

May, 2008

The (In)essentiality of Monopoly Power in Network Neutrality Violations

Matthias Bärwolff



SELECTEDWORKS™

Available at: <http://works.bepress.com/mbaer/1/>

The (In)essentiality of Monopoly Power in Network Neutrality Violations*

Matthias Bärwolff[†]

May 8, 2008

Abstract

It has recently been proposed that competition in the provision of internet access does not obtain the normative goals of network neutrality proponents. Even under competition internet access providers will still have substantial incentives to discriminate against independent providers' content and applications. We argue that this argument effectively conforms to basic insights from models of monopolistic competition and, in itself, holds little of the policy relevance alleged by network neutrality advocates. Without empirical validation the conclusions of such an argument—an urgent call for material network neutrality regulation—is unjustified. Further, we point to the duality of the discrimination problem, for the issue is often portrayed as one where content providers and “innovators” have little to no bargaining power vis à vis the internet providers.

1 Introduction

In most contributions to the debate about network neutrality a monopoly structure in the market for internet access has been regarded an undisputed and unquestioned precondition for network neutrality arguments to apply.¹ Recently, however, new arguments have been put forward claiming that considerable market power is a sufficient, but not necessary, condition for internet service providers and network operators to discriminate against independent content or applications travelling their

*This is a slightly revised version of an Unpublished Working Paper available online from <http://ig.cs.tu-berlin.de/ma/mb/ap/>. Comments are very welcome, please email me at mbaer-at-cs.tu-berlin.de.

[†]Matthias Bärwolff is PhD candidate at Technische Universität Berlin, Chair of Informatics and Society. Thanks go to Bernd Lutterbeck and Frank Pallas for inspiring and helpful comments on earlier drafts of this paper.

¹See, e. g., Lemley and Lessig (2001), Cooper (2004), Frischmann (2005), Yoo (2005), Frieden (2007).

wires.² It has even been argued that discrimination in violation of end-to-end rules³ is *more* likely to occur in the absence rather than in the presence of market power (van Schewick 2007). Clearly, this argument adds a whole new urge to the policy implications discussed in the network neutrality debate. The harm from leaving the internet service provision market unfettered from network neutrality rules would appear much larger, justifying material state intervention.

The aim of this paper is to show that such claims are unjustified because they are essentially speculative, lack compelling empirical support, and ignore economic insights from the theory of monopolistic competition.⁴ We do submit that with our brief comment we remain within the bounds of the economic legal framework of discourse established by the high-profile discussants to the network neutrality debate.⁵ Thus, in a sense, succumbing to the temptation of abstracting away from the technology we fail to add anything new to the debate that may serve to help reframe the issue more firmly within a proper informatics perspective. Nevertheless, we hope to at least offer a useful critique of arguments in favour of overly broad network neutrality regulation.

In the following section we will discuss the weaknesses of what we call the *monopoly-not-essential* argument. Along the way we shall discuss some of the issues raised by this argument. We will close with some notes about the duality of the discrimination problem.

2 A gentle critique of the *monopoly-not-essential* claim

The *monopoly-not-essential* argument may best be captured with a quote from van Schewick (2007):

[A] network provider may have the ability and incentive to exclude rival content, applications or portals from its network, even if it faces limited competition in the market for Internet services. [...] The

²See van Schewick (2007), Frischmann and van Schewick (2007), Hogendorn (2007).

³The technical arguments for an end-to-end design in network systems have been seminal developed by Saltzer, Clark, and Reed (1984). They put forward two basic design principles: First, functions should only be implemented at a given layer if they can be fully implemented at that layer. Otherwise that function must be left to higher layers that are capable of fully implementing it, for it will have to be reimplemented at that higher layer anyway. Incomplete functionality at lower layers will in many cases add but redundancy. Their second point is broader in scope, arguing that functions that *inhibit* certain applications (rather than merely adding redundancy) should not be implemented at lower network layers thus leaving a broader scope for applications (including unforeseeable) to develop at higher layers.

