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WOULD MANDATING BROADBAND NETWORK NEUTRALITY HELP OR HURT COMPETITION? A COMMENT ON THE END-TO-END DEBATE

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CHRISTOPHER S. YOO*

ABSTRACT

A chorus of commentators has drawn inspiration from the "end-to-end" argument first advanced by Saltzer, Reed, and Clark and called upon policy makers to mandate that last-mile broadband providers adhere to certain principles of network neutrality. In his contribution to this symposium, Professor Christopher Yoo offers an economic critique of these proposals. He first concludes that they are based on a misreading of Saltzer, Reed, and Clark, who implicitly reject turning the end-to-end argument into a categorical mandate. In addition, prohibiting the use of proprietary protocols can harm consumers by skewing the Internet towards certain types of applications. Finally, network neutrality raises the even more significant danger of forestalling the emergence of new broadband technologies by reinforcing the existing supply-side and demand-side economies of scale and by stifling incentives to invest in alternative network platforms. Although such considerations would be problematic under any circumstances, they carry particular weight with respect to industries such as broadband, which are undergoing rapid technological change.

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INTRODUCTION

The broadband industry has reached a crossroads. After avoiding the issue for years,[1] the Federal Communications Commission (FCC) has opened two comprehensive proceedings designed to resolve how the major broadband technologies should be regulated.[2] Congressional committees have also conducted hearings exploring many of the same issues.[3] At the same time, a chorus of commentators, led by Stanford law professor and Internet guru Lawrence Lessig, has invoked the "end-to-end argument" first advanced by Jerome Saltzer, David Reed, and David Clark in 1981[4] and has called upon the FCC to require that all broadband network owners adhere to certain principles of open access and network neutrality.[5] At their core, network neutrality proposals stem

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1. The FCC's reluctance to address these issues may end up limiting its latitude in determining how broadband should be regulated. When the Ninth Circuit first confronted the proper regulatory classification of cable modem services in *AT&T Corp. v. City of Portland*, 216 F.3d 871 (9th Cir. 2000), the FCC had not yet addressed the issue, *see id.* at 876, which forced the court to resolve the issue for itself by concluding that cable modem service is a "telecommunications service." Even though the FCC has since concluded that cable modem service is more properly regarded as an "information service," the Ninth Circuit has declined to accord *Chevron* deference to the FCC's rulings on the grounds that it is bound by stare decisis to adhere to its initial determination. *See* Brand X Internet Servs. v. FCC, 345 F.3d 1120 (9th Cir. 2003). This appears inconsistent with *Chevron*'s recognition that agency interpretations of statutes should be permitted to change over time. *See* Chevron USA Inc. v. Natural Res. Def. Council, 467 U.S. 837, 863-64 (1986). For an interesting discussion of the relationship between *Chevron* and stare decisis, see Richard L. Pierce, Jr., *Reconciling* Chevron *and Stare Decisis*, 85 GEO. L.J. 2225 (1997).

2. One docket addresses the regulatory regime to be applied to digital subscriber line (DSL) service. *See* Appropriate Framework for Broadband Access to Internet over Wireline Facilities, *Notice of Proposed Rulemaking*, 17 FCC Rcd. 3019 (2002) [hereinafter *Wireline Modem NPRM*]. The other docket focuses on cable modem services. *See* Inquiry Concerning High-Speed Access to the Internet Over Cable and Other Facilities, *Declaratory Ruling and Notice of Proposed Rulemaking*, 17 FCC Rcd. 4798 (2002) [hereinafter *Cable Modem Declaratory Ruling and NPRM*]; Inquiry Concerning High-Speed Access to the Internet Over Cable and Other Facilities, *Notice of Inquiry*, 15 FCC Rcd. 19,287 (2000) [hereinafter *Cable Modem NOI*].

3. *See The Government's Role in Promoting the Future of the Telecommunications Industry and Broadband Deployment: Hearings Before the Sen. Comm. on Commerce, Science and Transportation*, 107th Cong., 2d Sess. (2002).

4. *See* J. H. Saltzer et al., *End-to-End Arguments in System Design*, 2 ACM TRANSACTIONS ON COMPUTER SYS. 277 (1984) (revised version of paper first presented in 1981).

5. Lessig offered his most complete statements of this position in LAWRENCE LESSIG, THE FUTURE OF IDEAS 34-48, 147-75 (2001); and Mark A. Lemley & Lawrence Lessig, *The End of End-to-End: Preserving the Architecture of the Internet in the Broadband Era*, 48 UCLA L. REV. 925 (2001). For other leading commentaries offering related proposals, see Jim Chen, *The Authority to Regulate Broadband Internet Access over Cable*, 16 BERKELEY TECH. L.J. 677 (2001); Mark Cooper, *Open Access to the Broadband Internet: Technical and Economic Discrimination in Closed, Proprietary Networks*, 71 U. COLO. L. REV. 1011 (2000); William P. Rogerson, *The Regulation of Broadband Telecommunications, the Principle of Regulating Narrowly Defined Input Bottlenecks, and Incentives for Investment*

from the concern that network owners will use their control over last-mile broadband technologies to discriminate against nonproprietary Internet service providers (ISPs) and unaffiliated content and applications. According to these advocates, mandating open access interoperability is essential if the environment for competition and innovation on the Internet is to be preserved.

There can be no question that the widespread acceptance of the end-to-end argument has played a key role in fostering the Internet's meteoric success and remains a central tenet guiding decisions with respect to network design. That said, the academic debates and the arguments currently being advanced before the FCC have largely overlooked the fact that there is a crucial difference between embracing the end-to-end argument as a *design principle* and elevating it into a *regulatory mandate*. While adherence to the end-to-end argument may make sense in most cases, circumstances do exist in which mandating network neutrality would actually harm competition.

In this article, I develop three fundamental propositions that shed new light on the end-to-end debate. The first is that the leading network neutrality proposals are actually inconsistent with the end-to-end argument advanced by Saltzer, Reed, and Clark. A close reading of their seminal works supports applying the end-to-end argument on a case-by-case basis rather than in the categorical manner envisioned by the current proposals pending before the FCC, a conclusion confirmed by subsequent technologists.

Second, I show how network neutrality proposals in essence are rooted in concerns about vertical integration. Application of the conventional economic wisdom about vertical integration reveals that the dangers envisioned by network neutrality advocates are likely to be more imaginary than real. Although considerable disagreement exists over many aspects of vertical integration theory, there is widespread agreement that certain structural preconditions must be satisfied before vertical integration can plausibly threaten competition. An empirical analysis reveals that these preconditions are not met with respect to the broadband industry.

Third, I would like to outline a new economic approach that offers a radically different approach to promoting competition in the physical layer. One of the core insights of vertical integration theory is that any chain of production can maximize economic welfare only if every level of production is competitive. In other words, any chain of production is

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and Innovation, 2000 U. CHI. LEGAL F. 119; Daniel L. Rubinfeld & Hal J. Singer, *Open Access to Broadband Networks: A Case Study of the AOL/Time Warner Merger*, 16 BERKELEY TECH. L.J. 631 (2001); Timothy Wu, *Network Neutrality, Broadband Discrimination*, 2 J. ON TELECOMM. & HIGH TECH. L. 141 (2003).

only as efficient as its least competitive link, which in the case of the Internet is undoubtedly the last mile. In attempting to preserve and encourage competition and innovation in applications, content, and ISP services, these proposals are directed towards increasing competition in those segments of the broadband industry that are already the most competitive. Instead, basic economic principles suggest that the better course would be to eschew attempting to foster competition in ISP services, content, and applications and instead to pursue regulatory options that would promote competition in the segment that is most concentrated: last-mile technologies.

Restated in terms of the existing models of "layered competition,"[6] the major network neutrality proposals advocate regulating the logical layer in a way that promotes competition in the application and content layers. In the process, they direct their efforts towards the wrong policy problem. Instead, the focus of public policy should be to promote competition in the physical layer, which remains the level of production that is currently the most concentrated, the least competitive, and best protected by barriers to entry.

Finally and perhaps most importantly, the standardization implicit in compelled interoperability tends to reinforce and entrench the sources of market failure that have historically limited the level of competition among last-mile technologies. The traditional justification for regulating wireline communications networks is that the presence of large, up-front sunk costs creates large supply-side economies of scale that cause markets for telecommunications services to collapse into natural monopolies. Interestingly, allowing networks to differentiate the services they offer can mitigate the tendency towards natural monopoly by allowing multiple last-mile technologies to coexist notwithstanding the presence of unexhausted returns to scale. Providers confronting cost disadvantages inherent in the smaller scale of their operations can survive by tailoring their networks to the needs of subgroups who value a particular type of network services particularly highly in much the same manner that specialty stores survive in a world dominated by one-stop shopping. Permitting variations in the protocols and network infrastructure employed in broadband networks thus might enable competition to exist notwithstanding the presence of unexhausted returns to scale.

For example, it is conceivable that allowing networks to differentiate themselves might make it possible for multiple last-mile networks to coexist by serving the needs of a different subgroup: one optimizing its network for conventional Internet applications such as e-mail and website access, another incorporating security features to facilitate e-

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6. *See infra* Section III.A.2.

commerce, a third employing routers that prioritize packets in the manner needed to facilitate time-sensitive applications such as Internet telephony, generally known as "voice over Internet protocol" (VoIP), with others targeting other needs. Conversely, mandating interoperability commodifies bandwidth in ways that sharply limit opportunities to compete on dimensions other than price, which reinforces the advantages enjoyed by the largest and most established players. Moreover, by favoring innovation at the network's edge to the exclusion of innovation in the network's core, this approach risks introducing a regulation-induced bias in favor of certain types of applications and against others.

Other commentators have invoked the burgeoning literature on network economic effects as an alternative justification for regulatory intervention.[7] Network economic effects exist when the value of network access depends on the number of other users connected to the network, rather than the network's technological characteristics or price. The more people that are part of the network, the more valuable the network becomes. As a result, a user's decision to join a network increases the value of the network for others. The fact that the new user cannot capture all of the benefits generated by their adoption decision has led many theorists to regard network economic effects as a kind of externality that causes overall network utilization to drop below efficient levels. Some commentators also argue that network externalities can turn network access into a competitive weapon. By refusing to interconnect with other networks, network owners can force users to choose one network to the exclusion of others. Forcing users to commit to one network naturally leads users to flock to the largest network. In short, network economic effects can create demand-side economies of scale analogous to the supply-side economies of scale caused by the presence of sunk costs.

The current debate has overlooked a number of critical considerations that make it implausible that network economic effects are likely to harm competition.[8] Even more importantly for the debates

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7. *See, e.g.*, Jerry A. Hausman et al., *Residential Demand for Broadband Telecommunications and Consumer Access to Unaffiliated Internet Content Providers*, 18 YALE J. ON REG. 129 (2001). For the seminal works in the theory of network economic effects, see Joseph Farrell & Garth Saloner, *Standardization, Compatibility, and Innovation*, 16 RAND J. ECON. 70, 70 (1985); Michael L. Katz & Carl Shapiro, *Network Externalities, Competition, and Compatibility*, 75 AM. ECON. REV. 424 (1985).

8. As I will subsequently discuss in greater detail, the theory of network externalities are largely inapplicable to physical networks such as telecommunications networks, since the network owner is in a position to internalize whatever externalities that may exist. *See infra* notes 115-117 and accompanying text. Furthermore, a network must possess market power before network economic effects can even plausibly harm competition. *See infra* notes 113-114 and accompanying text. As I discuss in *infra* Section III.B.1, this precondition is not

surrounding network neutrality, compelled standardization runs the risk of reinforcing the tendencies towards concentration already extant in the broadband industry. The economic literature recognizes that network diversity can ameliorate the anticompetitive effects of the demand-side economies of scale associated with network economic effects in much the same manner as it can mitigate the problems caused by supply-side economies of scale. Imposing network neutrality would prevent such competition from emerging and would instead force networks to compete solely in terms of network size and price, considerations that tend to favor the largest players. As a result, imposing network neutrality as a regulatory matter can have the perverse effect of entrenching the oligopoly of last-mile providers that represents the central policy problem facing the broadband industry. In other words, mandating network neutrality raises the real danger that regulation would become the source of, rather than the solution to, market failure. Such considerations are particularly problematic when the industry is undergoing dynamic technological change, as is the case in broadband.

Emphasizing the potential harms associated with compelling network neutrality as a regulatory matter is not inconsistent with recognizing the value of adhering to standardization as a default principle. Interoperability and the end-to-end argument clearly offer benefits to both providers and consumers, and network designers should hesitate before deviating from those central precepts. Indeed, I would expect that most industry participants would voluntarily design their technologies to be fully interoperable and compatible in the vast majority of cases even in the absence of regulation. The question posed by the debate over network neutrality is not whether consumers benefit from standardization; they clearly do. To the extent that is true, there is no need to mandate network neutrality, since the benefits to consumers from standardization should be reflected in market outcomes. The real issue posed by the network neutrality debate is whether regulators should step in and impose standardization in those situations where the market exhibits a preference for differentiation. The fact that the structure of the broadband industry makes it unlikely that any network owner will be able to use nonstandardization to harm competition indicates that such intervention is unwarranted. In addition, by preventing last-mile providers from tailoring their networks to pursue alternative strategies, barring network diversity threatens to make matters worse.

