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Rethinking Broadband Internet Access

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INTRODUCTION

A series of technological and theoretical forces are currently effecting a fundamental transformation of the Internet. The widescale deployment of broadband technologies now allows end users to enjoy unprecedented speeds. The initial analog technology employed dial-up modems to modulate data communications into audible sounds that could be transmitted via conventional telephone lines, which had a maximum theoretical speed of 56 kilobits per second (kbps). Current broadband platforms, such as cable modem systems, digital subscriber lines (DSL), wireless technologies, and fiber-based transmission such as Verizon's FiOS service,

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employ digital technologies capable of delivering speeds that are up to 500 times faster. The increase in bandwidth has caused the relatively simple applications that dominated the narrowband Internet, such as e-mail and web browsing, to give way to more sophisticated and bandwidth-intensive multimedia applications, including streaming video, music and movie downloads, and virtual worlds (such as World of Warcraft and Second Life).

At the same time, competition in Internet service has increased dramatically. Cable modem service, which was the early leader in the broadband industry, has faced increasing competition from DSL and fiber-based services provided by local telephone companies. Even more dramatic has been the rise of wireless broadband technologies, which grew from having no subscribers as of the end of 2004 to having 21.9 million subscribers by the end of 2006, which represents over 25% of the market for high-speed lines.[1] Published reports suggest that wireless broadband providers continued to add subscribers at a brisk pace since that time, reaching as many as 45 million subscribers by September 2007.[2] The planned 2011 redeployment of spectrum previously dedicated to broadcast television to wireless Internet services promises to intensify last-mile broadband competition still further.

Other forces are more theoretical than technological. Scholars have increasingly explored the conceptual limits of the theories usually invoked to justify the regulation of telecommunications networks and underscored the extent to which they presume that a single firm dominates the provision of last-mile services. Furthermore, the basic paradigm for regulating network industries has shifted from traditional *rate regulation*, in which regulators

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[1] Fed. Commc'ns Comm'n, Indus. Analysis & Tech. Div., Wireline Competition Bureau, High-Speed Services for Internet Access: Status as of December 31, 2006, at tbl.2 (Oct. 2007), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-277784A1.pdf [hereinafter High-Speed Services Dec. 2006 Report].

[2] *See* Jom Ross, Casting the Mobile Net: The Net Goes Mobile, *at* http://www.ctia.org/content/index.cfm/AID/11203.

dictate the terms under which network owners sell *outputs* to *consumers*, to a new approach known as *access regulation*, under which regulators control the terms under which network owners must lease key *inputs* to *competitors*. This shift is perhaps best exemplified by the landmark Telecommunications Act of 1996, which requires telephone companies providing local service when the statute was enacted (which the statute calls "incumbent local exchange carriers" or ILECs) to provide competitors with access to key elements of their networks.[3] Access regulation has also emerged as a dominant feature in the regulation of a wide range of other network facilities, including cable television systems, utility poles, natural gas pipelines, and electric power distribution grids.[4]

Unfortunately, policymakers have struggled to determine the impact of these forces on the regulation of broadband technologies. When asked to address the proper regulatory classification for broadband between 1998 and 2002, the Federal Communications Commission (FCC) temporized and repeatedly declined to resolve the issue.[5] The FCC initial 2002 attempt to address the issue in earnest prompted three additional years of litigation that ultimately had to be resolved by the Supreme Court, and even then the FCC left open the precise nature of the

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3 47 U.S.C. § 251(c)(3) (2004). The statute requires that the accessed elements be "necessary" and that "the failure to provide access to such network elements would impair the ability of the telecommunications carrier seeking access to provide the services that it seeks to offer." *Id*. § 251(d)(2)(A) & (B). For a review of the regulatory antecedents to § 251(c)(3), see Daniel F. Spulber & Christopher S. Yoo, *Access to Networks: Economic and Constitutional Connections*, 88 CORNELL L. REV. 885, 960-65, 1005-09 (2003).

4 *See* Daniel F. Spulber & Christopher S. Yoo, *On the Regulation of Networks as Complex Systems: A Graph Theory Approach*, 99 NW. U. L. REV. 1687, 1689 (2005) (citing sources).

5 *See* Nat'l Cable & Telecomms. Ass'n v. Gulf Power Co., 534 U.S. 327, 348-49, 353-56 & nn.5-6 (2002) (Thomas, J., joined by Souter, J., concurring in part and dissenting in part) (recounting numerous examples between 1998 and 2002 in which the FCC declined to take a position on the proper regulatory classification for broadband services and criticizing the FCC for its failure to address the issue).

regulatory requirements might be imposed.[6] A subsequent 2005 FCC decision did not completely resolve the issue,[7] which is now the subject to an ongoing Notice of Inquiry.[8]

As a result, mandating access to last-mile broadband systems emerged as an issue in each of the mega-mergers that swept through cable and telecommunications industries between 1999 and 2007.[9] Requests to mandate access to broadband networks also drew congressional attention, playing a key role during the consideration of major telecommunications reform legislation in 2006.[10] On the academic side, scholars have advocated requiring

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[6] Inquiry Concerning High-Speed Access to Internet over Cable and Other Facilities, Declaratory Ruling and Notice of Proposed Rulemaking, 17 F.C.C.R. 4798, 4843-48 ¶¶ 83-95 (2002) [hereinafter Cable Modem Declaratory Ruling & NPRM], *aff'd sub nom.* Nat'l Cable & Telecomms. Ass'n v. Brand X Internet Servs., 545 U.S. 967 (2005).