⁴Our qualifications are not to be construed as a broad rejection of the whole set of arguments put forward by network neutrality proponents some of which have undisputed merit.

⁵The core arguments of the ongoing debate are economic ones, only very rarely do informatics arguments successfully inform the debate. Noteworthy exceptions to the unfortunate trend of framing the debate over technological artefacts such as software or the internet solely in economic and legal terms are van Schewick (2004) and Ishii (2005), two PhD theses at the Chair of Informatics and Society at Technische Universität Berlin.

lack of monopoly in the primary market even increases the network provider's incentive to increase profits by engaging in exclusionary conduct in the complementary market, as the network provider cannot simply extract the available monopoly profit by charging higher prices in the primary market. (pp. 370 f., footnotes omitted)

According to proponents of this theory, the disciplining forces of competition cannot remedy this situation in the face of pervasive lock-in effects and resulting switching costs.⁶ Thus effectively any provider of internet services in a competitive industry has the requisite means and a strong economic incentive to exclude or discriminate against rivals in secondary markets of content and applications. The potentially adverse implications of such discrimination have been discussed for some time (Frischmann 2005; van Schewick 2004).

There are two principal problems with the *monopoly-not-essential* claim. The prime weakness of the argument is its glaring lack of empirical foundation.⁷ Most if not all of the evidence presented in support of theoretical claims of discrimination and its adverse impacts are, in fact, secondary and often inadequate resources.⁸

⁶ Also, it is often argued that access providers will very likely use clandestine discrimination instead of obvious exclusion thus giving rise to asymmetric information that will put incumbents at a competitive advantage over rivals. See, e. g., van Schewick (2007, pp. 376–377).

⁷None of the theoretical papers such as Frischmann (2005), Frischmann and van Schewick (2007), van Schewick (2007) in favour of broad network neutrality regulation can point to substantial empirical foundation. Accordingly, the heavy use of qualifiers such as “may” and “potential” manifests the inherent limitations to their claims. In fact, sober empirical research creates a mixed if not benign picture of network neutrality violations. Beverly et al. (2007) conclude:

The fact that MIT and other non-profit organizations block the Windows file sharing ports potentially provides justifiable evidence that Comcast's intentions in blocking the same ports are not abuses of market power. Indeed, here *the motivation for blocking is based upon operators' concerns for end-user security and privacy*. (footnotes omitted, emphasis added)

(As an aside, many other major universities including University of California have been actively banning peer-to-peer file sharing applications on their campuses.) Others have identified insulated instances of blocking and discriminating of content and applications by ISPs or backbone carriers (Windhausen 2006, p. 16 ff.). However, most of these incidents have been dealt with successfully by swift antitrust actions or adverse consumer reactions. Last not least it has been pointed out that ISPs often contractually restrict usage of internet accesses (Wu 2004, pp. 211 ff.). But, as Sandvig (2007) has observed: “Many of these provisions have no legal force and are simply outrageous, presented legalistically as a scare tactic rather than an enforceable contract” (p. 139).

⁸Assuming the risk of digressing a little off topic, let us but briefly point to the inadequacy of relying on secondary and outdated sources for one's argument by looking into one of the secondary resources listed in van Schewick' paper. One footnote refers to some 1999 statistics about unique visitors and advertising revenues of Yahoo and Lycos assembled by MacKie-Mason (2000) who argues that “the relationship between reach and advertising revenues is not a linear one” (p. 13) but in effect one where the dominant party commands an even more dominant share of advertising revenues. Let us for the moment assume that the ratio of advertising revenues to unique visitors is related to the share of unique visitors in an industry and not, as one might think, to the value of the content offered, the effectiveness of the advertising measures and the wealth of the target audience. The most obvious objection would, of course, be that the data of MacKie-Mason are rather old and too singular to be