The balance of this article is organized as follows. Section I describes the Internet's basic structure and lays out the issues surrounding the network neutrality debate. Section II evaluates the end-to-end

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satisfied with respect to the broadband industry.

argument, concluding that it does not support the imposition of network neutrality as a regulatory mandate. Section III demonstrates the close relationship between network neutrality and the economics of vertical integration. It also examines the structure of the broadband industry, concluding that the structural preconditions needed for vertical integration to pose a threat to competition are not satisfied. Section IV analyzes the potential benefits of allowing last-mile providers to deviate from complete interoperability. Allowing last-mile providers to use vertical integration to differentiate their networks would allow the realization of certain efficiencies and would permit them to offer a broader range of services better attuned to consumers' preferences. Even more importantly, requiring all broadband networks to use nonproprietary protocols can actually reduce competition by reinforcing the economies of scale already enjoyed by large telecommunications providers. Section V discusses the proper role of regulation, concluding that regulatory authorities will be more effective at promoting entry by new network platforms than they would be in ascertaining whether a particular exclusivity arrangement would promote or hinder competition. Indeed, one of the benefits of pursing the strategy of promoting entry is that it has embedded within it a built-in exit strategy. Once a sufficient number of broadband network platforms exist, regulatory intervention will no longer be necessary.

I. FRAMING THE NETWORK NEUTRALITY DEBATE

Understanding the debates about broadband regulation requires an appreciation for certain key features of the Internet's underlying structure.[9] In order to facilitate the discussion, Part A offers a simplified description of the basic structure of the original narrowband Internet. Part B identifies the key architectural changes effected by the migration to broadband technologies. Part C considers the impact of shifts in users' relationship with the Internet. Part D examines how these various transformations have shaped the debates about network neutrality that have arisen in the broadband regulatory proceedings.

A. The Architecture of the Narrowband Internet

As has been often noted, the Internet is not a single, monolithic network. Rather it is a network of networks that are interconnected together. When the Internet first became popular, it was fairly easy to divide components of the network into three categories.[10] The core of

9. Those already familiar with the Internet and the debates about network neutrality may wish to skip directly to Section II.

10. *See* Inquiry Concerning the Deployment of Advanced Telecommunications

the Internet is provided by backbone providers, such as AT&T, Cable & Wireless, Level 3, MCI WorldCom, and Qwest.[11] Backbones are high-bandwidth, long-haul network providers that carry traffic between a limited number of recognized locations. By 1998, backbones interconnected through eleven public access points.[12] Since that time, major backbone providers have increasingly interconnected directly at private locations.

The final connection is provided by last-mile providers, which carry data traffic from central facilities located in different metropolitan areas to end users. In the narrowband world, last-mile services are almost invariably provided by the local telephone company. Narrowband customers typically connect by using a dial-up modem to place a conventional telephone call routed to another location within the same local calling area. Customers with higher volumes of data traffic employ more sophisticated telephone technologies, such as T-1 or T-3 lines, integrated services digital networks (ISDN), frame relay, or fiber optics.[13]

The gap between the limited geographic points served by backbone providers and the widely dispersed locations of last-mile providers is bridged by a third category of network provider, commonly called ISPs.[14] The best known ISPs include America Online, MSN, Earthlink, Juno, and Netzero. ISPs typically have a higher port density and carry a lower volume of traffic at lower speeds than backbone providers. In addition to carrying traffic between the NAPs and the points of presence

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Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, *Second Report*, 15 FCC Rcd. 20,913, 20,922-38 ¶¶ 16-59 (2000) (categorizing Internet network providers into a similar three-part taxonomy).

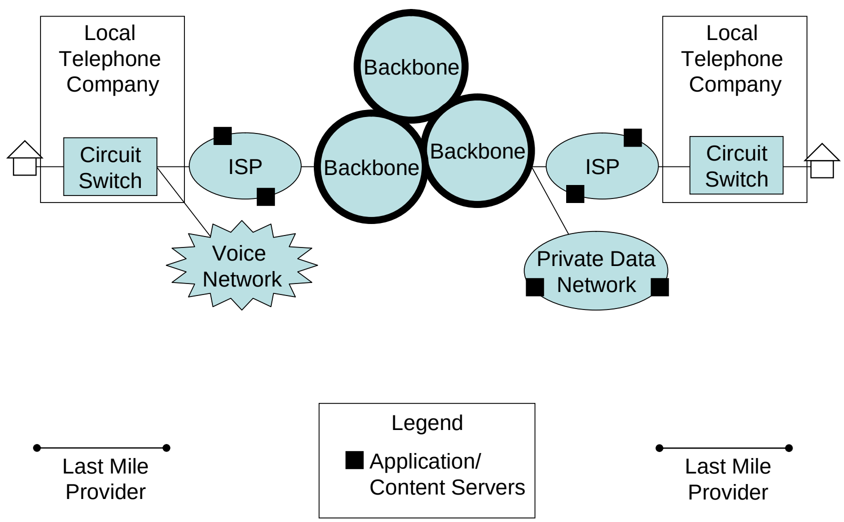
11. Backbone providers are also called "tier 1 ISPs."

12. The original backbone supported by the National Science Foundation until 1995 (known as NSFNet) carried traffic between three "network access points" (NAPs) located in San Francisco, Chicago, and New York. The restrictions the NSF placed on commercial uses of the backbone led a group of private companies to create an additional interconnection point known as the "commercial internet exchange" (CIX) located in Santa Clara, California. The federal government also established federal internet exchange (FIX) points in College Park, Maryland, and Mountain View, California. In addition, Metropolitan Fiber Systems, Inc. (now owned by WorldCom) expanded the fiber rings that it established in Chicago, Dallas, Los Angeles, San Jose, and Washington, D.C. into "metropolitan area exchanges" (MAEs) that essentially performed the same functions as NAPs. *See* Jack Rickard, *The Internet-What Is It?*, BOARDWATCH, Winter 1998, *available at* http://www2.cs.uh.edu/~klong/papers/WhatIsTheInternet.pdf; Michael Kende, *The Digital Handshake: Connecting Internet Backbones*, 11 COMMLAW CONSPECTUS 45, 48-50 (2003).

13. Kende, *supra* note 12 at 46.

14. National companies who connect local points of presence to NAPs are often called tier 2 ISPs. Regional providers are often called tier 3 ISPs. Note that many providers that I have termed backbone providers refer to themselves as ISPs. For simplicity, I will refer to tier 1 ISPs as "backbone providers" and reserve the term "ISP" for tier 2 and tier 3 providers.

FIGURE 1
BASIC ARCHITECTURE OF NARROWBAND TECHNOLOGIES



within each last-mile provider's service area, ISPs perform a number of other functions, including supplying e-mail servers, hosting end users' webpages, and caching the most popular content locally so that customers can access it more easily. ISPs also often offer portal services and proprietary content, which allow them to add value through their "unique aggregation and presentation of content that allowed for easy consumption by end users."[15]

Once a narrowband ISP receives a call, the ISP demodulates the signal from the dial-up modem and routes the traffic onto its own packet-switched networks. If the packets are addressed to a destination located on the same ISP network (such as an e-mail address associated with a different customer of the same ISP), the ISP conveys them to their destination without involving any other ISPs or backbones. If the packets are addressed to a more distant location, the ISP hands off the packets to a backbone provider, which in turn may hand off the packets to one or more downstream backbone providers. Eventually, one of the backbones hands off the packets to the destination ISP or a private data network, which in turn delivers them to their termination point.

The narrowband network configuration possesses two features that have influenced the debates about network neutrality. First, the last-mile

15. Rubinfeld & Singer, *supra* note 5, at 634.

provider does not need to maintain any packet-switching capability of its own. Instead, it simply routes calls it receives on an inbound local telephone line through its central office switch to an outbound local telephone line without modifying the traffic in any way. This transparency makes last-mile narrowband connections nondiscriminatory. Because customers can use the local telephone network to call any other customer connected to the network, all a narrowband ISP needs from the last-mile provider is an appropriate number of incoming business lines.

Second, the movement of packets through ISPs and backbone providers is controlled by a family of nonproprietary protocols known as the transmission control protocol/Internet protocol (TCP/IP). For our purposes, the most distinctive feature of TCP/IP is that it routes all packets in a nondiscriminatory (i.e., first come, first served) manner without regard to the packet's content, point of origin, or associated application.

B. Architectural Changes Resulting from the Migration to Broadband

The arrival of broadband technologies has effected some fundamental changes in the Internet's architecture. Many residences and small businesses now have the option of contacting the Internet through cable modem systems maintained by local cable operators, such as Comcast, Time Warner Cable, Cox, and Charter, or through a digital subscriber line (DSL) service offered by local telephone companies, such as Verizon, SBC, Qwest, and BellSouth.

Because both DSL and cable modem providers use the same infrastructure to provide two different types of service (either cable television combined with cable modem service or local telephone service combined with DSL), both types of providers must maintain equipment to segregate the two different communication streams. DSL systems route traffic through devices known as a digital subscriber line access multiplexers (DSLAMs), which separate the voice communications from the data-based communications.[16] Cable operators employ devices known as frequency up-converters and a cable modem termination systems (CMTSs) to divide the video and data streams.[17]

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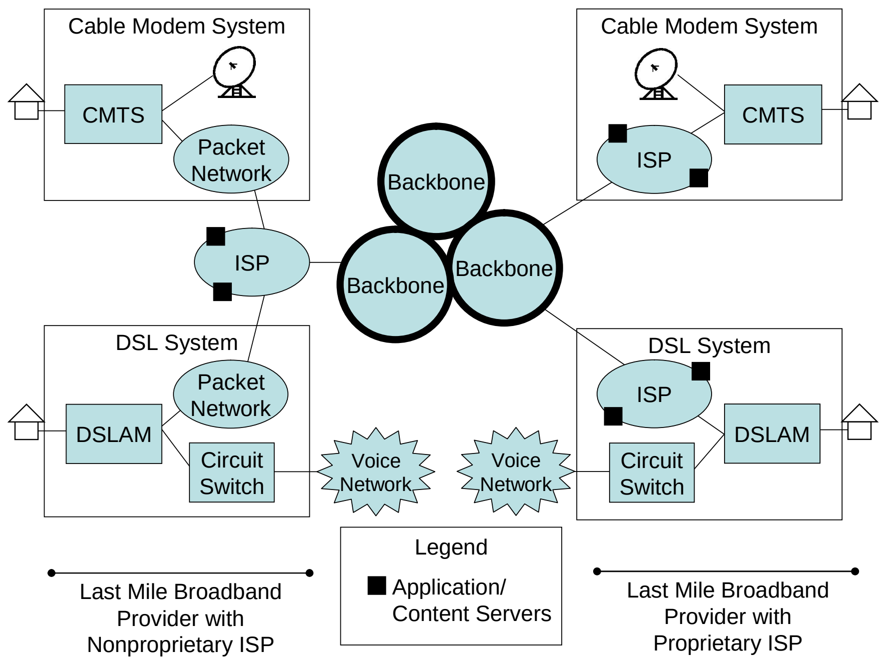
16. Note that although most DSLAMs are located in the central office switch, some local telephone companies are deploying digital loop carrier (DLC) architectures that allow DSLAMs to be located in remote terminals. Locating DSLAMs closer to end users represents one way to increase the coverage area of DSL service. *See* Daniel F. Spulber & Christopher S. Yoo, *Access to Networks: Economic and Constitutional Connections*, 88 CORNELL L. REV. 885, 1004-05 (2003).

17. *See id.* at 1014-15.

FIGURE 2
BASIC ARCHITECTURE OF BROADBAND TECHNOLOGIES



Unlike what was the case in the narrowband world, last-mile broadband providers must maintain a packet-switched network in their main facilities to hold and route the stream of data packets after they have been separated from other types of communications. Thus, under a broadband architecture, last-mile providers no longer serve as mere pass-throughs. They must instead necessarily perform the same routing functions previously carried out by ISPs. Indeed, some last-mile broadband providers have negotiated their own interconnection agreements with backbone providers and require all of their customers to use their own proprietary ISP, thereby supplanting the role of independent ISPs altogether. The migration of Internet users from narrowband to broadband technologies has thus had the inevitable effect of reducing the viability of many independent ISPs and encouraging last-mile providers to bundle their offerings with ISP services.

C. Shifts in User Demand

The advent of broadband technologies has also largely coincided with a number of fundamental changes in user demands that are placing increasing pressure on the continued adherence to a uniform, TCP/IP-based architecture. Although the forces are somewhat complex, a few examples illustrate the forces driving this fundamental shift.[18]

1. The Shift from Institutional to Mass-Market Users

The termination of NSF support for backbone services in 1995 eliminated the few remaining restraints on the commercialization of the Internet. The Internet's transformation from a network designed primarily to facilitate academic interchange into a medium of mass communications has made managing the Internet considerably more complicated. The Internet was once only charged with bringing together a relatively small number of fairly sophisticated, institutional users who generally shared common goals. It now must mediate among an increasingly disorderly onslaught of private users each pursuing ever more divergent objectives. This has greatly complicated traffic management, as the variability in usage patterns has increased and the beneficial effects of shared institutional norms and relationships have dwindled. This shift has also created pressure to simplify the demands imposed on end users by incorporating more of those functions into the core network.

