the characteristics of a monopolistic bottleneck, mandatory access to guarantee symmetric, non-discriminatory access conditions is required. Only then (active and potential) competition between service providers is effective.

The market driven evolution of flexible, innovative pricing structures in transportation is of particular importance (e.g. Odlyzko, 2004). It must be pointed out that there is no one system that is better than all the others and that could be centrally adopted as a pricing objective. Rather, it is a case of searching for the limits of price differentiation via a process of trial and error. This limit is reached when the transaction costs of avoiding arbitrage outweigh the benefits of differentiating prices further (Knieps, 2006b, 14).

3.3 Lessons for telecommunications regulation

3.3.1 Competitive long distance telecommunications infrastructure

Sunk costs are only relevant in the area of cable-based telecommunications infrastructure. Since economies of scale are exhausted in the provision of long distance telecommunications infrastructure, competition between active (and potential) firms will prevent the existence of market power (e. g. Laffont, Tirole, 2000, 98). Thus there remains no regulatory need for disciplining the market power of alternative infrastructure providers. As a consequence, all markets on the retail level as well as those markets on the wholesale level focussing on long-distance networks should be excluded from regulation.

3.3.2 Possible remaining regulatory problem in the local loop

As a result, monopolistic bottlenecks can nowadays only be relevant in the local loop. Due to technical progress it is important to view the localisation of mo-

nopolistic bottlenecks in a dynamic context. In the meantime, a considerable technological variety (e. g. optical fibre, wireless networks, CATV networks, satellite technology) and a consequent increase in varieties of network access can be observed. As a consequence, broadband technologies lose the characteristics of a natural monopoly. In addition, effective platform competition becomes relevant, where alternative providers have complete control of all aspects of their networks and the subsequent services. Because of these rapid developments, the local loop facilities in bigger cities and agglomerations are already losing their character of monopolistic bottlenecks.

In order to gain a complete overview of the competition potentials it is necessary to not only focus on the traditional copper cable technology (in the local loop), but to also take into consideration the existence of alternative (broadband) access technologies. These alternatives vary within different parts of a country, but also between different countries, depending on the different histories of the networks and the strategies of the market participants etc. It is therefore important that the phasing-out potential should be properly identified by the regulators, including the emergence of new access alternatives in the relevant market.

Although it is not possible at this point to predict exactly how long it will take for the monopolistic bottlenecks in the local loop to disappear completely, there cannot be any doubt that the regulation of monopolistic bottlenecks has to be viewed in a dynamic context, so that the potential for phasing out sector-specific regulation in telecommunications can be fully exhausted. Network access possibilities depend on the peculiarities of different relevant geographic markets; in any case all relevant alternatives should be taken into account.

3.4 Lessons for Internet access services

Internet traffic services are based on telecommunications capacities. To the extent that the markets for telecommunications capacities are competitive, no regulatory problems arise. To the extent that the markets for telecommunications capacities are characterised by a monopolistic bottleneck, a non-discriminatory

access regulation is required in order to guarantee competition on the complementary service markets.

Access to the IP-based backbone network is impossible without the inputs of long-distance telecommunications capacity. The market for long distance transmission capacity is competitive; moreover, the components for providing Internet logistics do not possess the characteristics of monopolistic bottlenecks resources. As a consequence, the markets for Internet backbone services are competitive without regulation of telecommunications inputs.

In contrast, in the local telecommunications infrastructure regulation may be necessary in order to guarantee competitive markets for Internet access services. However, network neutrality regulation of the markets for Internet access services is not only superfluous but detrimental from the welfare economic point of view.

In order to provide Internet access services (based on DSL services), local switch facilities are no longer necessary. Access to copper cable is sufficient, such that competing providers can implement alternative network upgrading strategies, e. g. upgraded copper cable by DSLAMs (Digital Subscriber Line Access Multiplexer). Similar to the situation of competing upgrading strategies by DSLAM on the basis of copper, competing upgrading strategies by means of fibre cables and other upgrading components are possible on the basis of ducts and ductworks. As an alternative to local telecommunications network infrastructures, ducts and ductworks from electricity or water companies may be available as well. Thus, ex ante regulation of access to ducts and ductworks may only be justified if alternative infrastructures for end customers (e. g. interactive broadband cable) are not available, or alternative duct networks, which can be upgraded for VDSL (Very High Speed Digital Subscriber Line) purposes at reasonable cost, are not available (Blankart, Knieps, Zenhäusern, 2007, pp. 425 ff.).