Second, the assertion that a monopoly is not a necessary condition to the ability of successfully discriminating independent producers and thus harming one's customers is based *solely* on the assumption that significant switching costs in the face of network effects and returns to scale render anti-competitive measures feasible.⁹ Note the contradiction in this line of reasoning: On the one hand, it is argued that monopoly power is unnecessary; on the other, that there are prohibitive switching costs. However, switching costs being sufficiently large to confer price-setting power upon a party render the situation one of plain monopoly again. Put differently, the existence of high switching costs is a sufficient condition for monopoly power. Thus the very claim that a monopoly is not essential to the ability and sensibility to discriminate against third parties remains speculative given the assumption of prohibitive switching costs.

We suggest that it would be more appropriate to model the situation at hand as one of "monopolistic competition" where *every* agent is, in effect, a monopolist

statistically significant. One should have run various regressions over the due time series to arrive at robust dependencies between unique visitors and advertising revenues. Shall it suffice here to look but briefly into the sources of MacKie-Mason and compare them to more recent figures in order to see if they even remotely support the argument of van Schewick. The MacKie-Mason quote that van Schewick (2007) refers to reads:

[T]he relationship between reach and advertising revenues is not a linear one. [...] Even larger portals do not attract advertising revenues in proportion to their reach statistics. For example, although Lycos, the #4 Web property, had 72% as many unique visitors as did Yahoo! in September 1999, it received only 36% as much advertising revenue. (p. 13)

These numbers have apparently been drawn from a comScore report at <http://www.comscore.com/press/displaycontent.asp?press=161&suffix=htm> and the two company's financial statements. The numbers themselves are sound, but one cannot draw the implication that Lycos would have to double its advertising revenues in order to be at par with Yahoo. Instead, it would be more appropriate to state that on the one hand Yahoo had 58% and Lycos the remaining 42% of their unique visitors combined, and on the other that Yahoo realised 74% and Lycos the remaining 26% of advertising revenues combined. Lycos would thus have to gain another 16% of their combined advertising revenues from Yahoo's share to equal advertising revenue shares and market shares. Put this way the figures look much less dramatic than MacKie-Mason would have us believe.

Worse still, if we look at more recent numbers the link between unique visitor share and advertising revenue per unique visitor seems to break down completely. Lycos advertising revenue figures are hard to come by, for Lycos is now a subsidiary of Daum Communications, Korea. Thus we chose to compare Yahoo and Time Warner as of September 2006. To this end we looked up unique worldwide visitors of both web properties at <http://www.comscore.com/press/release.asp?press=1049>, as well as advertising revenues for the year 2006 of both companies from their annual reports. The results are sobering: Yahoo reaches 480.6 million unique visitors globally whereas Time Warner reaches 217.8 million. Yet, advertising revenues were \$ 5,627 million for Yahoo and 8,515 million for Time Warner. The resulting ratios bear little resemblance to the ones put forward by MacKie-Mason (2000).

⁹Note that the elaborations of exceptions to the "one monopoly rent theorem" leading up to the central claim in van Schewick's papers are certainly worthwhile and interesting, yet are causally irrelevant for the central argument developed in section I. C. (pp. 368 ff.). Relaxing the monopoly assumption renders the foregoing considerations futile, for they are based precisely on this assumption.

subject to competition by others who are monopolists, too. Monopolistic competition posits that monopoly is an indispensable and valuable by-product of the very process of competition. It is but natural for *any* market participant to try and build some monopoly power with his customers.¹⁰ Bresnahan (1998) has argued in the more specific context of vertical competition between the various layers in IT industries that

[t]o participate at all in epochal vertical competition a firm absolutely needs a defensible ‘home’ monopoly”. (p. 36)

Put differently, not only is the prospect of monopoly an important source of innovation and growth (Schumpeter 1942), but a monopoly is a vital prerequisite to the very process of competition.