2. The Emergence of Network-Intensive Applications

By contemporary standards, early Internet applications, such as e-mail, web access, newsgroups, and file transfer, placed fairly modest demands on the network. Overall file sizes were relatively small, and delays of a second or two typically went unnoticed. The commercialization of the Internet has spurred the development of applications which place greater demands on network services. Bandwidth-hungry applications, such as music downloads, on-line gaming, and streaming video, are placing increasing pressure on network capacity, as has the growth in telecommuting and home networking. Equally important is the emergence of applications that are less tolerant of variations in throughput rates, such as streaming media and Internet telephony.

18. The discussion that follows draws in part on the analysis offered by Marjory S. Blumenthal & David D. Clark, *Rethinking the Design of the Internet: The End-to-End Arguments vs. the Brave New World*, 1 ACM TRANSACTIONS ON INTERNET TECH. 70 (2001), *reprinted in* COMMUNICATIONS POLICY IN TRANSITION: THE INTERNET AND BEYOND 91 (Benjamin M. Compaine & Shane Greenstein eds., 2001); *see also* Hans Kruse, William Yurcik & Lawrence Lessig, The Inter*NAT*: Policy Implications for Internet Architecture Debate (unpublished manuscript presented at the 28th Annual Telecommunications Policy Research Conference), *available at* http://www.tprc.org/abstracts00/internatpap.pdf.

These concerns have led many network providers to make the terms of interconnection vary with bandwidth usage. For example, many last-mile providers either forbid end users to use bandwidth-intensive applications, such as music downloads, streaming media, and website hosting, or instead require that they pay higher charges before doing so.[19] Similarly, backbone providers often base the amounts they charge for interconnection on volume-related considerations. Backbones who exchange traffic of roughly equal value enter into "peering" arrangements that are similar to telecommunications arrangements known as "bill and keep." Under peering arrangements, the originating backbone collects and retains all of the compensation for the transaction notwithstanding the fact that other backbones also incur costs to terminate the transaction. So long as the traffic initiated and terminated by each backbone is roughly equal in value, peering allows backbones to forego the costs of metering and billing these termination costs without suffering any adverse economic impact. Peering is not economical, however, in cases where the value of the traffic being terminated is not reciprocal. As a result, smaller-volume backbones are often required to enter into "transit" arrangements in which they must pay larger backbones compensation for terminating their traffic.[20]

The growing importance of time-sensitive applications is also placing pressure on system designers to employ "policy-based routers," which can discriminate among packets and assign them different levels of priority, depending upon the source of the packet or the nature of the application being run. This represents a marked departure from TCP/IP, which manages packets on a "first come, first served" basis and in which packets are routed without regard to the nature of the communications being transmitted.

3. The Growth in Distrust of Other Endpoints

As noted earlier, TCP/IP, which still represents the dominant suite of protocols employed by the Internet, dictates that packets be routed without regard to their source. The anonymity of this system of transmission was implicitly built on the presumption that the other endpoints in the system were relatively trustworthy and were cooperating in order to achieve common goals.

The rise of e-commerce has created the need for increased levels of confidence in the identity of the person on the other end of the connection. At the same time, end users have become increasingly

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19. Wu, *supra* note 5, at 152-54, 157-62.

20. *See* Kende, *supra* note 12, at 47-52 (providing an overview of backbone "peering" and "transit").

frustrated by intrusions thrust upon them by other end users. Although some examples, such as spam, are relatively innocuous, other examples are considerably more malicious, such as viruses, worms, Trojan horses,[21] pornographic websites masquerading as less objectionable content, and programs that mine cookies for private information. Although end users are in a position to undertake certain measures to protect themselves against these harms, some Internet providers are interposing elements into the body of their network to shield end users from such dangers.

4. The Needs of Law Enforcement

The demands of law enforcement represent another factor that is driving the Internet away from the anonymous, fully interoperable architecture that existed in the narrowband era. For example, the Communications Assistance for Law Enforcement Act (CALEA) requires that all telecommunications carriers configure their networks in a way that permits law enforcement officials to place wiretaps on telephone calls.[22] Emerging Internet telephone systems are not easily rendered wiretap compatible. In contrast to the architecture of conventional telephone networks, which requires that all voice traffic pass through a discrete number of network gateways, Internet telephony technologies rely upon the decentralized structure inherent in the Internet. Furthermore, even if law enforcement officials found an appropriate location to intercept Internet telephone traffic, the packet anonymity inherent in TCP/IP would make it extremely difficult for law enforcement officials to separate the telephony-related packets from the other packets in the data stream. As a result, the FCC recently issued a Notice of Proposed Rulemaking and Declaratory Ruling tentatively concluding that CALEA applies to all facilities-based providers of any type of broadband Internet access service and to managed or mediated Internet telephony services.[23] Similarly, states' desire to impose sales taxes on Internet transactions may prompt them to push for changes to the architecture of the Internet to permit them to conduct some degree of monitoring of on-line commercial activity. Any solution to either problem would almost certainly require a deviation from the content and application transparency inherent in TCP/IP.

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21. Trojan horses are malicious pieces of code concealed within programs that perform beneficial functions.

22. 47 U.S.C. § 1002(a) (2000).

23. Communications Assistance for Law Enforcement Act and Broadband Access Services, *Notice of Proposed Rulemaking and Declaratory Ruling*, FCC 04-187, slip op. at 18-35 ¶¶ 17-59 (F.C.C. Aug. 4, 2004), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-187A1.pdf.

D. Network Neutrality Proposals

Together these changes are placing increasing pressure on last-mile broadband providers to configure their networks in ways that differentiate among packets on the basis of the source, application, or content associated with it. These moves towards discriminatory treatment have raised the concern that some providers will use their control over the last mile to harm competition. Advocates of network neutrality have advanced two different types of regulatory proposals to curb the dangers that they perceive.[24] The first, known as "multiple ISP access," would require last-mile providers to serve all ISPs on a nondiscriminatory basis. The second, sometimes called "connectivity principles," would limit last-mile providers' ability to restrict end users' ability from attaching devices, running applications, and accessing content as they see fit.

1. Multiple ISP Access

The fact that some last-mile broadband providers require their customers to connect to the Internet through their own proprietary ISP has prompted calls for the FCC to prohibit such exclusivity arrangements and to require that last-mile providers make their networks accessible to all unaffiliated ISPs on a nondiscriminatory basis. The concern is that allowing the broadband provider to control the market for ISP services has the potential to reduce consumer choice and harm competition. The opposing sides each attempted to gain the rhetorical high ground by employing terminology designed to color the way the FCC viewed the issue. Network neutrality advocates attempted to frame the issue as focusing on "open access," while broadband network owners referred to the issue as "forced access."[25] In an apparent attempt to sidestep the political overtones associated with either designation, the FCC has since framed the issue as "multiple ISP access."[26]

The FCC has vacillated on multiple ISP access over the course of various merger clearance proceedings.[27] The agency initially rejected

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24. *See* Philip J. Weiser, *Toward a Next Generation Regulatory Strategy*, 35 LOY. U. CHI. L.J. 41, 44-48 (2004) (distinguishing between the two approaches to network neutrality); Wu, *supra* note 5, at 147-50 (same).

25. *See* Applications for Consent to Transfer of Control of Licenses and Section 214 Authorizations from MediaOne Group, Inc., Transferor, to AT&T Corp., Transferee, *Memorandum Opinion and Order*, 15 FCC Rcd. 9816, 9866 ¶ 114 (2000) [hereinafter *AT&T-MediaOne Merger*].

26. *See Cable Modem Declaratory Ruling and NPRM*, *supra* note 2, at 4839 ¶ 72.

27. For a more detailed review of the regulatory history of multiple ISP access, see Christopher S. Yoo, *Vertical Integration and Media Regulation in the New Economy*, 19 YALE J. ON REG. 171, 251-52 (2002); Spulber & Yoo, *supra* note 16, at 1015-18.

calls for multiple ISP access when clearing AT&T's acquisitions of TCI and MediaOne,[28] only to backtrack somewhat by acceding to a multiple ISP access requirement imposed by the Federal Trade Commission (FTC) during the America Online-Time Warner merger.[29] Since then, the FCC has returned to its original position, declining to impose multiple ISP access when approving the sale of AT&T's cable properties to Comcast.[30] At the same time, the FCC has successfully forestalled attempts by cities to impose multiple ISP access either as a matter of municipal ordinances[31] or as part of their approval of the transfer of licenses needed to complete these mergers[32] on the grounds that such regulation falls within the exclusive jurisdiction of the federal government. Throughout these preemption disputes, the FCC continued to emphasize that it had not yet determined whether to impose open access and asked the courts not to resolve the issue.[33]

It is only recently that the FCC has finally begun to address the issue in earnest. In the ongoing cable modem proceedings, the FCC has twice requested comment on the advisability of requiring cable modem systems to provide multiple ISP access.[34] It also raised the issue in the ongoing wireline broadband proceedings, seeking comment on whether it should impose multiple ISP access on DSL providers in the event that it decided to exempt them from the unbundled network element (UNE)

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28. *AT&T-MediaOne Merger*, *supra* note 25, at 9866 ¶¶ 114-115; Applications for Consent to Transfer of Control of Licenses and Section 214 Authorizations from Tele-Communications, Inc., Transferor, to AT&T Corp., Transferee, *Memorandum Opinion and Order*, 14 FCC Rcd. 3160, 3197-98 ¶ 75 (1999) [hereinafter *TCI-AT&T Merger*].

29. Applications for Consent to Transfer of Control of Licenses and Section 214 Authorizations by Time Warner, Inc. and America Online, Inc., Transferors, to AOL Time Warner Inc., Transferee, *Memorandum Opinion and Order*, 16 FCC Rcd. 6547, 6568-69 ¶¶ 57-58 (2001) [hereinafter *Time Warner-AOL Merger*]; America Online, Inc., *Decision & Order,* No. C-3989, slip op. at 2, 6-9, 11-17 (F.T.C. Dec. 18, 2000), *available at* http://www.ftc.gov/os/2000/12/aoldando.pdf.

30. Applications for Consent to Transfer of Control of Licenses from Comcast Corp. and AT&T Corp., Transferors, to AT&T Comcast Corp., *Memorandum Opinion and Order*, 17 FCC Rcd. 23,246, 23,300-01 ¶ 135 (2002).

31. *See* Comcast Cablevision of Broward County, Inc. v. Broward County, 124 F. Supp. 2d 685, 686-87 (S.D. Fla. 2000).

32. *See* MediaOne Group, Inc. v. County of Henrico, 257 F.3d 356, 360 (4th Cir. 2001); AT&T Corp. v. City of Portland, 216 F.3d 871, 875 (9th Cir. 2000).

33. *See* Amicus Curiae Brief of the Federal Communications Commission at 15-18, *MediaOne Group, Inc. v. County of Henrico* (Nos. 00-1680(L), 00-1709, 00-1719) (available at 2000 WL 33991834); Brief of the Federal Communications Commission as Amicus Curiae at 19-26, 30-31, *AT&T Corp. v. City of Portland* (No. 99-35609) (available at 1999 WL 33631595).

34. The FCC made its initial request in 2000 when issuing its Notice of Inquiry in the cable modem proceeding. *See Cable Modem NOI*, *supra* note 2, at 19,298-306 ¶¶ 25-49. It reiterated the request in its subsequent Declaratory Ruling and Notice of Proposed Rulemaking in 2002. *See Cable Modem Declaratory Ruling and NPRM*, *supra* note 2, at 4839-41 ¶¶ 72-74, 4843-47 ¶¶ 80-93.

access requirements imposed by the Telecommunications Act of 1996.[35] The FCC's request for comments would prove prescient, as the subsequent Triennial Review Order would eventually strike most DSL-related facilities from the list of network elements to which telecommunications carriers have the right of unbundled access.[36]

A number of entities have submitted comments calling upon the FCC to mandate multiple ISP access.[37] An alliance of trade associations representing the computer, telecommunications equipment, semiconductor, consumer electronics, software and manufacturing sectors known as the High Tech Broadband Coalition (HTBC)[38] has offered a more limited proposal, which calls for the FCC to require DSL providers to honor any existing access agreements with unaffiliated ISPs and to make any arrangements with their affiliated ISPs available to unaffiliated ISPs in a nondiscriminatory manner for a period of at least two years.[39]

2. Connectivity Principles

Other proposals have shifted their attention away from preserving ISP competition and have instead focused on preserving competition among content and applications providers. For example, Professors Timothy Wu and Lawrence Lessig have proposed a network neutrality regime that would prohibit last-mile providers from imposing any restrictions on end users' ability to run the applications, attach the devices, and access the content of their own choosing except those restrictions that are necessary to comply with a legal duty, prevent

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35. *See Wireline Modem NPRM*, *supra* note 2, at 3042-43 ¶¶ 50-52.

36. Competitors remain free, however, to obtain unbundled access to the entire local loop and provide both voice and DSL services. *See* Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers, *Report & Order & Order on Remand & Further Notice of Proposed Rulemaking*, 18 FCC Rcd. 16,978, 17,131-36 ¶¶ 255-63 (2003), *aff'd in relevant part sub nom.* U.S. Telecom Ass'n v. FCC, 359 F.3d 554, 578-85 (D.C. Cir. 2004).