[7] Appropriate Framework for Broadband Access to the Internet over Wireline Facilities, Report and Order and Notice Of Proposed Rulemaking, 20 F.C.C.R. 14853, 14856 ¶ 2 (2005) [hereinafter Wireline Broadband Access Order].

[8] Broadband Industry Practices, Notice of Inquiry, 22 F.C.C.R. 7894 (2007).

[9] Regulatory authorities rejected requests to mandate access to last-mile broadband networks as a condition for approval of major cable mergers, including the AT&T's acquisition of TCI and MediaOne, AT&T's subsequent spinoff of those assets to Comcast, and the sales in conjunction with the resolution of the Adelphia bankruptcy. *See* Applications for Consent to the Assignment and/or Transfer of Control of Licenses: Adelphia Communications Corporation (and subsidiaries, debtors-in-possession), Assignors, to Time Warner Cable Inc. (subsidiaries), Assignees et al., Memorandum Opinion and Order, 21 F.C.C.R. 8203, 8296-99 ¶¶ 217-223 (2006) [hereinafter Adelphia Order]; 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 F.C.C.R. 23246, 23299-301 ¶¶ 135-137 (2002) [hereinafter Comcast-AT&T Order]; 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 F.C.C.R. 9816, 9872-73 ¶ 127 (2000) [hereinafter AT&T-MediaOne Order]; 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 F.C.C.R. 3160, 3205-08 ¶¶ 92-96 (1999) [hereinafter AT&T-TCI Order]. The only time that the FCC imposed any access requirements was during AOL's acquisition of Time Warner. *See* 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 F.C.C.R. 6547, 6568-69 ¶¶ 57-58 (2001) [hereinafter AOL-Time Warner Order]; America Online, Inc., No. C-3989, slip op. at 2, 6-9, 11-17 (F.T.C. Dec. 18, 2000) (Decision and Order), *at* http://www.ftc.gov/os/2000/12/aoldando.pdf;

Regulatory authorities also entertained requests to mandate access to last-mile broadband systems when evaluating major mergers in the telecommunications industry, including SBC-AT&T, Verizon-MCI, and AT&T-BellSouth. *See* AT&T Inc. and BellSouth Corp. Application for Transfer of Control, Memorandum Opinion and Order, 22 F.C.C.R. 5662, 5727-31 ¶¶ 116-120, 5742-46 ¶¶ 151-153 (2007) [hereinafter AT&T-BellSouth Order]; Verizon Communications, Inc. and MCI, Inc. Applications for Approval of Transfer of Control, Memorandum Opinion and Order, 20 F.C.C.R. 18433, 18507-09 ¶¶ 139-142 (2005) [hereinafter Verizon-MCI Order]; SBC Communications, Inc. and AT&T Corp. Applications for Approval of Transfer of Control, Memorandum Opinion and Order, 20 F.C.C.R. 18290, 18365-68 ¶¶ 140-143 (2005) [hereinafter SBC-AT&T Order].

[10] *See* Christopher S. Yoo, *Network Neutrality and the Economics of Congestion*, 94 GEO. L.J. 1847, 1859-60 (2006).

nondiscriminatory access to last-mile broadband networks first under the rubric of "open access to cable modem systems"[11] and more recently as part of the debates over "network neutrality."[12] As support for their proposals, these advocates have based their arguments two regulatory precedents (commonly known as the *Carterfone*[13] and the *Computer Inquiries*[14]) that imposed nondiscriminatory access requirements on the local telephone networks then monopolized by AT&T.[15]

Unfortunately, the debate over these issues has failed to take into account the extent to which the transformative forces discussed above changes the fundamental analysis. As an initial matter, access proponents have proposed extending narrowband regulatory regimes to broadband without analyzing whether the technological and economic differences that characterize the broadband environment undercut the applicability of the rationales traditionally invoked to justify regulation of telecommunications networks. In addition, the existing commentary has also largely failed to incorporate the insights into the practical and theoretical limits of the tools used to implement access that regulators have amassed through their experience overseeing access mandates.

Equally importantly, existing scholarship has treated access to broadband networks as a unitary phenomenon by either regarding the network to which access is sought as a black box

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11 *See, e.g.*, 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); 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).

12 *See, e.g.*, Tim Wu, *Network Neutrality, Broadband Discrimination*, 2 J. ON TELECOMM. & HIGH TECH. L. 141 (2003); Philip J. Weiser, *Toward a Next Generation Regulatory Strategy*, 35 LOY. U. CHI. L.J. 41, 74-84 (2003).

13 *See* Use of the Carterfone Device in Message Toll Telephone Services, Decision, 13 F.C.C.2d 420 (1968).

14 *See* Robert Cannon, *The Legacy of the Federal Communications Commission's Computer Inquiries*, 55 FED. COMM. L.J. 167 (2003) (providing an overview of the *Computer Inquiries*).