There is a well-developed literature dealing not only with the social benefits of returns to scale, network effects, and vertical integration efficiencies, but also with the limits to feasibly establishing and maintaining monopolies based on such forces.¹¹ The crucial point is that a monopoly is never perfect, for there are always substitutes that limit what a monopolist can do without losing customers to competitors. More to the point of this paper, it is instructive to note that switching costs in internet access are, in fact, rather low, and do not present a major barrier to entry for would-be competitors as van Schewick (2007) argues.¹² While switching

¹⁰See Chamberlin (1950) who has seminally developed the notion of monopolistic competition and has put the main insight succinctly:

Anything which makes buyers prefer one seller to another, be it personality, reputation, convenient location, or the tone of his shop, differentiates the thing purchased to that degree, for what is bought is really a bundle of utilities, of which these things are a part. [...] With differentiation appears monopoly, and as it proceeds further the element of monopoly becomes greater. Where there is any degree of differentiation whatever, each seller has an absolute monopoly of his own product, but is subject to the competition of more or less imperfect substitutes. Since each is a monopolist and yet has competitors, we may speak of them as “competing monopolists”, and, with peculiar appropriateness, of the forces at work as those of “monopolistic competition.” (pp. 8–9)

See also Dixit and Stiglitz (1977) for the now prevailing canonical approach to monopolistic competition.

¹¹For one of the more recent authoritative references see Shapiro and Varian (1999). For a comprehensive advanced textbook on modern microeconomics based on the assumptions of increasing returns to scale see Bowles (2004). See also Baumol et al. (1988) for the notion of “contestable markets”.

¹²An exemplary quote reads:

Bundling Internet transport service with proprietary content and applications that are offered exclusively to transport customers is a common way to increase switching costs. In this case, consumers lose access to their old provider’s proprietary content and applications when they switch to another provider. (p. 375, footnotes omitted)

Clearly, however, this argument is informed by industry characteristics from the time when the AOL merger with Time Warner raised fears of vertical integration resulting in substantial lock-in effects. Today, it is tenuous at best to argue that ISPs’ offering proprietary content and applications to cus-

costs are generally an issue in digital goods markets (Shapiro and Varian 1999), the “lock-in” to an internet access provider is confined to the sunk costs in equipment and configuration of user devices which may easily be overcome by a competitor. An alternative provider offering internet access of comparable quality and bandwidth to an incumbent will incur trivial switching costs to a customer willing to change his provider.

As for last mile bottlenecks to internet access, there are alternatives which, of course, provide only so much of a substitute. But nevertheless, no monopoly in internet access is absolute. First, a consumer can fall back on a narrowband connection provided the significantly lower bandwidth does not incur prohibitive costs to him.¹³ Second, there are the increasingly viable options of broadband internet access via wireless mobile networks¹⁴ or geostationary satellites¹⁵ further eroding the market power of telephone or cable monopolies. And, most importantly, as for producers and “innovators”¹⁶, they are even less constricted in their ability to put their content or “innovation” on the internet, for they may generally host their application or content wherever they please.¹⁷

tomers confer substantial market power upon them. See also *supra* footnotes 6 and 9 and accompanying text.

¹³It is intuitively obvious that a broadband connection enables real-time, bandwidth-intensive applications that are simply impossible to implement over narrowband (Kwok 1997). However, as Noam (2003) observes:

Of course it is preferable to have an internet connection that runs at 1 megabit per second rather than a slow dial-up service that might be 100 times slower. [...] [However,] [t]he extra speed of broadband is convenient but not essential. There are few things one could not do on narrowband outside its use for music and video.

While in the age of podcasts and YouTube a narrowband connection seems hopelessly outdated, the basic logic of Noam holds true: there is no doubt a diminishing return from marginal increases to connection speed. As of yet, virtually the only important and widely used applications of high bandwidth, low latency connections are real time video, and, to a certain extent, audio (VoIP). Remote login, messaging, email, WWW, even file transfer are much less dependent on broadband connectivity.