37. *See* Comments of Amazon.com at 9, *Cable Modem Declaratory Ruling and NPRM* (F.C.C. filed June 17, 2002) (CS Dkt. No. 02-52), *available at* http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6513198055; EarthLink, Inc. Comments in CS Docket No. 02-52 at 3-14, *Cable Modem Declaratory Ruling and NPRM* (F.C.C. filed June 17, 2002) (CS Dkt. No. 02-52), *available at* http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6513198478.

38. The specific trade associations include the Business Software Alliance, Consumer Electronics Association, Information Technology Industry Council, National Association of Manufacturers, Semiconductor Industry Association, and Telecommunications Industry Association. It has the active support of such companies as Intel, Alcatel, Catera, and Corning.

39. Reply Comments of High Tech Broadband Coalition at i-ii, 6-8, Appropriate Framework for Broadband Access to the Internet over Wireline Facilities (F.C.C. filed July 1, 2002) (CC Dkt. No. 02-33).

physical harm to the network, prevent interference with other users' connections, ensure quality of service, and prevent violations of security.[40]

HTBC has advanced a similar proposal that would impose a series of "connectivity principles" on all last-mile broadband providers. This proposal would require that all last-mile broadband providers give end users unrestricted access to all content and allow them to run any applications and attach any devices they desire, so long as these efforts do not harm the providers' networks, enable theft of services, or exceed the bandwidth limitations of the particular service plan.[41] The HTBC's proposal has drawn the support of a group composed primarily of software and content providers known as the Coalition of Broadband Users and Innovators (CBUI).[42] FCC Chairman Michael Powell sounded similar themes when called upon the broadband industry to embrace a series of "Internet Freedoms." In sharp contrast to the HTBC's proposal, however, Powell's vision would arise through voluntary conduct rather than through regulation.[43]

II. UNDERSTANDING THE ECONOMICS OF END-TO-END

As noted earlier, network neutrality advocates have drawn much of the inspiration for their regulatory proposals from the end-to-end argument pioneered by Saltzer, Reed, and Clark. Simply put, the end-to-end argument counsels against introducing intelligence into the core of the Internet and in favor of restricting higher levels of functionality to the servers operating at the edges of the network. The "pipes" that constitute the core of the network should be kept "dumb" and should focus solely on passing along packets as quickly as possible. Part A describes the basic intuitions underlying the end-to-end argument. Part B undertakes a close analysis of the implications of the end-to-end argument for the major regulatory proposals, concluding that network neutrality proposals are based on an over reading of Saltzer, Reed, and

40. *Ex parte* Letter of Timothy Wu and Lawrence Lessig, *Cable Modem Declaratory Ruling and NPRM*, at 12-15 (F.C.C. filed Aug. 22, 2003) (CS Docket No. 02-52), *available at* http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6514683884; *see also* Wu, *supra* note 5, at 165-72.

41. Comments of the High Tech Broadband Coalition at 6-9, *Cable Modem Declaratory Ruling & NPRM* (F.C.C. filed June 17, 2002) (CC Dkt. No. 02-52), *available at* http:// gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6513198026.

42. *Ex parte* Communication from the Coalition of Broadband Users and Innovators at 3-4, *Cable Modem Declaratory Ruling and NPRM* (F.C.C. filed Jan. 8, 2003) (CS Dkt. No. 02-52), *available at* http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6513401671. CBUI includes such notable content and software providers as Microsoft, Disney, Amazon.com, eBay, and Yahoo!, as well as the Media Access Project, the Consumer Electronics Association, and the National Association of Manufacturers.

43. *See generally* Michael K. Powell, *The Digital Broadband Migration: Toward a Regulatory Regime for the Internet Age*, 3 J. ON TELECOMM. & HIGH TECH. L. 5 (2004).

Clark's work that expands it far outside its proper scope. In fact, a careful examination of the rationale underlying the end-to-end argument reveals that it is fundamentally incompatible with network neutrality advocates' attempts to turn the end-to-end argument into a regulatory mandate.

A. The Classic Statement of the End-to-End Architecture

The fundamental logic of the end-to-end argument is most easily understood by examining the core illustration offered by Saltzer, Reed, and Clark to articulate it: careful file transfer, in which a file stored on the hard drive of computer *A* is transferred to the hard drive of computer *B* without errors.[44] Roughly speaking, this function can be divided into five steps:

1. Computer *A* reads the file from its hard disk and passes it to the file transfer program.
2. The file transfer program running on computer *A* prepares the file for transmission by dividing it into packets and hands off the packets to the data communication network.
3. The data communication network moves the packets from computer *A* to computer *B*.
4. The file transfer program running on computer *B* reassembles the packets into a coherent file.
5. The file transfer program saves the file onto computer *B*'s hard disk.

Errors can emerge at any step in this process. Computer *A* can misread the file from the hard disk. The file transfer program on Computer *A* can introduce mistakes when copying the data from the file. The communication network can drop or change bits in a packet or lose a packet altogether. The file transfer program on Computer *B* can also produce errors when converting the packets back into a coherent file. Computer *B* can miswrite the file to its hard disk. The transfer can also be jeopardized by larger-scale hardware or software failures.

Saltzer, Reed, and Clark compare two different approaches to managing the risk of such errors. One approach is to perform error checking at each intermediate step along the way. The other approach is known as "end-to-end check and retry." Under this approach, no error

44. The discussion that follows is based on Saltzer et al., *supra* note 4, at 278-80.

checking is performed at any of the intermediate steps. Instead, the only error checking occurs when the terminating end of the process (computer *B*) verifies the accuracy of the file transfer with the initiating end (computer *A*) after the entire transaction has been completed.

The core conclusion of Saltzer, Reed, and Clark's work is that system designers should adopt a presumption in favor of the latter approach. They base their argument on two insights. First, no matter how many intermediate error checks are introduced, the terminating end of the file transfer must still verify the transaction with the originating end after all of the steps have been completed. The fact that such end-to-end verification is necessary no matter what other intermediate reliability measures are built into the system renders any additional measures redundant, thus raising doubts as to the justifiability of any additional measures.[45]

Second, intermediate error checking should properly be regarded as an engineering tradeoff between reliability and performance. Errors can be reduced, but only at the cost of introducing a degree of redundancy into the network that will have the inevitable effect of slowing it down. Saltzer, Reed, and Clark emphasize that different applications vary in their tolerance for unreliability as well as their demand for speed. Imposing reliability checks in low-level subsystems that are common to all applications may have the uneconomical result of forcing all applications to incur the performance costs even if the increase in reliability does not provide particular applications with commensurate benefits.[46]

Together these insights suggest that system designers should avoid designing higher-level functions into routers located in the core of the network. Instead, the Internet should presumptively be engineered with any such functions concentrated in the servers that operate at the network's edge. Saltzer, Reed, and Clark extend the same basic rationale to other system functions, such as delivery guarantees, secure transmission of data, duplicate message suppression, and transaction management.[47]

B. End-to-End as a Case-by-Case Approach

Network neutrality proponents contend that the end-to-end argument justifies prohibiting Internet providers from introducing additional degrees of intelligence into their core networks. In short, all of the intelligence should be restricted to the servers operating at the

45. *Id.* at 281.
46. *Id.*
47. *Id.* at 282-84.

edge of the network. They also argue that the end-to-end argument mandates that all broadband network owners employ protocols like TCP/IP that ensure that the core of the network remains relatively transparent and dumb.[48]

Although the end-to-end argument does support a presumption against introducing higher-level functions into the network's core, it does not justify elevating this presumption into an inviolable precept. Conceding that it is "too simplistic to conclude that the lower levels should play no part in obtaining reliability,"[49] Saltzer, Reed, and Clark's original article articulating the end-to-end argument squarely concludes that "the end-to-end argument is not an absolute rule, but rather a guideline that helps in application and protocol design analysis."[50] In fact, the cost-performance tradeoff underlying the end-to-end argument requires "subtlety of analysis" and can be "quite complex."[51] Indeed, a later article by the same authors responding to calls for allowing the core of the Internet to exercise a greater level of functionality explicitly recognizes that "[t]here are some situations where applying an end-to-end argument is counterproductive"[52] and concludes that the proper approach is to "take it case-by-case."[53] The end-to-end argument is thus more properly regarded as merely "one of several important organizing principles for systems design" rather than as an absolute.[54] Although Saltzer, Reed, and Clark suggest that deviations from it will be rare, they acknowledge that "there will be situations where other principles or goals have greater weight."[55]

Other technologists have drawn similar conclusions. One of the original authors of the end-to-end argument, writing with Marjory Blumenthal, candidly acknowledges that "the end-to-end arguments are not offered as an absolute" and that "[t]here are functions that can only be implemented in the core of the network."[56] Indeed, they argue that the developments described in Section I have made the case for introducing greater intelligence into Internet's core all the more

48. *See, e.g.*, Lemley & Lessig, *supra* note 5, at 931-32.
49. Saltzer et al., *supra* note 4, at 280.
50. *Id.* at 285.
51. *Id.* at 284. To take but one example, the desirability of end-to-end depends in part on the length of the file. If a system drops one message per one hundred messages sent, the probability that all packets will arrive correctly decreases exponentially as the length of the file increases (and thus the number of packets composing the file) increases. *Id.* at 280-81.
52. David P. Reed et al., *Commentaries on "Active Networking and End-to-End Arguments*,*"* 12 IEEE NETWORK 69, 69 n.1 (1998).
53. *Id.* at 70.
54. *Id.*
55. *Id.*
56. Blumenthal & Clark, *supra* note 18, at 71.

compelling. They conclude, apparently with the concurrence of Saltzer,[57] that in many cases "an end-to-end argument isn't appropriate in the first place."[58] Samrat Bhattacharjee, Kenneth Calvert, and Ellen Zegura conclude that the end-to-end argument "do[es] *not* rule out support for higher-level functionality within the networks" and instead simply requires that the costs and benefits inherent in the engineering tradeoff be carefully evaluated.[59] Indeed, there are services that depend on information that is only available inside the network and thus cannot exist without relying to some degree on what has been called "active networking."[60] Dale Hatfield acknowledges that the desire to improve the security, manageability, scalability, and reliability of the Internet may justify introducing greater intelligence into the core of the network.[61] As a result, Hatfield argues against allowing regulation that prevents network owners from deviating from the end-to-end architecture and instead simply warns that deviations from the end-to-end argument should be undertaken with extreme care.[62]

At this point, the incongruity of invoking the end-to-end argument as support for network neutrality as a regulatory mandate should be apparent. Far from justifying an absolute prohibition against placing intelligence in the core of the network, the end-to-end argument stands squarely opposed to such a simplistic approach.[63] Simply put, a close analysis of the end-to-end argument reveals that it does not support the proposition for which many network neutrality proponents invoke it. Indeed, as Marjory Blumenthal has noted, this incongruity demonstrates the extent to which network neutrality advocates' embrace of the end-to-end argument has left the realm of cost-benefit analysis and has instead

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57. *See id.* at 102 n.19 (citing personal communication with Jerome Saltzer as support for this proposition).

58. *Id.* at 80.

59. Samrat Bhattacharjee et al., *Active Networking and the End-to-End Argument*, 1997 PROC. INT'L CONF. ON NETWORK PROTOCOLS 220, 221.

60. *Id.*; *see also* Samrat Bhattacharjee et al., *Commentaries on "Active Networking and End-to-End Arguments*," 12 IEEE NETWORK 66 (1998).

61. Dale N. Hatfield, *Preface*, 8 COMMLAW CONSPECTUS 1, 3 (2000).

62. *Id.*

63. Although the end-to-end argument only supports a case-by-case approach to network design, it is arguable that such cases will prove so rare that the costs of evaluating the merits of each individual case exceed the benefits of doing so. Such categorical balancing is particularly perilous in industries, such as broadband, that are in a state of technological and economic flux. Even if regulators were to strike the proper balance today, the underlying technological and economic context would soon shift. A real danger exists that this inherent lag will cause regulation intended to promote economic efficiency to inhibit it. *See, e.g.*, STEPHEN BREYER, REGULATION AND ITS REFORM 286-87 (1982); 2 ALFRED E. KAHN, THE ECONOMICS OF REGULATION 127 (1971); Richard A. Posner, *Natural Monopoly and Its Regulation*, 21 STAN. L. REV. 548, 611-15 (1969). Such concerns counsel strongly in favor of allowing private ordering rather than the government to determine network configurations.

entered the realm of ideology.[64] As a result, it is critical that network neutrality proposals not evade critical analysis by masquerading as nothing more than the application of sound engineering principles.

The foregoing discussion casts a new and somewhat ironic light on Lessig's observation that "code is law."[65] The point Lessig was attempting to make was that the architecture enshrined in the Internet's communications protocols can have as dramatic an impact on competition and innovation as direct regulation. Most network neutrality advocates have failed to appreciate that this admonition cuts both ways.[66] While it is true that allowing Internet providers to impose proprietary protocols could have a significant impact on innovation and competition, forbidding them from doing so could have equally dramatic effects. Either decision necessarily involves policymakers in the unenviable task of picking technological winners and losers. The impossibility of technologically neutral government intervention undercuts claims that imposing the end-to-end argument as a regulatory mandate represents the proper way to show humility about the future of the Internet.[67]

Not only does government-imposed network neutrality contradict the letter of the end-to-end argument, it turns Lessig's admonition on its head. Lessig intended the statement to indicate how the architecture of the Internet could constitute a private substitute for many of the functions previously served by law. Indeed, Lessig warned of the dangers of allowing the government to dictate the standards that must be included in Internet code.[68] It would be a strange inversion of this argument to give the phrase "code is law" literal rather than figurative meaning and to sanction greater governmental control over the architecture of the Internet.