15 *See* Lemley & Lessig, *supra* note 11, at 970 (citing *Carterfone*); Weiser, *supra* note 12, at 65-68, 80-84 (citing the *Computer Inquiries* and *Carterfone*); Tim Wu, *Why Have a Telecommunications Law? Anti-Discrimination Norms in Communications*, 5 J. ON TELECOMM. & HIGH TECH. L. 15, 33 (2006) (citing the *Computer Inquiries* and *Carterfone*).

without analyzing how the network is configured by discussing different approaches to determining the cost of individual network elements, which effectively treats the individual network elements being accessed as if they existed in isolation. Both approaches fail to reflect that networks are complex systems whose behavior can only be understood after considering particular way that the various network elements are configured. Indeed, one of the most distinctive characteristics of networks is their ability to reroute traffic along alternate pathways to compensate for changes in traffic flow. Although this process of accommodation and redirection can alleviate in whole or in part the impact of any unanticipated changes in volume, to the extent that other areas of the network were already at or near saturation, it can also transfer congestion and the accompanying degradation in network performance to other portions of the network discontinuous with the point of disruption in ways that can be quite unpredictable unless one analyzes the configuration of the entire network, viewed in light of the magnitude and variability of the traffic flowing through it at any given time. In short, for networks, the whole exceeds the sum of the parts and can only be understood if analyzed as an integrated system in light of an overarching theory of how different network components interact with one another.

This Article seeks to address both of these shortcomings. Part I reviews the manner in which the leading last-mile broadband technologies have been regulated. Part II describes the theories invoked to justify mandating access to telecommunications in the past—including natural monopoly, network economic effects, vertical exclusion, and managed competition—and evaluates their applicability to last-mile broadband networks. It concludes that each of these previous theories have little significance to an industry characterized by vibrant intermodal competition, rapid customer growth, and dynamic technological change. Part III employs a five-part conceptual framework that we have developed based on a branch of mathematics known as graph theory to analyze the impact of various types of access in a more systematic manner. This framework illustrates the extent to which mandating different types of access to last-mile broadband networks, showing how the regulations proposed by proponents of open access to cable modem systems and network neutrality would adversely affect network owners' ability to manage their networks and to respond to consumer preferences as well as how the incentives of both incumbents and new entrants to invest in deploying the new network capacity that represents the best long-run solution to these problems.

I. Overview of the Regulation of Access to Broadband Networks

Until 2004, broadband, which the Federal Communications Commission (FCC) has defined broadband as the capability of providing speeds of at least 200 kbps in both directions,[16] was dominated by two technologies. Cable modem service was the early industry leader, deploying nearly one million lines by 1999, and peaking at 77% of the broadband market at the end of 2003. Since that time, DSL has emerged as a vibrant competitor, capturing 36% of the market and reducing cable modem's share to 53% by the end of 2006. Given that DSL's growth rate of 33% exceeded cable modem's growth rate of 21%, this gap is likely to narrow still further in the future.[17]

The deployment of two additional technologies promises to alter the competitive landscape still further. Verizon in the process of deploying its fiber-optic based FiOS network, committing to invest $23 billion between 2004 and 2010, at which point FiOS should be

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16 Inquiry Considering the Deployment of Advanced Telecommunications 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, Report, 14 F.C.C.R. 2398, 2406 ¶ 20 (1999) [hereinafter First Section 706 Report].

17 High-Speed Services Dec. 2006 Report, *supra* note 1, tbl.2.

available in half of its service area.[18] In addition, mobile wireless providers are in the process of upgrading their networks to support Internet applications. These services have grown sharply since the beginning of 2005, capturing 7% of the broadband market. The impact of mobile wireless becomes all the more striking if one considers the other category of high-speed services tracked by the FCC, i.e., "high-speed lines," defined to be services that provide at least 200 kbps in at least one direction. Between their introduction at the beginning of 2005 and the end of 2006, mobile wireless providers had captured nearly 27% of the market for high-speed lines, which reduced the shares of cable modem services and DSL to 39% and 30% respectively.[19] Competition is also beginning to emerge from unlicensed wireless technologies, such as WiFi and WiMax. The planned auction of additional spectrum in the 700 MHz range for wireless Internet services promises to further diversify the market structure in the future.[20]

The principal question facing regulatory authorities was determining how last-mile broadband services fit into the regulatory categories created by our nation's communications laws. "Telecommunications carriers" are governed by Title II of the Communications Act of 1934 and subject to a wide range of common carriage and nondiscriminatory access requirements.[21] Providers of "cable service" are governed by Title VI, which was enacted in

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[18] Verizon Commc'ns Inc., All About Verizon FiOS – Fact Sheet, *at* http://newscenter.verizon.com/kit/fios-symmetrical-internet-service/all-about-fios.html (last visited Nov. 27, 2007).

[19] High-Speed Services Dec. 2006 Report, *supra* note 1, tbls. 1, 2.

[20] Service Rules for the 698-746, 747-762, and 777-792 MHz Bands, Second Report and Order, 22 F.C.C.R. 15289 (2007).

[21] The statute defines "telecommunications" as "the transmission, between or among points specified by the user, of information of the user's choosing, without change in the form or content of the information as sent and received." 47 U.S.C. § 153(43). "Telecommunications service" is "the offering of telecommunications for a fee directly to the public . . . regardless of the facilities used." *Id.* § 153(46). "Telecommunications carriers" are "provider[s] of telecommunications services." *Id.* § 153(44). Telecommunications carriers must satisfy every reasonable request for service on terms that are just, reasonable, and nondiscriminatory. *See, e.g.*, 47 U.S.C. §§ 201, 202, 205. They are also subject to the access requirements created by the Telecommunications Act of 1996. *See* 47 U.S.C. § 251.