¹⁴Modern “third-generation” technologies such as Universal Mobile Telecommunications System (UMTS) are becoming increasingly deployed and offer true broadband connectivity.

¹⁵A condition is sufficient visibility to the sky. Plus, while there are latency issues with such a connection, it generally allows for data intensive applications. And, while upload speeds have been something of an issue, true bidirectional connections without reliance on additional telephone connectivity for the uplink are becoming increasingly affordable.

¹⁶The notion of innovation is often used in a very casual manner in the network neutrality discussion. Quite often it is taken as a substitute for invention, the step that, in fact, precedes the process of innovation. On the difference between inventions and innovations see, e. g., Rogers (2003). For convenience’s sake we adopt here the sloppy wording.

¹⁷We shall also note that the vertical borders between the horizontal layers in the internet network are highly malleable and often there is a substantial interest by innovators and content producers to integrate tightly with services at lower network layers so as to improve the efficiency of the overall product. Put differently, successful innovations go well beyond the act of inventing and “posting something to the appropriate website”. They often involve multiple layers, substantial outlays, and strong determination (Bresnahan 1998). Google is a good example of this (McTaggart 2006), the recent iPhone frenzy another.

The crucial point is that there is simply no evidence that switching costs in a competitive environment are prohibitive so as to lower social welfare significantly. As Mahoney (2004) notes in a slightly different but essentially related context:

The fact that a shift in a particular property regime makes some projects harder to accomplish [...] is hardly proof of its deficiency. (p. 2318)

In fact, it is precisely those kinds of costs that incentivise others to build businesses that reduce these costs.¹⁸

The argument that providers will successfully use clandestine measures to discriminate against independent parties' content or applications is equally shaky. First, for discrimination measures to have any appreciable effect, they must, of course, be recognisable by a party accessing the rival's content or application. It is, however, naïve to assume that the discrimination will be restricted to unknowing and ignorant consumers while at the same time being disguised so as not to be noticeable as a discrimination. As a result, there is sufficient scope and incentive for parties to capitalise on any remaining information asymmetries or at least disclose such discoveries so as to incur public disfavour or give rise to antitrust actions.¹⁹ Second, if the discrimination efforts were really to be successfully hidden from consumers, it is not clear which if any policy implications beyond the conventional banning of deception and anti-competitive practices would flow from this insight.

3 A Note on the Duality of the Problem

Before we close, a note on the disincentives of unaffiliated producers and innovators due to discriminating incumbents is in order. It is often lamented that independent parties in complementary markets are in a much better position to produce and innovate thus creating significant economic value. But, due to the incentives of network providers to exclude them and enter the market themselves at the expense

¹⁸For a discussion of adapters and the dynamics of interoperability standards see Shapiro and Varian (1999). It is also clear that the presence of monopoly profits in the ISP market—not the regulation of those monopolies—induces competitors to erect alternatives to these monopolies (Yoo 2005). See, e. g., the ongoing efforts by private as well as—to some extent—public parties to establish alternative WI-FI wireless internet access structures (Travis 2006). The future may well see more such efforts based on the emergent WiMAX technology (Gunasekaran and Harmantzis 2006).

¹⁹The recent notorious Comcast interfering with bittorrent traffic by inserting fake TCP RST packets in the communication between two end hosts (<http://www.msnbc.msn.com/id/21376597/>) has not only triggered outrage (<http://bits.blogs.nytimes.com/2007/10/22/comcast-were-delaying-not-blocking-bittorrent-traffic/>) and a formal inquiry by the FCC (<http://www.nytimes.com/2008/01/09/business/media/09fcc.html>), but also heightened awareness for the rôle that end users can play in uncovering such interference of ISPs with the IP traffic between end hosts. In the immediate aftermath of the incident a group of people around Lauren Weinstein and Vinton G. Cerf formed an initiative called Net Neutrality Squad, “an open-membership, open-source effort, enlisting the Internet's users to help keep the Internet's operations fair and unhindered from unreasonable restrictions” (<http://www.nnsquad.org/>).