III. THE INTERRELATIONSHIP BETWEEN NETWORK NEUTRALITY AND THE ECONOMICS OF VERTICAL INTEGRATION

In addition to misunderstanding the proper scope of the end-to-end argument, network neutrality proponents have largely overlooked the close relationship between their proposals and the economics of vertical integration. This section examines how vertical integration theory sheds new light on the debates surrounding network neutrality. Part A reviews

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64. Marjory S. Blumenthal, *End-to-End and Subsequent Paradigms*, 2002 L. REV. MICH. ST. U. DET. C.L. 709, 710 (2002).

65. LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE 6 (1999).

66. For a notable exception, see Wu, *supra* note 5, at 148.

67. *See* LESSIG, *supra* note 5, at 35, 39.

68. *See* Lawrence Lessig, *The Limits in Open Code: Regulatory Standards and the Future of the Net*, 14 BERKELEY TECH. L.J. 759, 764-67 (1999).

the structure of the broadband industry and describes how network neutrality is designed to redress the supposed problems caused by vertical integration. The relationship between network neutrality and vertical integration is clear whether one conceives of the broadband industry as consisting of a traditional, three-step chain of production implicit in multiple ISP access proposals or whether one follows the more recent trend of describing the broadband industry as consisting of a series of horizontal "layers" underlying the regulatory approach embodied in the connectivity principles.

Part B reviews the key insights of vertical integration theory. It is now widely recognized that vertical integration can create economic harms only if certain structural preconditions are met. An empirical analysis reveals that these structural preconditions are not satisfied with respect to the broadband industry. This in turn undermines claims that the types of vertical integration that network neutrality is designed to foreclose poses a serious policy concern.

A. Two Conceptions on the Structure of the Broadband Industry

The major network neutrality proposals have embedded within them two, rather different conceptions of the vertical structure of the broadband industry. Multiple ISP access proposals implicitly conceive of providers being organized in a traditional, three-step chain of distribution, in which the ISPs act as a wholesaler and the last-mile providers play the role of the retailer. The proponents of connectivity principles conceive of the broadband industry as consisting of a series of layers.

1. The Conventional Vertical Market Structure Implicit in Multiple ISP Access

Although the structure of the broadband industry may at times seem mysterious, it is in fact quite ordinary when viewed from a certain perspective.[69] Its basic organization differs little from that of the typical manufacturing industry, which is divided into a three-stage chain of production. The first and last stages are easiest to understand. The manufacturing stage is occupied by companies that create the actual products to be sold. The retail stage consists of those companies responsible for the final delivery of the products to end-users. Although it is theoretically possible for retailers to purchase products directly from manufacturers, in practice logistical complications often give rise to an intermediate stage mediating between manufacturers and retailers.

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69. The following discussion is adapted from Yoo, *supra* note 27, at 182, 250-51.

Firms operating in this intermediate stage, known as wholesalers, purchase goods directly from manufacturers and assemble them into complete product lines and distribute them to retailers.

Despite claims that the Internet is fundamentally different from other media, the broadband industry mapped comfortably onto this three-stage vertical market structure. The manufacturing stage encompasses those companies that generate the webpage content and Internet-based services that end users actually consume. The wholesale stage is occupied by the ISPs and backbone providers, which aggregate content and applications. Finally, last-mile providers deliver the content and service packages assembled by the ISPs to end customers.

The proponents of multiple ISP access in essence are concerned that vertical integration between the retail and wholesale levels of this chain of distribution will allow network owners to use the leverage provided by their control of the retail stage to harm competition at the wholesale level. In other words, they argue that allowing last-mile providers to deny unaffiliated ISPs access to their customers threatens ISP competition.[70]

2. The "Layered" Approach Implicit in Connectivity Principles

The connectivity principles implicitly rely on what has become known as the "layered model" to Internet regulation.[71] This approach disaggregates networks into four horizontal layers that cut across different network providers.[72] The bottommost layer is the *physical*

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70. *See, e.g.*, Hausman et al., *supra* note 7, at 158-65; Lemley & Lessig, *supra* note 5, at 940-43; Rubinfeld & Singer, *supra* note 5, at 664-70.

71. *See* Kevin Werbach, *A Layered Model for Internet Privacy*, 1 J. ON TELECOMM. & HIGH TECH. L. 37, 57-64 (2002); Richard Whitt, *A Horizontal Leap Forward: Formulating a New Communications Public Policy Framework Based on the Network Layers Model*, 56 FED. COMM. L.J. 587, 624 (2004). For other leading discussions analyzing the Internet through the layered model, see LESSIG, *supra* note 5, at 23-25; Yochai Benkler, *From Consumers to Users: Shifting the Deeper Structures of Regulation Towards Sustainable Commons and User* Access, 52 FED. COMM. L.J. 561 (2000); Douglas C. Sicker & Joshua L. Mindel, *Refinements of a Layered Model for Telecommunications Policy*, 1 J. ON TELECOMM. & HIGH TECH. L. 69 (2002); Timothy Wu, *Application-Centered Internet Analysis*, 85 VA. L. REV. 1163, 1189-92 (1999). For a different vision of layered competition, see Timothy F. Bresnahan, *New Modes of Competition: Implications for the Future Structure of the Computer Industry*, *in* COMPETITION, INNOVATION AND THE MICROSOFT MONOPOLY: ANTITRUST IN THE DIGITAL MARKETPLACE 155 (Jeffrey A. Eisenach & Thomas M. Lenard eds., 1999).

72. The layered model is related to the Open Systems Interconnection (OSI) model developed by the International Standards Organization (ISO) in the 1980s, which divides seven different layers: application, presentation, session, transport, network, data link, and physical. Some of these distinctions between those layers have greater relevance for technologists than for policy analysts. *See* Werbach, *supra* note 71, at 59.

FIGURE 3
THE LAYERED MODEL OF BROADBAND ARCHITECTURE

CONTENT LAYER (*e.g.*, individual e-mail, webpages, voice calls, video programs)
APPLICATIONS LAYER (*e.g.*, web browsing, e-mail, Internet telephony, streaming media, database services)
LOGICAL LAYER (*e.g.*, TCP/IP, domain name system, telephone number system)
PHYSICAL LAYER (*e.g.*, telephone lines, coaxial cable, backbones, routers, servers)

layer, which consists of the hardware infrastructure that actually carries the communications. The second layer is the *logical layer*, which is composed of the protocols responsible for organizing the management and routing functions of the network. The third layer is the *applications layer*, comprised of the particular programs and functions used by consumers. The fourth layer is the *content layer*, which consists of the particular data being conveyed.

The distinction between the layers can be illustrated in terms of the most common Internet application: e-mail. Assuming that the particular e-mail in question is sent via DSL, the physical layer consists of the telephone lines, e-mail servers, routers, and backbone facilities needed to convey the e-mail from one location to another. The logical layer consists of the SMTP protocol employed by the network to route the e-mail to its destination. The application layer consists of the e-mail program used, such as Microsoft Outlook. The content layer consists of the particular e-mail message sent.

The connectivity principles are motivated by a concern that last-mile providers will use their control of the physical layer to reduce competition in the application and content layer by deviating from TCP/IP currently employed in the logical layer and replacing it with proprietary, noninteroperable protocols. The connectivity principles are designed to forestall this dynamic by mandating that last-mile providers adhere to nonproprietary protocols and to open their networks to all applications and content on a nondiscriminatory basis.[73]

73. *See also id.* at 65-66 (arguing that the layered model requires that interfaces between each layer be kept open).

B. Market Structure and Vertical Integration

Vertical integration has long been a source of economic controversy.[74] Until the 1970s, competition policy generally viewed vertical integration with considerable hostility. The emergence of the Chicago School of antitrust law and economics raised serious doubts regarding the preexisting orthodoxy, arguing that a monopolist would have little to gain by vertically integrating. In addition, certain structural preconditions must be satisfied before vertical integration can harm competition. Specifically, both the upstream and downstream markets that are being brought together through vertical integration must be concentrated and protected by barriers to entry. If not, vertical integration should be permitted.

These developments in turn prompted the emergence of a post-Chicago School, which contradicted the Chicago School by identifying circumstances in which vertical integration can harm competition. While disagreeing over many key aspects of vertical integration theory, the post-Chicago School implicitly agreed that the same structural preconditions must be met before vertical integration can plausibly be problematic.[75] The fact that these structural preconditions are enshrined in the Merger Guidelines promulgated by the Justice Department and the FTC demonstrates the broad acceptance that these principles now enjoy.[76]

Applying these principles to the broadband industry strongly suggests that the FCC should not erect what would amount to a per se bar to vertical integration. Considering first the requirement that the primary market be concentrated, the Merger Guidelines employs a measure of concentration known as the Hirschman-Herfindahl index (HHI) that has become the standard concentration under modern competition policy. HHI is calculated by adding the square of the market share of each competitor.[77] The result is a continuum that places

74. The discussion that follows is based on the more complete presentation at Yoo, *supra* note 27, at 253-68. For a review of the historical development of vertical integration theory presented, see *id.* at 185-205.

75. Specifically, post-Chicago scholarship typically models the relevant markets either as dominant firm industries or as oligopolies engaged in Cournot or Bertrand competition. Both of these approaches require that the relevant markets be highly concentrated and protected by barriers to entry. Yoo, *supra* note 27, at 203-05, 265-67.

76. *See* U.S. DEPARTMENT OF JUSTICE & FEDERAL TRADE COMMISSION, *Non-Horizontal Merger Guidelines, in* 1992 HORIZONTAL MERGER GUIDELINES, §§ 4.131, 4.212, 57 Fed. Reg. 41,552 (1992), *available at* http://www.usdoj.gov/atr/public/guidelines/2614.htm [hereinafter *Non-Horizontal Merger Guidelines*] (requiring that the relevant markets be concentrated); *id.* §§ 4.132, 4.133, 4.21 (requiring that the relevant markets be protected by barriers to entry).

77. For example, a market of four firms with market shares of 30%, 30%, 20% and 20%, respectively, would have an HHI of $30^2 + 30^2 + 20^2 + 20^2 = 900 + 900 + 400 + 400 = 2600$.

the level of concentration on a scale from 0 (in the case of complete market deconcentration) to 10,000 (in the case of monopoly). The Guidelines indicate that the antitrust authorities are unlikely to challenge a vertical merger unless HHI in the primary market exceeds 1800, which is the level of concentration that would result in a market comprised of between five and six competitors of equal size.[78]

Determining whether the market is concentrated depends on a proper market definition, which in turn requires the identification of the relevant product and geographic markets.[79] Defining the relevant product market is relatively straightforward: empirical evidence indicates that broadband represents an independent product market that is distinct from narrowband services.[80] Defining the relevant geographic market has proven more problematic. Many analyses have mistakenly assumed that the relevant geographic market is the local market in which last-mile broadband providers meet end users. Because these markets are typically dominated by two players—the incumbent cable operators selling cable modem service and the incumbent local telephone company offering DSL service—defining the geographic market in this manner yields HHIs well in excess of 4000.[81]

The problem with this analysis is that network neutrality proposals are designed to limit the exercise of market power not in the final downstream market in which last-mile providers meet end users, but rather in the upstream market in which last-mile providers meet ISPs and content/application providers. The following thought experiment

78. *Non-Horizontal Merger Guidelines*, *supra* note 76, §§ 4.131, 213. Note that the relevant threshold for vertical mergers is more lenient than the HHI thresholds applicable to horizontal mergers. Under the Horizontal Merger Guidelines, markets with HHIs between 1000 and 1800 are regarded as "moderately concentrated" and thus "potentially raise significant competitive concerns." U.S. DEPARTMENT OF JUSTICE & FEDERAL TRADE COMMISSION, 1992 HORIZONTAL MERGER GUIDELINES § 1.51(b), 57 Fed. Reg. 41,552 (1992), *revised*, 4 Trade Reg. Rep. (CCH) ¶ 13,104 (Apr. 8, 1997), *available at* http://www.usdoj.gov/atr/public/guidelines/horiz_book/hmg1.html [hereinafter HORIZONTAL MERGER GUIDELINES]. Because vertical mergers are less likely than horizontal mergers to harm competition, the Merger Guidelines apply a more lenient HHI threshold to vertical integration. *Non-Horizontal Merger Guidelines*, *supra* note 76, § 4.0. The Merger Guidelines also reserve the possibility of challenging a vertical merger at HHI levels below 1800 if "effective collusion is particularly likely." *Id.* § 4.213. Such problems are more properly regarded as horizontal rather than vertical in nature.

79. HORIZONTAL MERGER GUIDELINES, *supra* note 78, §§ 1.0-1.3.

80. *See Time Warner-AOL Merger*, *supra* note 29, at 78-88 ¶¶ 69-73; Jerry A. Hausman et al., *Cable Modems and DSL: Broadband Internet Access for Residential Customers*, 91 AM. ECON. REV. 302, 303-04 (2001).