1984 and created a different set of access requirements.[22] "Information services" fall under Title I, which are not subject to any statutory access requirements, but remain subject to any access requirements that the FCC chooses to impose under its general regulatory authority.[23]

A. The Early Regulation of Cable Modem Systems

Cable modem systems provide service through the network of coaxial cables originally designed for cable television. The thickness of the coaxial cable allows some cable modem providers to offer faster speeds than DSL. The initial cable modem architecture, designed around DOCSIS 1.0, supported maximum theoretical speeds of 27 megabits per second (Mbps) downstream and 10 Mbps upstream,[24] with the actual downloads speeds reaching 6 Mbps.[25] The

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[22] Federal law defines "cable service" as "(A) the one-way transmission to subscribers of (i) video programming, or (ii) other programming service, and (B) subscriber interaction, if any, which is required for the selection or use of such video programming or other programming service." 47 U.S.C. § 522(6). "Video programming" is defined as "programming provided by, or generally considered comparable to programming provided by, a television broadcast station." *Id.* § 522(20). "Other programming service" is defined as "information that a cable operator makes available to all subscribers generally." *Id.* § 522(14). A "cable system" is generally defined to be "a facility . . . designed to provide cable service which includes video programming and which is provided to multiple subscribers within a community." *Id.* § 522(7). A "cable operator" is "any person or group of persons (A) who provides cable service over a cable system and directly or through one or more affiliates owns a significant interest in such cable system, or (B) who otherwise controls or is responsible for, through any arrangement, the management and operation of such a cable system." *Id.* § 522(5). Cable operators are not regulated as common carriers, *id.* § 541(c), but are subject to a wide range of other access requirements. *See id.* §§ 531 (access for public, educational, and governmental use), 532 (leased access), 534 (must carry for commercial broadcasters), 535 (must carry for noncommercial broadcasters).

[23] An "information service" is "the offering of a capability for generating, acquiring, storing, transforming, processing, retrieving, utilizing, or making available information via telecommunications, and includes electronic publishing, but does not include any use of any such capability for the management, control, or operation of a telecommunications system or the management of a telecommunications service." *Id.* § 153(20). "Information-service providers . . . are not subject to mandatory common-carrier regulation under Title II, thought he Commission has jurisdiction to impose additional regulatory obligations under its Title I ancillary jurisdiction to regulate interstate and foreign communications." Nat'l Cable & Telecomms. Ass'n v. Brand X Internet Servs., 545 U.S. 967, 976 (2005); *accord id.* at 996 (noting that the FCC "remains free to impose special regulatory duties on facilities-based ISPs under its Title I ancillary jurisdiction"), 1002 (noting the FCC's authority to require cable companies to provide access to independent ISPs).

[24] *See* Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of Telecommunications Act of 1996, Third Report, 17 F.C.C.R. 2844, 2917-18 ¶ 21 (2002).

[25] *See* Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of

cable industry is just beginning its shift to DOCSIS 3.0, which can support download speeds of up to 160 Mbps and upload speeds of up to 120 Mbps.[26]

The architecture of cable modem systems requires that the same infrastructure be shared with multiple users, which renders cable modem systems susceptible to congestion and which limits cable modem providers' ability to guarantee particular levels of network performance. Cable networks do require some reconfiguration before they can support broadband service. The network must be transformed from the typical tree-and-branch configuration associated with one-way television transmission into a ring or star-type configuration needed for data transmission, and the distance between certain facilities and the end user must be reduced. This is usually accomplished through the deployment of a ring of neighborhood nodes connected via optical fiber to their main offices (known as headends). Cable operators must also improve system quality to reduce signal leakage. In order to convert their networks to two-way service, cable modem providers must install amplifiers and optical lasers in both directions. They must also deploy cable modem termination systems (CMTS) to separate the data stream from the other traffic as well as establish the routers and switches to manage the data traffic emerging from the CMTS.[27] An early FCC report placed the cost of these upgrades at between $800 and $1000 per subscriber.[28]

Because cable modems arose from a technology subject to joint municipal-federal oversight, some ambiguity existed as to the proper division of regulatory jurisdiction. On

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Telecommunications Act of 1996, Fourth Report, 19 F.C.C.R. 20540, 20554 (2004) [hereinafter Fourth Section 706 Report].

[26] *See* CableLabs, DOCSIS—Project Primer, *at* http://www.cablemodem.com/primer/ (last visited Mar. 9, 2008).

[27] Inquiry Considering the Deployment of Advanced Telecommunications 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 F.C.C.R. 20913, 20928-29 ¶¶ 29-31 (1999) [hereinafter Second Section 706 Report].

[28] *See* First Section 706 Report, *supra* note 16, at 2431 chart 2.

multiple different occasions between 1998 and 2002, the FCC declined to decide which regulatory classification that should apply to cable modem service, let alone decide the scope of any access obligations that might apply,[29] with its reluctance to do so drawing a rebuke from two members of the Supreme Court.[30] In the absence of a clear assertion of federal authority, several municipal regulators attempted to exercise jurisdiction over cable modem systems, either by mandating access to those systems by municipal ordinance[31] or as a condition for the transfer of licenses needed to complete a cable merger.[32] Municipal regulation was soon cut short by a series of judicial decisions holding that municipal authorities lacked the jurisdiction to compel multiple ISP access.[33]

The fact that the FCC also had to provide regulatory approval for these mergers forced the FCC to confront requests for mandatory access cable modem systems as well. In 1999 and 2000, the FCC declined to require AT&T to provide independent ISPs with nondiscriminatory access to its cable modem systems as a condition of its acquisitions of TCI and MediaOne.[34] In 2001, however, the Federal Trade Commission and the FCC imposed just such requirement