of said independent parties, it is argued, these parties will have a severely reduced incentive to innovate or even refrain from innovating or producing at all. However, for the incumbent to enter the market himself where it has driven the rival from by means of discrimination and exclusion may well imply infringing upon intellectual property rights held by that rival.²⁰ There are very strong and coherent legal norms with respect to copyright in software and digital content.²¹ Patents and trademarks may well apply, too. Those rights, which effectively amount to limited yet enforceable property rights in the resources subject to possible discrimination, will severely inhibit the network provider from simply emulating a independent rival's offer.

And, while it is true that there are significant costs and uncertainties in pursuing infringement of intellectual property rights,²² it is likely that the artefacts in question giving rise to such disputes are rather valuable, in turn justifying incurring non-trivial transaction costs. If the value of the artefacts were negligible there would be little reason for the network provider to discriminate against an independent producer in the first place.²³

The property rights giving rise and legal recognition—however circumscribed and imperfect—to exclusion and discrimination work both ways, from the internet provider to the independent innovator and vice versa. The former may exclude the latter from access to his network by virtue of his ownership and control over the network, while the latter may keep the former from imitating his content or invention by virtue of intellectual property rights and enforcement through courts of law. Thus there is a reciprocity of powers that often goes unnoticed. At the very least, the intellectual property rights on part of an independent innovator will increase the costs of discriminating, for the entire surplus thus created vanishes from the reach of the network provider or, even worse, goes elsewhere altogether so as to impact the competitive position of the network provider adversely.

²⁰Conventional antitrust and competition law may apply, too.

²¹See the WIPO Copyright Treaty of 1996 (<http://www.wipo.int/documents/en/diplconf/distrib/94dc.htm>) which has largely been implemented by all major economies including the US and Europe.

²²Lessig (2004) has argued:

Many of the most significant innovations [on the internet] were developed first by [...] the population of innovators least likely to manage the transaction costs of negotiating with network owners before their innovations get deployed. (p. 40)

This may or may not be true, but it is no proof that the invention and the actual innovations would not occur when network providers had the legal right and the technical means to discriminate against independent parties. As we have argued above, an inventor is generally free to host his invention wherever he pleases. Plus, the actual *process* of innovation—the dissemination of an invention into a broader social context—is rarely achieved by a single independent party merely “posting stuff to a website”. More often, a promising invention is adopted by a party which is capable of fulfilling the potential of that invention by doing the innovation part which is often enough much trickier than doing the underlying invention (Rogers 2003).

²³There is, indeed, no significant empirical evidence whatsoever of discrimination against third parties disseminating trivial and to all intents and purpose non-commercial artefacts over the internet.

4 Conclusion

We have argued that a lack of monopoly power by ISPs will hardly make adverse discrimination against independent parties likely per se, let alone *more* likely compared to monopoly or duopoly situations. The arguments put forward by proponents of such theory are no doubt interesting but ultimately tenuous. The theory that a monopoly is unnecessary or even detrimental for successfully discriminating against rival third parties has no compelling empirical support whatsoever. Moreover, it exhibits some troubling inconsistencies in argument. Thus existing network neutrality considerations should not be applied to competitive ISPs without due empirical accounts justifying such efforts.

We have also argued that valuable innovations will occur despite the—however likely—prospect of discrimination by incumbent ISPs, for the underlying inventions will be subject to intellectual property rights in the shape of copyright and trademarks, and possibly patents, too. Those property rights will serve as a complement to the power of ISPs to exclude such independent inventions and content from their networks by virtue of their property rights in the network. Thus the intellectual property rights of inventors and content producers will also confer the prospect of surplus and thus economic incentive to produce or invent in the first place.