81. *See* Amendment of Parts 1, 21, 73, 74 & 101 of the Commission's Rules to Facilitate the Provision of Fixed & Mobile Broadband Access, Educational & Other Advanced Servs. in the 2150-2162 & 2500-2690 Mhz Bands, *Notice of Proposed Rule Making & Memorandum Opinion & Order*, 18 FCC Rcd. 6722, 6774-75 ¶¶ 123-124 (2003); Hausman et al., *supra* note 7, at 155; Rubinfeld & Singer, *supra* note 5, at 649.

confirms this insight: Suppose that every last-mile provider were required to sell their proprietary interests in ISPs, application providers, and content providers. Such a change would not affect the economic relationship between end users and last-mile providers; end users seeking to purchase last-mile services would still face a de facto duopoly even if the broadband industry were completely vertically disintegrated. Compelled vertical disintegration would, however, substantially change the bargaining power between last-mile providers and ISPs and content/application providers.

It is thus this upstream market in which last-mile providers meet ISPs and providers of Internet content and applications that represents the true target of network neutrality proposals. This market is properly regarded as national in scope.[82] Major web-based providers, such as Amazon.com or eBay, are focused more on the total customers they are able to reach nationwide than they are on their ability to reach customers located in any specific metropolitan area. Their inability to reach certain customers is of no greater concern, however, than the inability of manufacturers of particular brands of cars, shoes, or other conventional goods to gain access to all parts of the country. Being cut off from certain distribution channels should not cause economic problems, so long as those manufacturers are able to obtain access to a sufficient number of customers located elsewhere. The proper question is thus not whether the broadband transport provider wields oligopoly power over broadband users in any particular city, but rather whether that provider has market power in the national market for obtaining broadband content.

When the relevant inquiry is properly framed as the national market, it becomes clear that the market is too unconcentrated for vertical integration to pose a threat to competition. The HHI is 1079, well below the 1800 threshold for vertical integration to be a source of economic concern. In addition, the two largest broadband providers (Comcast and SBC) control only 21% and 14% of the national market respectively. Absent collusion or some other impermissible horizontal practice (which would be a basis for sanction independent of concerns about vertical integration), the national broadband market is sufficiently unconcentrated to vitiate concerns about the vertical integration in the broadband industry.

In addition, the precondition that the secondary markets be concentrated and protected by entry barriers is also not met.[83] As the FCC has recognized, the market for ISPs has long been quite

82. Yoo, *supra* note 27, at 253-54.
83. *See id.* at 259.

FIGURE 4
LAST-MILE BROADBAND SUBSCRIBERS AS OF YEAR END 2003

Provider	Technology	Subscribers (000s)	Share	HHI
Comcast	cable modem	5,284	21%	442
SBC	DSL	3,516	14%	196
Time Warner Cable	cable modem	3,228	13%	165
Verizon	DSL	2,319	9%	85
Cox	cable modem	1,999	8%	63
Charter	cable modem	1,566	6%	39
BellSouth	DSL	1,462	6%	34
Cablevision	cable modem	1,057	4%	18
Adelphia	cable modem	960	4%	14
Qwest	DSL	637	3%	6
Bright House	cable modem	625	2%	6
Covad	DSL	517	2%	4
Sprint	DSL	304	1%	1
Mediacom	cable modem	280	1%	1
Insight	cable modem	230	1%	1
RCN	cable modem	200	1%	1
Alltel	DSL	153	1%	0
Cable One	cable modem	134	1%	0
Cincinnati Bell	DSL	99	0%	0
Century Tel	DSL	83	0%	0
Other		503	2%	1
Total		25,136	100%	1078

Source: *Fiber Faces the Inevitable Shakeout, DSL Competition*, FIBER OPTICS NEWS, Mar. 17, 2004.

competitive, and entry into ISP services has historically been quite easy.[84] Similarly, the markets for applications and content have long been the most competitive segments of the entire industry, marked by low levels of concentration and low barriers to entry. The failure to satisfy these structural preconditions renders implausible any claims that vertical integration in the broadband industry constitutes a threat to competition.

84. *TCI-AT&T Merger*, *supra* note 28, at 3206 ¶ 93(1999).

IV. THE POTENTIAL BENEFITS OF NETWORK DIVERSITY

Conventional economic theory thus indicates that allowing last-mile providers to vertically integrate by entering into exclusivity arrangements with respect to certain content and applications providers or by requiring the use of proprietary ISPs is unlikely to harm competition. In this section, I raise a number of points that have yet to appear in either the academic literature or in the filings in the ongoing broadband proceedings before the FCC. These points show how allowing last-mile broadband providers to deviate from the principles of network neutrality can actually benefit consumers.[85] Part A examines the economic efficiencies that can result from vertical integration. Part B discusses how allowing network owners to deviate from complete interoperability can increase economic welfare by increasing the diversity of products available. Conversely, imposing network neutrality as a regulatory matter may actually have the effect of reducing innovation and limiting consumer choice by skewing the Internet towards certain types of applications and away from others. Part C analyzes the impact that connectivity principles can have on the concentration of last-mile technologies, which looms as a far more central threat to the competitive performance of the Internet than does the robustness of competition among content and applications providers. It also details how standardizing network protocols can reinforce the supply-side and demand-side economies of scale that are the primary impetus towards concentration in last-mile services. By forcing broadband providers to compete solely on price and network size, network neutrality reinforces the advantages already enjoyed by the largest players. Conversely, allowing network heterogeneity can provide new last-mile platforms, such as 3G, with a strategy for survival.

These arguments should not be misconstrued as favoring noninteroperability as a general matter. On the contrary, I would expect most network owners to continue to adhere to a basic architecture based TCP/IP. Maintaining interoperability provides consumers and network owners with such substantial financial advantages that most will adopt standardized protocols voluntarily. In most cases, then, mandating network neutrality would be superfluous. The only situations in which network neutrality has any purpose are those in which the market exhibits a preference for nonstandardization. My concern is that compelling interoperability under those circumstances runs the risk of reducing economic welfare, either by preventing the realization of

85. The discussion that follows expands upon ideas I initially advanced in a brief editorial. *See* Christopher S. Yoo, *Fighting Traffic on the Disinformation Superhighway*, NASHVILLE TENNESSEAN, July 8, 2003, at 7.

efficiencies or by reinforcing the economies of scale that are the primary causes of potential market failure.

A. Economic Efficiencies from Vertical Integration

In addition to finding common ground on the structural preconditions necessary for vertical integration to harm competition, both Chicago and post-Chicago School theorists agree that vertical integration can yield substantial cost efficiencies.[86] The potential for enhanced economic welfare from vertical integration is reflected in the Merger Guidelines, which explicitly recognize that the efficiencies created from vertical merger may outweigh the possibility of anticompetitive effects.[87]

The broadband industry possesses many characteristics that make it likely that allowing a greater degree of vertical integration would yield substantial economic efficiencies.[88] For example, the presence of large, up-front fixed costs leave both network owners and content/application providers vulnerable to a range of opportunistic behavior that vertical integration can substantially mitigate. In addition, the fact that last-mile broadband providers must necessarily maintain a packet-switched network within their primary facilities to hold the data-based traffic after it has been separated from the other forms of communications[89] makes it unsurprising that last-mile broadband providers find it more economical to provide ISP services themselves.

The presence of such efficiencies is perhaps demonstrated most dramatically by the manner in which the multiple ISP access mandated during the AOL-Time Warner merger has been implemented.[90] Contrary to the original expectations of the FTC, the unaffiliated ISPs that have obtained access to AOL-Time Warner's cable modem systems under the FTC's merger clearance order have not placed their own packet network and backbone access facilities within AOL-Time Warner's headends. Instead, traffic bound for these unaffiliated ISPs

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86. *See* Yoo, *supra* note 27, at 192-200 (reviewing efficiencies resulting from vertical integration identified by Chicago School commentators); *id.* at 204 (reviewing the acknowledgement by post-Chicago theorists that vertical integration can yield substantial efficiencies).

87. *Non-Horizontal Merger Guidelines*, *supra* note 76, §§ 4.135, 4.24. In addition, the Guidelines give more weight to expected efficiencies in the case of vertical integration than with respect to a horizontal merger. *Id.* § 4.24.

88. For a more detailed analysis of this phenomenon, see Yoo, *supra* note 27, at 260-64. *See also* Joseph Farrell & Philip J. Weiser, *Modularity, Vertical Integration and Open Access Policies: Towards a Convergence of Antitrust and Regulation in the Internet Age*, 17 HARV. J.L. & TECH. 85, 97-105 (2004).

89. *See supra* Section I.B.

90. *See* Spulber & Yoo, *supra* note 16, at 1023 n.728.

exits the headend via AOL-Time Warner's backbone and is handed off to the unaffiliated ISP at some external location. It is hard to see how consumers benefit from such arrangements, given that they necessarily use the same equipment and thus provide the same speed, services, and access to content regardless of the identity of their nominal ISP.[91] The fact that these unaffiliated ISPs have found it more economical to share AOL Time Warner's existing ISP facilities rather than build their own strongly suggests that integrating ISP and last-mile operations does in fact yield real efficiencies.

The absence of consumer benefits underscores the extent to which compelled access represents something of a competition policy anomaly.[92] When confronted with an excessively concentrated market, competition policy's traditional response is to deconcentrate the problematic market, either by breaking up the existing monopoly or by facilitating entry by a competitor. Compelled access, in contrast, leaves the concentrated market intact and instead simply requires that the bottleneck resource be shared. Such an approach may be justified if competition in the concentrated market is infeasible, as was generally believed to be the case with respect to local telephone service until recently. Simply requiring that the monopoly be shared is inappropriate when competition from new entrants is technologically and economically achievable.[93]

B. The Tradeoff Between Network Standardization and Product Variety

The current debate has largely ignored how network neutrality can harm economic welfare by limiting the variety of products. The predominance of price theory, in which the sole source of economic welfare is the difference between reservation prices and the actual prices charged, has caused commentators studying the economics of broadband networks to overlook the potential benefits associated with product

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91. *See* COLUMBIA TELECOMMUNICATIONS CORPORATION, TECHNOLOGICAL ANALYSIS OF OPEN ACCESS AND CABLE TELEVISION SYSTEMS 22-23 (Dec. 2001), *available at* http:// archive.aclu.org/issues/cyber/broadband_report.pdf.

92. *See* Yoo, *supra* note 27, at 268-69; Spulber & Yoo, *supra* note 16, at 1020.

93. The feasibility of platform competition underscores the problems with viewing previous efforts to standardize and compel access to the local telephone service as precedent for imposing network neutrality on the Internet. *See* LESSIG, *supra* note 5, at 147-51; Lemley & Lessig, *supra* note 5, at 934-36, 938. Most steps to mandate access to local telephone networks were justified by the fact that competition in local telephony was believed impossible at the time. Such arguments do not apply to broadband, in which platform competition has emerged as a real possibility.

differentiation.[94] Simply put, allowing network owners to employ different protocols can foster innovation by allowing a wider range of network products to exist. Conversely, compulsory standardization can reduce consumer surplus by limiting the variety of products available.[95]

Viewed from this perspective, the pressure towards proprietary standards may not represent some sinister attempt by last-mile providers to harm competition. Instead, it may represent nothing more than the natural outgrowth of the underlying heterogeneity of consumer preferences. In the words of two leading commentators on network economics, "market equilibrium with multiple incompatible products reflects the social value of variety."[96] It is for this reason that economic theorists have uniformly rejected calls for blanket prohibitions of exclusivity arrangements and other means for differentiating network services.[97] Indeed, some models indicate that the deployment of proprietary network standards may actually prove more effective in promoting innovation and the adoption of socially optimal technologies.[98]

The current forces that are motivating network providers to consider introducing increasing levels of intelligence into their core networks provide an apt illustration of this dynamic. As discussed

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94. *See* Christopher S. Yoo, *Copyright and Product Differentiation*, 79 NYU L. REV. 212, 236-46 (2004) [hereinafter Yoo, *Copyright and Product Differentiation*] (reviewing the literature on product differentiation); Christopher S. Yoo, *Rethinking the Commitment to Free, Local Television*, 52 EMORY L.J. 1579, 1602-18 (2003) [hereinafter Yoo, *Rethinking Free, Local Television*] (applying product differentiation theory to electronic communications).

95. *See, e.g.*, Michael L. Katz & Carl Shapiro, *Systems Competition and Network Effects*, 8 J. ECON. PERSP. 93, 110 (1994) (noting that "the primary cost of standardization is loss of variety: consumers have fewer differentiated products to pick from"); Farrell & Saloner, *supra* note 7, at 71 (counting "reduction in variety" as one of the "important social costs" of standardization).

96. Katz & Shapiro, *supra* note 95, at 106 (citing Joseph Farrell & Garth Saloner, *Standardization and Variety*, 20 ECON. LETTERS 71 (1986)); *see also* S. J. Liebowitz & Stephen E. Margolis, *Should Technology Choice Be a Concern of Antitrust Policy?*, 9 HARV. J.L. & TECH. 283, 292 (1996) ("Where there are differences in preference regarding alternative standards, coexistence of standards is a likely outcome."); James B. Speta, *A Vision of Internet Openness by Government Fiat*, 96 NW. U. L. REV. 1553, 1569 (2002) ("If there were competition among broadband platforms, companies would pursue different strategies to differentiate themselves . . . .").