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29 *See* Implementation of Section 703(e) of the Telecommunications Act of 1996: Amendment of the Commission's Rules and Policies Governing Pole Attachments, 13 F.C.C.R. 6777, 6795 ¶ 34 (1998); Federal-State Joint Board on Universal Service, Report to Congress, 13 F.C.C.R. 11501, 11535 n.140 (1998); Brief of the Federal Communications Commission as Amicus Curiae at 19-26, AT&T Corp. v. City of Portland, 216 F.3d 871 (9th Cir. 2000) (No. 99-35609) (filed Aug. 17, 1999); Amicus Curiae Brief of the Federal Communications Commission at 15-16, 18, MediaOne Group, Inc. v. County of Henrico, 257 F.3d 356, 360 (4th Cir. 2001) (filed Aug. 9, 2000); AT&T-MediaOne Order, *supra* note 9, at 9872 ¶ 126; Inquiry Concerning High-Speed Access to Internet Over Cable and Other Facilities, Notice of Inquiry, 15 F.C.C.R. 19287, 19293-28 ¶¶ 15-24 (2000); Petition for Certiorari at 15 n.4, Nat'l Cable & Telecomms. Ass'n v. Gulf Power Co., 534 U.S. 327 (2002) (No. 00-843) (filed Nov. 22, 2000); Brief for the Federal Petitioners at 30, *Gulf Power* (No. 00-843) (filed Apr. 6, 2001).

30 *Gulf Power*, 534 U.S. at 353-56 (Thomas, J., joined by Souter, J., concurring in part and dissenting in part).

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*, 257 F.3d at 360; *Portland*, 216 F.3d at 875.

33 *See MediaOne*, 257 F.3d at 363-64; *Portland*, 216 F.3d at 878-79.

34 *See* AT&T-MediaOne Order, *supra* note 9, at 9872-73 ¶ 127; AT&T-TCI Order, *supra* note 9, at 3205-08 ¶¶ 92-96.

when approving America Online's acquisition of Time Warner.[35] When the issue arose again in 2002 during regulatory clearance of Comcast's acquisition of AT&T's cable assets, the FCC returned to its initial position and declined to make its approval of their merger conditional on the merged company's willingness to provide multiple ISP access.[36]

In the midst of the foregoing series of merger reviews, the FCC initiated a notice of inquiry seeking comment on, among other things, whether it should impose access requirements on cable modem systems.[37] The FCC added further guidance in 2002 in its *Cable Modem Declaratory Ruling*, in which it determined that cable modem service is an interstate "information service" that was exempt from both the common carriage regime established under Title II to govern telecommunications services and from the regulatory regime established by Title VI to govern cable television services.[38] In addition, the FCC declined to impose the tariffing and unbundling requirements created by the *Computer Inquiries* to cable modem service, noting that the agency previously "has applied these obligations only to traditional wireline services and facilities, and has never applied them to information services provided over cable facilities."[39] These aspects of the FCC's decision were sustained by the Supreme Court's 2005 decision in *National Cable and Telecommunications Ass'n v. Brand X Internet Services*.[40]

Declaring that cable modem systems constituted information services did not resolve exactly how cable modem systems would be regulated. On the contrary, the FCC specifically

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35 America Online, Inc., No. C-3989, slip op. at 2, 6-9, 11-17 (F.T.C. Dec. 18, 2000) (Decision and Order), *at* http://www.ftc.gov/os/2000/12/aoldando.pdf; AOL-Time Warner Order, *supra* note 9, at 6568-69 ¶¶ 57-58.

36 Comcast-AT&T Order, *supra* note 9, at 23299-301 ¶¶ 135-137.

37 Inquiry Concerning High-Speed Access to the Internet Over Cable and Other Facilities, Notice of Inquiry, 15 F.C.C.R. 19287 (2000).

38 Inquiry Concerning High-Speed Access to Internet over Cable and Other Facilities, Declaratory Ruling and Notice of Proposed Rulemaking, 17 F.C.C.R. 4798, 4820-39 ¶¶ 34-69 (2002) [hereinafter Cable Modem Declaratory Ruling & NPRM].

39 *Id.* at 4825 ¶ 44; *accord id.* at 4825 ¶ 43.

40 545 U.S. 967, 1001 (2005).

sought comment on what, if any, access requirements it shod impose on cable modem service.[41] Also, concerned that a patchwork of inconsistent state and local regulation could discourage investment and innovation, the FCC sought comment on whether it should preempt state regulation, including access requirements.[42] Until the agency addresses the issue directly, the possibility remains that state and local authorities will exercise concurrent jurisdiction over cable modem service that leaves them free to mandate access.[43] That said, because services classified as information services in the past had been subject to minimal regulatory requirements, classifying cable modem service as an information service was regarded by many as a signal that the FCC was unlikely to mandate multiple ISP access.[44] The fact that the FCC had preempted state regulation in the *Computer Inquiries* also suggested that that the FCC was likely to do the same with respect to cable modem services.[45]

B. The Early Regulation of Digital Subscriber Lines (DSL)

The other principal technology for providing last-mile broadband Internet service is known as digital subscriber lines (DSL), which was first deployed in 1996. DSL takes advantage of the fact that conventional voice communications only occupy the lower transmission frequencies (typically those ranging from 300 to 3400 Hz). It is thus possible to use the higher frequencies (i.e., those above 20 kHz) to convey data communications through the same

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41 Cable Modem Declaratory Ruling & NPRM, *supra* note 38, at 4840-41 ¶ 74, 4843-47 ¶¶ 80-93, 4849 ¶ 100.