References

- Baumol, W. J., J. C. Panzar, and R. D. Willig (1988). *Contestable markets and the theory of industry structure* (revised ed.). San Diego, CA: Harcourt Brace Jovanovich.
- Beverly, R., S. Bauer, and A. Berger (2007). The internet's not a big truck: Toward quantifying network neutrality. In *Proceedings of the 8th Passive and Active Measurement (PAM 2007) Conference, Louvain-la-neuve, Belgium*. <http://www.mit.edu/~rbeverly/papers/truck-pam07.pdf>.
- Bowles, S. (2004). *Microeconomics: Behavior, Institutions, and Evolution*. Princeton University Press.
- Bresnahan, T. (1998). New modes of competition and the future structure of the computer industry. In *Competition, Convergence, and the Microsoft Monopoly*, Volume Progress and Freedom Foundation Volume. Kluwer. <http://www.stanford.edu/~tbres/research/pff.pdf>.
- Chamberlin, E. H. (1950). *The theory of monopolistic competition: A re-orientation of the theory of value* (6th ed.). Harvard University Press. First published in 1933.
- Cooper, M. N. (2004). Making the network connection. In M. N. Cooper (Ed.), *Open Architecture as Communications Policy: Preserving Internet Freedom*

- in the Broadband Era*, pp. 95–154. Center for Internet and Society, Stanford Law School. <http://cyberlaw.stanford.edu/attachments/openarchitecture.pdf>.
- Dixit, A. K. and J. E. Stiglitz (1977). Monopolistic competition and optimum product diversity. *The American Economic Review* 67(3), 297–308.
- Frieden, R. (2007). Network neutrality or bias? Handicapping the odds for a tiered and branded internet. *Hastings Communications and Entertainment Law Journal* 29(2), 171–216. <http://law.bepress.com/cgi/viewcontent.cgi?article=8300&context=expresso> (2006 working paper version).
- Frischmann, B. M. (2005). An economic theory of infrastructure and commons management. *Minnesota Law Review* 89(4), 917–1030. <http://ssrn.com/abstract=704463>.
- Frischmann, B. M. and B. van Schewick (2007). Network neutrality and the economics of an information superhighway: A reply to Professor Yoo. *Jurimetrics: The Journal of Law, Science and Technology* 47(4), 383–428. <http://ssrn.com/abstract=1014691> (2007 working paper version).
- Gunasekaran, V. and F. Harmantzis (2006). Towards a Wi-Fi ecosystem: Technology integration and emerging service models. Summary paper based on earlier conference contribution of the two authors, Howe School of Technology Management. http://howe.stevens.edu/fileadmin/Files/publications/Towards_a_Wi-Fi_Ecosystem.pdf.
- Hogendorn, C. (2007). Broadband internet: Net neutrality versus open access. Working Paper 2006-09, Technische Universität Berlin. http://www.cni.tu-berlin.de/fileadmin/documents/RePEc/cni/working_paper/hogendorn_2006-broadband-internet-cni_wp_no_2006-09.pdf and a slightly larger 2007 version at <http://chogendorn.web.wesleyan.edu/oa.pdf>.
- Ishii, K. (2005). *Code Governance: “Code” as Regulation in a Self-governed Internet Application from a Computer Science Perspective*. Dissertation zum Doktor der Ingenieurwissenschaften (Dr. Ing.) (PhD Thesis), Technische Universität Berlin, Germany. <http://ishii.de/kei/codegovernance/Ishii2005-CodeGovernance.pdf>.
- Kwok, T. C. (1997). Residential broadband internet services and applications requirements. *IEEE Communications Magazine* 35(6), 76–83.
- Lemley, M. A. and L. Lessig (2001). The end of end-to-end: Preserving the architecture of the internet in the broadband era. *UCLA Law Review* 48(4), 925–972. Also published in the 2004 Stanford collection