97. *See, e.g.*, David Balto, *Networks and Exclusivity: Antirust Analysis to Promote Network Competition*, 7 GEO. MASON L. REV. 523 (1999); David S. Evans & Richard Schmalensee, *A Guide to the Antitrust Economics of Networks*, 10 ANTITRUST 36 (1996); Carl Shapiro, *Exclusivity in Network Industries*, 7 GEO. MASON L. REV. 673, 678 (1999).

98. *See* Michael L. Katz & Carl Shapiro, *Product Introduction with Network Externalities*, 40 J. INDUS. ECON. 55, 73 (1992); Michael L. Katz & Carl Shapiro, *Technology Adoption in the Presence of Network Externalities*, 94 J. POL. ECON. 822, 825, 838-39 (1986).

earlier,[99] consumer demand for more time-sensitive applications, such as Internet telephony and streaming media, may be providing much of the impetus away from standardization. Forbidding network owners to introduce routers that can assign different priority levels to packets based on the nature of the application would have the effect of precluding consumers from enjoying the benefits of certain types of applications.[100] The current ubiquity of TCP/IP makes it seem like an appropriate default rule and appears to justify placing the burden on those who would deviate from it. A moment's reflection makes clear how adherence to the Internet's nonproprietary structure may actually impede innovation.

There is considerable irony in the network neutrality proponents' insistence that allowing Internet providers to introduce intelligence into their core networks would skew innovation and that technological humility demands adherence to an end-to-end architecture. The decision to concentrate intelligence at the edges of the network and to require packet nondiscrimination would itself skew the market towards certain applications and away from others. The choice is thus not between neutrality and nonneutrality in the overall direction of innovation. Mandating either would have the inevitable effect of determining technological winners and losers. My point is not that policy makers should reverse the presumption and erect a preference for innovation in the network's core over innovation at the network's edge. The better course is to favor neither and to allow consumer preferences to dictate the eventual outcome.

Some of the more thoughtful network neutrality proponents concede that consumers may well benefit from allowing broadband network owners to deploy proprietary protocols and that it can be difficult, if not impossible, to distinguish whether procompetitive or anticompetitive motivations prompted a particular network owner's conduct.[101] In light of the ambiguity regarding the economic impact of any particular use of proprietary protocols, it is somewhat surprising that network neutrality proponents nonetheless turn to government-mandated uniformity as their preferred regulatory response. The difficulties in distinguishing legitimate business practices from those motivated by a desire to harm competition would appear to favor the adoption of a contextual, case-by-case methodology over the use of categorical regulatory mandates.[102] Moreover, the position advanced by

99. *See supra* Section I.B.

100. *See* Speta, *supra* note 96, at 1574.

101. *See* LESSIG, *supra* note 5, at 46-47, 167-76; Cooper, *supra* note 5, at 1050-52; Wu, *supra* note 5, at 148.

102. For a related proposal, see Weiser, *supra* note 24, at 48-57 (advocating a case-by-case regulatory approach that erects a presumption against discriminatory access, but allows the

network neutrality proponents implicitly assumes that the government is in a better position to evaluate the competitive impact of particular practices than are private individuals and that the benefits of governmental intervention will outweigh the inevitable costs imposed by a regulatory lag.[103] That network neutrality advocates would embrace such a position is rendered all the more puzzling by the fact that it contradicts the decentralized, nonhierarchical spirit that they claim has animated the Internet since its inception.[104]

C. Network Neutrality and Competition in the Last Mile

On a more fundamental level, network neutrality advocates' focus on innovation in content and applications may be misplaced. Application of the basic insights of vertical integration theory reveals that markets will achieve economic efficiency only if each stage of production is competitive.[105] In other words, any vertical chain of production will only be as efficient as its most concentrated link. The central focus of broadband policy should be on how best to foster competition in the last mile. The intuition underlying this insight can be easily discerned by returning to the thought experiment in which we supposed that regulators required complete vertical disintegration of the broadband industry. As noted earlier, the fundamental economic problems stemming from the paucity of last-mile options would persist until new entrants appear.

Viewing the issues in this manner reveals how the major network neutrality proposals are focusing on the wrong policy problem. By directing their efforts towards encouraging and preserving competition among ISPs and content/application providers, they concentrate their attention on the segments of the industry that are already the most competitive and the least protected by entry barriers.[106] Restated in terms of the "layered model" of the broadband industry, the major network neutrality proposals advocate regulating the logical layer in a

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network owner to offer legitimate business reasons to justify the practice).

103. *See* Philip J. Weiser, *The Internet, Innovation, and Intellectual Property Policy*, 103 COLUM. L. REV. 534, 581 (2003).

104. See Lessig, supra note 5, at 37, 40, 44. I must confess to being somewhat skeptical of the historical claim that the essence of the Internet has been its freedom from centralized control. The supposedly libertarian Internet of 1995 was largely the product of direct governmental support provided by DARPA and the National Science Foundation. Conversely, the supposedly sinister forces pushing the Internet away from its interoperable structure are actually the result of the shift to private ordering. It would thus be quite ironic to support governmental intervention as a means for promoting decentralization and the lack of hierarchy.

105. Yoo, *supra* note 27, at 241-42.

106. *See TCI-AT&T Merger*, *supra* note 28, at 3206 ¶ 93 (noting the high level of competition among ISPs).

way that best promotes competition in the application and content layers.[107] Broadband policy would be better served if such efforts were directed towards identifying and increasing the competitiveness of the most concentrated level of production. In other words, the logical layer should be regulated in the way that best promotes investment and the emergence of competition in the alternative physical network capacity, since it is the physical layer that is currently the most concentrated.

The lack of competition in the last mile has traditionally been attributed to both supply-side and demand-side considerations. The supply-side consideration is the fact that building the physical network of wires needed to provide DSL and cable modem service requires incurring substantial sunk costs. The presence of high sunk costs gives rise to a tendency towards natural monopoly conditions. The demand side consideration focuses on economic effects, which exist when the value of a network is determined by the number of other people connected to that network. The more people that are part of the network, the more valuable the network becomes. This dynamic can in turn create considerable demand-side economies of scale that reinforce the tendency towards concentration.

What has been largely overlooked in the current debates is how allowing networks to differentiate in the services they offer can mitigate the forces that are driving the broadband industry towards concentration. Conversely, measures that limit networks' ability to differentiate their services can exacerbate the already extant tendencies towards oligopoly in the last mile. There is thus a real possibility that imposing network neutrality may actually worsen, rather than alleviate, the central policy problem confronting the broadband industry.

1. Declining Average Costs and Supply-Side Economies of Scale

The supply-side considerations that cause last-mile services to exhibit a tendency towards natural monopoly can most easily be understood by focusing on the shape of the average cost curve.[108] If the

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107. *See, e.g.*, *Ex parte* Letter of Timothy Wu and Lawrence Lessig, *supra* note 40, at 2-9; Werbach, *supra* note 71, at 65-66.

108. A more complete analysis of natural monopoly would require additional refinements. For example, a market may exhibit a tendency towards a natural monopoly even when average costs are increasing so long as the industry costs are subadditive, which occurs when one firm could produce the industry's entire output more cheaply than could two firms. WILLIAM J. BAUMOL ET AL., CONTESTABLE MARKETS AND THE THEORY OF INDUSTRY STRUCTURE 16-24 (rev. ed. 1988). That said, declining average costs are sufficient to give rise to natural monopoly. *Id.* at 176. *See generally* Yoo, *Rethinking Free, Local Television*, *supra* note 94, at 1596-1600 (discussing the determinants of declining average cost and their

average cost curve is decreasing, firms with the largest volumes can provide services the most cheaply, which in turn allows them to undercut their smaller competitors. This price advantage allows the largest players to capture increasingly large shares of the market, which reinforces their pricing advantage still further. Eventually the largest firm will gain a sufficient cost advantage to drive all of its competitors out of the market.

Whether average cost is increasing or decreasing is determined by the magnitude of the sunk costs. On the one hand, the ability to spread sunk costs over increasingly large volumes places downward pressure on average cost. For example, spreading a $100 million sunk-cost investment across one million customers would require allocating an average of $100 in sunk costs to each customer. If the same sunk-cost investment were spread over ten million customers, each consumer would have to pay only an average of $10 in order to cover sunk costs. The larger the sunk costs relative to the overall demand, the more pronounced these scale economies will be, although the marginal impact of this effect will decay exponentially as production increases. At the same time, the scarcity of factors of production and the principle of diminishing marginal returns tend to cause average costs to increase as volume increases.

Whether average cost is rising or falling at any particular point is determined by which of these two effects dominates the other. When the sunk-cost investments needed to establish the network are large, the former effect tends to loom as the more important and cause average cost to decline. Because entry by new broadband networks tends to require large sunk-cost investments, the market for last-mile providers is generally expected to exhibit a natural tendency towards concentration.

What network neutrality advocates have failed to recognize is how allowing last-mile broadband providers to differentiate their product offerings can help prevent declining-cost industries from devolving into natural monopolies.[109] It is not unusual for small-volume producers to survive against their larger rivals even in the face of unexhausted economies of scale by targeting those customers who place the highest

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relationship to natural monopoly); Yoo, *Copyright and Product Differentiation*, *supra* note 94, at 226-28 (same).

109. The seminal analysis of how competition among differentiated products can yield an equilibrium in which multiple declining-cost firms can coexist is EDWARD CHAMBERLIN, THE THEORY OF MONOPOLISTIC COMPETITION (7th ed. 1956). For more complete analysis of how product differentiation can mitigate the problems caused by declining average costs, see Yoo, *Copyright and Product Differentiation*, *supra* note 94, at 248-49. For a brief statement of how nonstandardization can facilitate competition among telecommunications networks, see Paul L. Joskow & Roger G. Noll, *The Bell Doctrine: Applications in Telecommunications, Electricity, and Other Network Industries*, 51 STAN. L. REV. 1249, 1251 (1999). For a discussion applying a similar analysis to another type of electronic communications, see Yoo, *Rethinking Free, Local Television*, *supra* note 94, at 1603 & n.61.

value on the particular types of products or services they offer, as demonstrated by the survival of specialty stores in a world increasingly dominated by larger and more efficient stores offering one-stop shopping. It is true that consumers of these small-volume producers will pay more for these specialized products. That said, it is difficult to see how these consumers are worse off. The value that they derive from the specialized product necessarily exceeds the amount they must pay for it, otherwise they simply would not agree to the transaction. Indeed, if consumers were unable to use higher prices to signal the intensity of their preferences, the low-volume version would not exist at all.

Last-mile providers have a number of avenues open to them for differentiating the networks. One way is by entering into exclusivity arrangements with respect to content, as demonstrated by the role played by such arrangements in helping direct broadcast satellite (DBS) provider DirecTV emerge as a viable alterative to cable television. For example, DirecTV is offering an exclusive programming package known as "NFL Sunday Ticket" that allows sports fans to watch the entire NFL schedule and not just the games being shown by CBS and Fox in their service area. Many cable customers have been frustrated by their inability to purchase NFL Sunday Ticket through their local cable operators. If regulators viewed exclusivity arrangement solely in static terms, they might be tempted to increase consumer choice by requiring this programming package also be made available to cable subscribers. The impolicy of such a reaction becomes manifest when one recalls that the central problem confronting the television industry is the local cable operators' historic dominance over multichannel video distribution. The market reaction has already demonstrated how exclusive programming like NFL Sunday Ticket is serving as a major driver towards the deployment of DBS as an alternative outlet for distributing television programming. Conversely, requiring that such programming be made available to cable as well as DBS customers would run the risk of further entrenching the local cable operator by eliminating one of the primary inducements to shift from cable to DBS.

Another way that last-mile providers can differentiate the services they provide is by optimizing the architecture of their networks for different types of applications. To offer an illustration in the context of broadband, it is theoretically possible that multiple broadband networks could co-exist notwithstanding the presence of unexhausted economies of scale. The first network could be optimized for conventional Internet applications, such as e-mail and website access. The second network could incorporate security features designed to appeal to users focused on e-commerce. The third network could employ policy-based routers that prioritize packets in the manner that allows for more effective provision of time-sensitive applications such as Internet telephony. Other networks could be designed to optimize the provision of still other services. If this were to occur, the network with the largest number of customers need not enjoy a decisive price advantage. Instead, each could survive by targeting and satisfying those consumers who place the highest value on the types of service they offer.

This example illustrates how imposing network neutrality could actually frustrate the emergence of platform competition in the last mile. Put another way, protocol standardization tends to commodify network services. By focusing competition solely on price, it tends to accentuate the pricing advantages created by declining average costs, which in turn reinforces the market's tendency towards concentration. Conversely, increasing the dimensions along which networks can compete by allowing them to deploy a broader range of architectures may make it easier for multiple last-mile providers to co-exist.[110]

2. Network Externalities and Demand-Side Economies of Scale

Other commentators have argued that network neutrality must be mandated as a regulatory matter in order to redress the competitive problems posed by network economic effects.[111] For reasons that I have discussed in detail elsewhere,[112] such claims are subject to a number of important analytical limitations and qualifications. A few brief comments on two of the more salient limitations will suffice to make my point.