By implementing access regulation of local loop bottleneck components the transfer of market power from the telecommunications network bottleneck components into the complementary Internet access service markets can be avoided.

Regulation between access service providers and Internet application service providers is not only superfluous but detrimental. The avoiding of network neutrality regulation is of particular importance, because only then can the adequate market signals (congestion tariffs, quality differentiations etc.) be supplied to the content provider, leading to a more efficient exploitation of the Internet traffic resources.

Arrangements among access service providers and Internet service application providers are not subject to sector-specific regulation. The agreements that cover the conditions of providing Internet access services to Internet application service providers (including content service providers) are characterised by private negotiations and are subject to the non-disclosure rules of general competition law. From the economic theory of regulation it follows that there is indeed no need for ex ante regulation of these vertical relations, due to the absence of network-specific market power on these service markets.⁷ It can be expected that within the “smart” Internet architecture each Internet access service provider develops its own logistic concepts, leading to a variety of quality of service differentiation strategies.

Given ex ante access regulation of monopolistic bottleneck components within the local loop it can be expected that Internet access service providers are under the pressure of competition, such that foreclosure strategies with respect to Internet service providers (including Internet content providers) are not incentive-compatible. If an Internet access service provider were to discriminate against a specific application, the Internet application service provider could easily find an alternative Internet access service provider.

⁷ According to Kahn, 2007, 3 there is only one example known of discrimination, namely the refusal of small Madison River Telephone Company to carry the messages of its VoIP competitor, Vonage, the leading independent provider of telephone service over the Internet. The Federal Communications Commission immediately prohibited that obvious violation of antitrust principles (see also Yoo, 2006, 1855).

4. Conclusions

Our main results can be summarized as follows:

- (1) The debate on network neutrality is mainly driven by an attempt to impose, by regulatory measures, principles from the historical Internet on the current status of the evolution of the Internet architecture. In the historical Internet, there was no application awareness, no intelligence within the Internet itself, routers functioning according to “first in first out”, basically no time-sensitivity of content etc. Therefore this Internet is referred to as the “dumb” Internet. In contrast, in today’s “smart” Internet, content delivery networks worldwide are increasingly installed as overlay networks in order to manage time-sensitive content such as video conferences, remote medical applications etc. As a consequence, heterogeneous needs for traffic qualities and congestion management exist.
- (2) An economically founded way of dealing with traffic capacity scarcity within today’s Internet is the application of congestion pricing and quality differentiation. But exactly these economic measures would be banned, if network neutrality regulation became effective. Competitive traffic shaping as a result of contract negotiations between market actors would be prohibited.
- (3) The regulation envisaged in the network neutrality debate is not based on regulatory economics. In order to understand the economic damage following from such regulation, one has to take a disaggregated view of the Internet. It is crucial to differentiate between the Internet and its periphery. Basically, the Internet periphery consists of terminal equipment, content, local telecommunications infrastructure and long-distance telecommunications infrastructure. The Internet itself consists of Internet access services, Internet backbone services and Internet application services.
- (4) Nowhere can stable sector-specific market power be localised within the Internet; stable market power constellations do not exist, meaning a natural monopoly occurring in combination with sunk cost in the relevant range of demand (monopolistic bottleneck).

- (5) It is necessary to regulate market power at its roots, meaning the remaining bottleneck components within the local loop in the telecommunications network. The complementary Internet access service market is competitive. Network neutrality regulation would be detrimental. It would prevent the necessary contractory arrangements between Internet access service providers and providers of Internet applications and subsequently limit flexibility with respect to the design of the Internet architecture, quality differentiation and congestion management.

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