42 *Id.* at 4848 ¶¶ 97-100.

43 Cal. ISP Ass'n v. Pac. Bell Tel. Co., Decision 03-07-032, 2003 WL 21704389 (Cal. Pub. Utils. Comm'n July 10, 2003) (affirming Assign Commissioner's and Administrative Law Judge's ruling that the state regulatory authorities had concurrent jurisdiction over cable modem service).

44 Yochai J. Dreazen, *FCC Ruling Frees Cable-TV Firms from Sharing Wires*, WALL ST. J., Mar. 15, 2002, at B2.

45 Chérie R. Kiser & Angela F. Collins, *Regulation on the Horizon: Are Regulators Poised to Address the Status pf IP Telephony?*, 11 COMMLAW CONSPECTUS 19, 38 (2003); John T. Nakahata, *Regulating Information Platforms: The Challenge of Rewriting Communications Regulation from the Bottom Up*, 1 J. ON TELECOMM. & HIGH TECH. L. 95, 118 (2002).

telephone line without interfering with voice communications. The most common form of DSL is asymmetric DSL (ADSL), which typically supports download speeds of up to 3 Mbps and uploads speeds of up to 768 kbps.[46] More recent versions of ADSL support download speeds of up to 24 Mbps.[47] AT&T and other local telephone companies are in the process of deploying faster technologies, such as very high-data-rate digital subscriber lines (VDSL), capable of providing speeds of up to 50 Mbps.

Several technical changes must be made before a local telephone network can be used for DSL. First, local telephone lines must be "conditioned" by removing devices destined to improve the quality of voice calls (such as bridge taps, low-pass filters, and range extenders) that interfere with the provision of DSL service. In addition, special equipment known as a digital subscriber line access multiplexer (DSLAM) must be installed to separate voice traffic from data traffic. In addition, the local telephone company must establish a data network, including routers and switches, to manage the traffic after it emerges from the DSLAM.[48] Early estimates place the cost of these upgrades at $400 to $600 per subscriber.[49]

The fact that resistance increases with the length of the copper wire places a natural limit on the range of DSL. For ADSL, customers must be located no farther than twelve to eighteen thousand feet from the DSLAM. For VDSL, customers must be located no more than four thousand feet from the DSLAM. Local telephone companies can extend the range of DSL by deploying a technology known as digital loop carriers (DLCs). Instead of using an all-copper loop to connect the central office and the customer's premises, DLC systems deploy DSLAMs in

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[46] *See* Fourth Section 706 Report, *supra* note 25, at 20556.

[47] *See* DSL Forum, About ADSL, *available at* http://www.dslforum.org/learndsl/adslfaq.shtml (last visited Feb. 24, 2008).

[48] *See* Second Section 706 Report, *supra* note 27, at 20930 ¶ 35.

[49] First Section 706 Report, *supra* note 16, at 2431 chart 2.

satellite facilities known as remote terminals, which connected to the local telephone company's central office via optical fiber. Under this architecture, only the distance between the remote terminal and the customer's premises are connected through a copper subloop. By shortening the length of the copper wire providing the final connections to end users, DLC architectures also increase the effective range of DSL, although it greatly increases the costs of deployment. The limited space available in remote terminals can also make mandating access to those terminals quite problematic.

In stark contrast to the tentativeness of the FCC's regulatory approach to cable modems, the agency did not hesitate to assert jurisdiction over DSL. From the beginning, the FCC concluded that DSL was analogous to private-line services offering dedicated connections providing direct access to long distance providers. So long as interstate traffic represented more than ten per cent of the total traffic, DSL was properly tariffed at the federal level and not at the state level.[50] The net result was that DSL was typically offered as a tariffed service.[51]

The FCC did struggle over whether the Telecommunications Act of 1996 applied to the Internet, which Congress all but ignored when enacting the legislation.[52] The major access provisions of the 1996 Act applied only to incumbent local telephone companies that provided "telephone exchange service," which is the use of the local telephone network to reach other local customers, or "exchange access," which is the use of the local telephone network to

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[50] GTE Telephone Operating Cos., Memorandum Opinion and Order, 13 F.C.C.R. 22466, 22480 ¶ 25, 22481 ¶ 27 (1998) [hereinafter GTE DSL Order].

[51] *See* Communications Assistance for Law Enforcement Act, Second Report and Order, 15 F.C.C.R. 7105, 7120 ¶ 27 (1999) ("noting that "digital subscriber line (DSL) services are generally offered as tariffed telecommunications services.").