First, for reasons analogous to the similar requirement with respect to vertical integration, the existing theories require that the network owner have a dominant market position before network economic effects can even plausibly harm competition.[113] The classic illustration of this

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110. By emphasizing the promotion of platform competition, my argument bears some resemblance to the proposal advanced by Philip Weiser. *See* Weiser, *supra* note 103, at 583-91. Our analyses differ in that Professor Weiser focuses his attention on the application and logical layers of the Internet, see *id.* at 542, whereas I am primarily concerned with competition in the physical layer. We also differ in our preferred policy response to a dominant player. Professor Weiser would support allowing others to have access to a proprietary protocol if the protocol owner achieves or is headed towards a dominant position. *Id.* at 591-94. I would attempt to dispel dominance not by direct regulation, but rather by attempting to facilitate entry by new broadband platforms and allowing the ensuing competition to dissipate any problems. Thus, my analysis favors allowing the use of proprietary protocols even when one firm is dominant. It also has the advantage of charging regulators with tasks for which they are better suited and establishing a regime that envisions an end to governmental intervention.

111. *See supra* note 8 and accompanying text.

112. *See* Yoo, *supra* note 27, at 278-82; Spulber & Yoo, *supra* note 16, at 924-33.

113. Spulber & Yoo, *supra* note 16, at 923, 926.

phenomenon is the development of competition in local telephony during the 1890s made possible by the expiration of the initial telephone patents. After the Bell System's market share was cut in half, it attempted to employ network economic effects to reverse its losses. Specifically, it refused to interconnect with these upstarts, hoping that its greater network size would make it sufficiently more attractive to consumers to give it a decisive advantage. This effort ultimately failed, however, since the independent companies that comprised the other half of the industry were able to forestall any negative network economic effects by allying with one another to form a network that was similar in size to the Bell network.[114] In the end, it was control of certain patents critical to providing high-quality long distance service and not network economic effects that allowed the Bell System to return to dominance. The clear implication is that the presence of a single competitor of roughly the same size as the network owner is likely sufficient to eliminate any such problems.

Second, the argument that network economic effects create externalities that lead to market failure is wholly inapplicable in the context of telecommunications networks.[115] This is because any externalities that may exist will necessarily occur within a physical network that can be owned.[116] Thus, although individual users may not be in a position to capture all of the benefits created by their demand for network services, the network owner will almost certainly be in a position to do so. Any benefits created by network participation can thus be internalized and allocated through the interaction between the network owner and network users.[117]

The commentary on network economic effects thus does not support the contention that imposing network neutrality is necessary to protect competition. Quite the contrary, the literature indicates that compelling interoperability could affirmatively harm competition. This is because allowing last-mile providers to differentiate their networks can mitigate the problems resulting from any demand-side economies of scale created by network economic effects that may exist. Simply put, allowing networks to tailor their services to the needs of different groups

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114. *See* Roger Noll & Bruce M. Owen, *The Anticompetitive Uses of Regulation:* United States v. AT&T, *in* THE ANTITRUST REVOLUTION 290, 291-92 (John E. Kwoka, Jr. & Lawrence J. White eds., 1989).

115. The discussion that follows is based on Spulber & Yoo, *supra* note 16, at 926-27.

116. The literature refers to network externalities that occur in the context of a physical network as "direct network externalities." Katz & Shapiro, *supra* note 7, at 424.

117. *See* S. J. Liebowitz & Stephen E. Margolis, *Are Network Externalities a New Source of Market Failure?*, 17 RES. LAW & ECON. 1, 11-13 (1995); S. J. Liebowitz & Stephen E. Margolis, *Network Externality: An Uncommon Tragedy*, 8 J. ECON. PERSP. 133, 137, 141-44 (1994).

of customers can offset the economic advantages enjoyed by larger networks in much the same manner as differentiation can offset the supply-side economies of scale. Targeting those customers who value the differentiated services makes it possible for smaller networks to survive despite the greater inherent appeal of larger networks.[118]

Conversely, mandating that all broadband networks employ nonproprietary protocols can foreclose network owners from using differentiation to mitigate the pressures towards concentration. Preventing network owners from varying the services that they offer forces networks to compete solely on price and network size, further reinforcing and accentuating the benefits already enjoyed by the largest players. As a result, network neutrality runs the danger of becoming the source of, rather than the solution to, market failure, thus allowing less innovation and fewer participants.

V. THE ROLE OF REGULATION

It is thus clear that permitting last-mile providers to deviate from the universal interoperability envisioned by the proponents of network neutrality may actually yield substantial economic benefits. Not only does differentiation potentially put networks in a better position to satisfy any underlying heterogeneity in consumer preferences; it also has the potential to alleviate the supply-side and demand-side economies of scale that are the sources of market failure that justify regulatory intervention in the first place.

The case against network neutrality is further bolstered by the risk that regulation might itself induce market failure by causing the existing oligopoly in last-mile technologies to persist long after technological improvements have made real competition possible. If access to a bottleneck network were not compelled, those who did not want to pay supracompetitive prices for network services would have the incentive to invest in alternative network capacity. Compelling access, on the other hand, would rescue those who would otherwise be financing the buildout of other last-mile technologies from having to undertake those investments. Network neutrality may thus have the effect of depriving alterative broadband platforms of their natural strategic partners and of starving them of the resources they need to build out their networks. Although such a policy might have been reasonable during previous eras, when the fact that construction of new network platforms was unfeasible rendered such considerations immaterial, it is unjustifiable in the current

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118. *See* Farrell & Saloner, *supra* note 96; Katz & Shapiro, *supra* note 95, at 106; Liebowitz & Margolis, *supra* note 96, at 292. For a related argument, see Weiser, *supra* note 103, at 587-89.

environment, in which competition from alternative network platforms is a real option.

The task confronting policy makers is made all the more difficult by the fact that making any difference would require policy makers to intervene at a fairly early stage in the technology's development, since governmental intervention after the market has settled on the optimal technology would serve little purpose.[119] Although whether regulation or private ordering would provide the better means for determining the optimal technology is ultimately an empirical question, there are a number of examples that suggest that public policy would be better served by relying on the latter. For example, during its early years the electric power industry went through an extended period of competition between standards based on direct current (DC) and alternating current (AC) that enhanced competition and promoted innovation in electrical appliances.[120] Even now, the electrical power network is diverse enough to accommodate appliances designed to run on the predominant 110-volt standard as well as larger appliances requiring 220 volts. Another example, drawn this time from the telecommunications industry, is the competition between time division multiple access (TDMA) and code division multiple access (CDMA) standards for mobile telephony. Rather than imposing a particular technological vision, the government has allowed these standards to compete in the marketplace.

In addition, governmental processes are subject to a number of well-recognized biases. Regulatory decisions are all too often shaped by political goals that are not always consistent with good policy.[121] In addition, policymakers may also find it tempting to give too little weight to the future benefits associated with the entry of alternative network capacity, which will no doubt seem uncertain and contingent, and to overvalue the more immediate and concrete benefits of providing consumers with more choices in the here and now. Indeed, the FCC has allowed short-term considerations to override longer-term benefits in the past.[122] Public choice theory strongly suggests that the bias in favor of

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119. Bresnahan, *supra* note 71, at 200-03.

120. BRUCE M. OWEN & GREGORY L. ROSSTON, LOCAL BROADBAND ACCESS: *PRIMUM NON NOCERE* OR *PRIMUM PROCESSI*? A PROPERTY RIGHTS APPROACH 11-12 (AEI-Brookings Joint Center for Regulatory Studies Related Publication No. 03-19, Aug. 2003), *available at* http://www.aei.brookings.org/admin/authorpdfs/page.php?id=285 (citing Paul A. David & Julie Ann Bunn, *Gateway Technologies and the Evolutionary Dynamics of Network Industries: Lessons from Electricity Supply History*, *in* EVOLVING TECHNOLOGY AND MARKET STRUCTURE 121 (Arnold Heertje & Mark Perlman eds., 1990)). There is thus some irony in the fact that some network neutrality proponents point to the example of electric power as supporting the need for early governmental intervention. *See Ex parte* Letter of Timothy Wu and Lawrence Lessig, *supra* note 40, at 3; Wu, *supra* note 71, at 1165.

121. *See* Bresnahan, *supra* note 71, at 202-03.

122. *See* Christopher S. Yoo, *The Rise and Demise of the Technology-Specific Approach*

the former over the latter is no accident.[123]

There thus appears to be considerable danger that compelling access will forestall the buildout of 3G, fixed wireless, and other alternative broadband platforms.[124] I acknowledge the possibility that last-mile broadband providers may be able to use the market power provided by the degree of concentration in local markets to harm competition. For example, it is conceivable that cable operators might prohibit cable modem customers from streaming video in order to protect their market position in the market for conventional television. At the same time, such a prohibition might also represent an understandable attempt to prevent high-volume users from imposing congestion costs on other users.[125] Even network neutrality proponents acknowledge how difficult it can be to determine which is the case.[126]

In effect, policymakers are presented with a choice between two possible responses. On the one hand, they can trust their ability to distinguish between these two different situations and limit network neutrality to those in which deviations from full interoperability are motivated by anticompetitive considerations. The costs of doing so include the danger that regulators might err in making this determination as well as the risk that compelling access might delay entry by alternative last-mile technologies. On the other hand, regulators can adopt a more humble posture about their ability to distinguish anticompetitive from procompetitive behavior and attempt to resolve the problem by promoting entry by alternative broadband platforms. Once a sufficient number of alternative last-mile providers exist, the danger of anticompetitive effects disappears, as any attempt to use an exclusivity arrangement to harm competition will simply induce consumers to obtain their services from another last-mile provider. In this case, the

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to the First Amendment, 91 GEO. L.J. 245, 272-75 (2003).

123. There are also practical reasons to question the efficacy of access as a remedy. Network owners can be expected not to cooperate with those seeking access by charging the highest prices possible and by imposing restrictive nonprice terms and conditions. As a result, the FCC is likely to find itself embroiled in having to police all aspects of the parties' business relationship. This has led some scholars that suggest that attempts to mandate are likely to prove futile. *See* Paul L. Joskow & Roger G. Noll, *The Bell Doctrine: Applications in Telecommunications, Electricity, and Other Network Industries*, 51 STAN. L. REV. 1249 (1999). Indeed, the FCC's experience in implementing the UNE access requirements of the Telecommunications Act of 1996 appears to confirm this suspicion. *See also* Time Warner Entm't Co. v. FCC, 93 F.3d 957, 970 (D.C. Cir. 1996) (describing difficulties in implementing leased access to cable systems).

124. *See* Yoo, *supra* note 27, at 268-69; Spulber & Yoo, *supra* note 16, at 1020; *see also* Glenn A. Woroch, *Open Access Rules and the Broadband Race*, 2002 L. REV. MICH. ST. U. DET. C.L. 719 (presenting a formal economic model of this effect).

125. *See* James B. Speta, *The Vertical Dimension of Cable Access*, 71 U. COLO. L. REV. 975, 1004-07 (2000).

126. *See supra* note 101 and accompanying text.

primary costs stem from delay. Because entry by new network platforms will not be instantaneous, there will necessarily be a period of time during which consumers may remain vulnerable to anticompetitive behavior.[127]

Choosing between these two approaches depends upon weighing their relative merits, with the understanding that each represents a second-best alternative. Although a formal analysis of the tradeoff exceeds the scope of my comments, my instinct is to favor the latter. It is motivated in part by my belief that regulatory authorities will be more effective at pursuing the goal of stimulating entry by new network platforms than they would be in ascertaining whether a particular exclusivity arrangement would promote or hinder competition. In addition, because the long-term benefits will be compounded over an indefinite period of time, they should dominate whatever short-run static inefficiency losses that may exist.[128] Perhaps most importantly, promoting entry has embedded within it a built-in exit strategy. Once a sufficient number of broadband network platforms exist, regulatory intervention will no longer be necessary. This stands in stark contrast with access-oriented solutions, which implicitly assume that regulation will continue indefinitely.

CONCLUSION

The claim that guaranteeing interoperability and nondiscrimination would benefit consumers has undisputed intuitive appeal. The fact that interoperability and neutrality have represented the historical norm makes it seem appropriate to put the burden of persuasion on those who would move away from that architecture.

A close examination of the economic tradeoffs underlying network neutrality reveals a number of countervailing considerations that may not be readily apparent at first blush. Not only does network neutrality risk reducing consumer choice in content and applications; it raises the even more significant danger of stifling competition in the last-mile by forestalling the emergence of new broadband technologies. Although such an admonition would be well taken under any circumstances, it carries particular force in industries like broadband that are undergoing rapid technological change.

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127. *See* Weiser, *supra* note 103, at 561; Yoo, *Copyright and Product Differentiation*, *supra* note 94, at 254 n.135.

128. *See* Janusz Ordover & William Baumol, *Antitrust Policy and High-Technology Industries*, 4 OXFORD REV. ECON. POL'Y 13, 32 (1988); David J. Brennan, *Fair Price and Public Goods: A Theory of Value Applied to Retransmission*, 22 INT'L REV. L. & ECON. 347, 355 (2002).