- “Open Architecture as Communications Policy: Preserving Internet Freedom in the Broadband Era”, <http://cyberlaw.stanford.edu/attachments/openarchitecture.pdf>.
- Lessig, L. (2004). Coase’s first question: When should there not be property rights? *Regulation* 27, 38–41. <http://www.cato.org/pubs/regulation/regv27n3/v27n3-4.pdf>.
- MacKie-Mason, J. K. (2000). An AOL/Time Warner merger will harm competition in internet online services. Report submitted to the U.S. Federal Trade Commission, University of Michigan. <http://www-personal.umich.edu/~jmm/papers/aol-tw00-public.pdf>.
- Mahoney, J. D. (2004). Lawrence lessig’s dystopian vision. *Virginia Law Review* 90(8), 2305–2333. <http://www.virginialawreview.org/content/pdfs/90/2305.pdf>.
- McTaggart, C. (2006). Was the internet ever neutral? In *34th Telecommunications and Communications Policy Research Conference (Papers online)*, Number ID: 593, pp. 1–31. <http://web.si.umich.edu/tprc/papers/2006/593/mctaggart-tprc06rev.pdf>.
- Noam, E. (2003). Let them eat megabits. *Financial Times* (November 25). http://www.citi.columbia.edu/elinoam/articles/Let_Them_Eat_Megabits.pdf, <http://search.ft.com/nonFtArticle?id=031126008289>.
- Rogers, E. M. (2003). *Diffusion of Innovation* (5th ed.). Simon & Schuster International.
- Saltzer, J. H., D. Clark, and D. Reed (1984). End-to-end arguments in system design. *ACM Transactions in Computer Systems* 2, 277–288. <http://web.mit.edu/Saltzer/www/publications/endoend/endoend.pdf>.
- Sandvig, C. (2007). Network neutrality is the new common carriage. *Info: The Journal of Policy, Regulation and Strategy for Telecommunications, Information and Media* 9(2/3), 136–147. http://www.spcomm.uiuc.edu/csandvig/research/Network_Neutrality_is_the_New_Common_Carriage.pdf (different layout).
- Schumpeter, J. A. (1942). *Capitalism, socialism and democracy*. New York: Harper & Brothers.
- Shapiro, C. and H. R. Varian (1999). *Information Rules: A Strategic Guide to the Network Economy*. Harvard: Harvard Business School Press.
- Travis, H. (2006). Wi-Fi everywhere: Universal broadband access as antitrust and telecommunications policy. *American University Law Review* 55(6), 1697–1800. http://www.wcl.american.edu/journal/lawrev/55/travis55_6.pdf.

- van Schewick, B. (2004). *Architecture and Innovation: The Role of the End-to-End Argument in the Original Internet*. Dissertation zum Doktor der Ingenieurwissenschaften (Dr. Ing.) (PhD Thesis), Technische Universität Berlin, Germany.
- van Schewick, B. (2007). Towards an economic framework for network neutrality regulation. *Journal on Telecommunications and High Technology Law* 5(2), 329–392. http://www.colorado.edu/law/jthtml/articles_0502/0502_web_vanschewick.pdf.
- Windhausen, Jr., J. (2006). Good fences make bad broadband: Preserving an open internet through net neutrality. Public Knowledge white paper, Public Knowledge, Washington, DC. <http://www.publicknowledge.org/pdf/pk-net-neutrality-whitep-20060206.pdf>.
- Wu, T. (2004). Network neutrality, broadband discrimination. In M. N. Cooper (Ed.), *Open Architecture as Communications Policy: Preserving Internet Freedom in the Broadband Era*, pp. 197–229. Center for Internet and Society, Stanford Law School. <http://cyberlaw.stanford.edu/attachments/openarchitecture.pdf>.
- Yoo, C. S. (2005). Beyond network neutrality. *Harvard Journal of Law and Technology* 19(1), 1–77. <http://jolt.law.harvard.edu/articles/pdf/v19/19HarvJLTech001.pdf>.