[52] *See, e.g.*, ACLU v. Reno, 521 U.S. 844, 857 (1997) ("The major components of the [Telecommunications Act of 1996] have nothing to do with the Internet."); John D. Podesta, *Unplanned Obsolescence: The Telecommunications Act of 1996 Meets the Internet*, 45 DEPAUL L. REV. 1093, 1109 (1996) ("[W]ith the rather major exception of censorship, Congress simply legislated as if the Net were not there.").

connect to long distance providers to reach long distance customers.[53] The FCC's *Advanced Services Order* concluded that DSL service constituted either telephone exchange service or exchange access without resolving into which category DSL service fell and thus was subject to the 1996 Act's resale, interconnection, unbundled access, and collocation mandates. The order also initiated a rulemaking seeking comment on precisely how to apply these resale, unbundling, and collocation requirements and proposing that DSL be allowed to avoid the restrictions imposed incumbent local telephone companies so long as they provide service through a separate subsidiary.[54] After US West sought judicial review of the *Advanced Service Order*, the FCC moved to remand the matter voluntarily so that it could consider the arguments raised US West's brief.[55] On remand, the FCC reaffirmed its conclusion that DSL represented either telephone exchange service or exchange access.[56] On judicial review, the D.C. Circuit vacated and remanded the order. Agency and judicial precedent dictated that telephone exchange service and exchange access constituted exclusive categories that occupy the entire field and thus that traffic either had to be classified as one or the other. The FCC's failure to resolve into which category DSL properly fell represented a want of reasoned decisionmaking sufficient to justify invalidating the agency's action.[57]

In addition, the FCC had to address precisely which network elements needed were subject the 1996 Act's provisions mandating access to unbundled network elements (UNE).[58] Initially, the agency adopted a permissive, if somewhat grudging, stance. Because the statute by

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53 47 U.S.C. § 251.

54 Deployment of Wireline Services Offering Advanced Telecommunications Capability, Memorandum Opinion and Order, and Notice of Proposed Rulemaking, 13 F.C.C.R. 24012, 24034-35 ¶¶ 46-47 (1998).

55 US West Communications, Inc. v. FCC, No. 98-1410 (D.C. Cir. Aug. 25, 1999) (unpublished disposition available at 1999 WL 728555).

56 Deployment of Wireline Services Offering Advanced Telecommunications Capability, Order on Remand, 15 F.C.C.R. 385 (1999).

57 WorldCom, Inc. v. FCC, 246 F.3d 690, 695-96 (D.C. Cir. 2001).

58 47 U.S.C. § 251(c)(3).

its own terms applies only to elements used in telephone exchange service and exchange access, the initial order implementing the 1996 Act declined to subject packet switches to UNE access requirements and ruled that collocation did not extend to equipment used to provide enhanced services, although it included multifunction equipment supporting both conventional telephone and enhanced services so long that equipment was necessary to providing conventional telephone service. Furthermore, any company obtaining interconnection or UNE access to provide telecommunications services may offer information services through the same arrangement. The order did mandate UNE access to all loops connecting central offices to end users, including the loops used to provide DSL. The order also obligated incumbent local telephone company to fulfill any requests to condition existing loops to make them DSL compatible.[59] A subsequent order confirmed that collocation included multifunction equipment that could be used to provide both voice and data services.[60] Perhaps most importantly, the FCC's *Line Sharing Order* mandated UNE access to the high frequency portion of the loop used to carry DSL so that two competitors could provide services over the same loop, with one offering conventional telephone service in the lower frequencies and the other offering DSL in the upper frequencies.[61]

The courts soon began to question the breadth of the FCC's rulings, beginning with the Supreme Court's decision in *AT&T Corp. v. Iowa Utilities Board*, which remanded the FCC's initial UNE access rules for construing the "necessary" and "impair" standards too broadly.[62] On remand, the FCC reiterated that incumbent local telephone companies must condition DSL loops upon request. Although UNE access to loops generally included all attached electronics,

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[59] Implementation of the Local Competition Provisions in the Telecommunications Act of 1996, First Report and Order, 11 F.C.C.R. 15499, 15691-92 ¶¶ 380-382, 15713 ¶ 427, 15794-95 ¶¶ 580-581, 15990 ¶ 995 (1996).

[60] Deployment of Wireline Services Offering Advanced Telecommunications Capability, First Report and Order and Notice of Proposed Rulemaking, 14 F.C.C.R. 4761, 4776-79 ¶¶ 27-31 (1999).

[61] Deployment of Wireline Services Offering Advanced Telecommunications Capability, Third Report and Order in CC Docket No. 98-147 and Fourth Report and Order in CC Docket No. 96-98, 14 F.C.C.R. 20912 (2000).

[62] 525 U.S. 366, 387-92 (1999).

the FCC specifically excepted packet switches and DSLAMs on the grounds that the incumbents did not maintain a monopoly position with respect to these functions and that granting UNE access to them would deter investment in a nascent market. The FCC did permit UNE access to DSLAMs located in remote terminals that were too small to permit physical collocation.[63]

In 2000, the D.C. Circuit struck down the FCC's decision permitting the collocation of multifunction equipment as a violation of the statutory provision authorizing collocation only if "necessary for interconnection or access to unbundled network elements."[64] In response, the FCC revised its rules in 2001 to limit collocation of multifunction equipment to equipment whose primary purpose is to provide the requesting carrier either with interconnection that is "equal in quality" to the that provided by the incumbent local telephone company for its own services or with "nondiscriminatory access" to an unbundled network element, a revision that survived judicial review.[65] These revisions to the collocation rules were sufficient to survive judicial scrutiny.[66]

These judicial decisions eventually led the FCC to begin a broader retreat from extending the regulatory regime applicable to conventional telephone service to DSL and other wireline broadband technologies. In 2002, shortly before adopting its *Cable Modem Declaratory Ruling*, the FCC issued its *Wireline Broadband NPRM,* which tentatively concluded that DSL and other broadband services provided by local telephone companies constituted "information services" that were not subject to the tariffing and common carriage requirements of Title II of the Communications Act of 1934. At the same time, the FCC sought comment on whether changes

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[63] Implementation of Local Competition Provisions of Telecommunications Act of 1996, Third Report and Order and Fourth Further Notice of Proposed Rulemaking, 15 F.C.C.R. 3696, 3775 ¶ 172, 3776-77 ¶ 175, 3783-84 ¶¶ 190-194, 3835-37 ¶¶ 306-309, 3839-40 ¶¶ 314-317 (1999).

[64] GTE Serv. Corp. v. FCC, 205 F.3d 416, 422-24 (D.C. Cir. 2000) (quoting 47 U.S.C. § 251(c)(6)).

[65] Deployment of Wireline Services Offering Advanced Telecommunications Capability, Fourth Report and Order, 16 F.C.C.R. 15435, 15452-60 ¶¶ 32-44 (2001).

[66] Verizon Tel. Cos. v. FCC, 292 F.3d 903 (D.C. Cir. 2002).

in technology and the competitive environment justified modifying or eliminating the regulatory regime created by its *Computer Inquiries*.[67] Later in 2002, the FCC detariffed DSL services that SBC offered through its separate subsidiary.[68]

In 2002, the D.C. Circuit further hastened the deregulation of DSL by striking down the FCC's decision requiring line sharing, reasoning that the FCC's findings that DSL faced robust competition from cable modem providers meant that line sharing violated the "necessary" and "impair" requirements of the 1996 Act.[69] This led the FCC to eliminate line sharing and lifted UNE access obligations to most high-capacity loops in its landmark 2003 *Triennial Review Order*. The FCC also eliminated the limited exceptions it had recognized for UNE access to DSLAMs and other packet switching equipment.[70] Although the D.C. Circuit would invalidate other portions of the *Triennial Review Order,* it explicitly affirmed this portion of the FCC's decision.[71] In 2005, the FCC also responded to concerns that last-mile providers were blocking access to certain applications when it sanctioned a small rural local telephone company known as Madison River Communications, which was attempting to preserve its local telephone revenues by preventing its DSL customers from accessing using the ports needed to access Internet telephony.[72]

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[67] Appropriate Framework for Broadband Access to the Internet over Wireline Facilities, Notice of Proposed Rulemaking, 17 F.C.C.R. 3019, 3029-33 ¶¶ 17-24, 3040-43 ¶¶ 43-53 (2002) [hereinafter Wireline Broadband NPRM].

[68] Review of Regulatory Requirements for Incumbent LEC Broadband Services, Memorandum Opinion and Order, 17 F.C.C.R. 27000 (2002).

[69] United States Telecom Ass'n v. FCC, 290 F.3d 415, 428-29 (D.C. Cir. 2002) (citing Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, Notice of Proposed Rulemaking, 17 F.C.C.R. 2844, 2864 ¶ 44, 2865 ¶ 48 (2002); First Section 706 Report, *supra* note 16, at 2423 ¶ 48.

[70] Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers, Report and Order and Order on Remand and Further Notice of Proposed Rulemaking, 18 F.C.C.R. 16978, 17327-33 ¶¶ 549-580 (2003) [hereinafter Triennial Review Order].

[71] U.S. Telecom Ass'n v. FCC, 359 F.3d 554, 578-85 (D.C. Cir. 2004).

[72] Madison River Commc'ns, LLC, Order, 20 F.C.C.R. 4295 (2005).

Most importantly, the FCC issued its *Wireline Broadband Internet Access Services Order* in 2005, which as of now represents the most complete statement of the FCC's last-mile broadband policy. This order ruled that DSL and other broadband services provided by local telephone companies constitute information services that were not subject to Title II's common carriage and tariffing requirements, in essence extending to DSL the same reasoning embodied in the *Cable Modem Declaratory Ruling* and endorsed by the Supreme Court in *Brand X*. In addition, the order eliminated all *Computer Inquiry* requirements with respect to all broadband technologies used to provide Internet service, although this ruling did not extend them to broadband technologies used to provide traditional telephone service, such as frame relay services, stand-alone asynchronous transfer mode (ATM) services, and gigabit Ethernet services. The FCC also found insufficient evidence to justify mandating nondiscriminatory access to content and applications providers, while reserving the right to change its mind should circumstances warrant doing so.[73] At the same time, the FCC issued a Policy Statement recognizing its intention to preserve consumers' rights to access content, run applications, and attach devices as they see fit, subject to the needs of law enforcement, protection against harm to the network, and reasonable network management.[74] The *Wireline Broadband Internet Access Services Order* was sustained on judicial review.[75]

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[73] Appropriate Framework for Broadband Access to the Internet over Wireline Facilities, Report and Order and Notice of Proposed Rulemaking, 20 F.C.C.R. 14853, 14860-61 ¶ 9 & n.15, 14862-65 ¶¶ 12-17, 14875-79 ¶ 41-46 & n.107, 14882-98 ¶¶ 32-85, 14904 ¶ 96 (2005) [hereinafter Wireline Broadband Internet Access Services Order], *petition for review denied sub nom.* Time Warner Telecom, Inc. v. FCC, 507 F.3d 205 (3d Cir. 2007).

[74] Appropriate Framework for Broadband Access to the Internet over Wireline Facilities, Policy Statement, 20 F.C.C.R. 14986 (2005).

[75] Time Warner Telecom, Inc. v. FCC, 507 F.3d 205 (3d Cir. 2007).

C. The Current Regulatory Status of Last-Mile Broadband Networks

Since the *Wireline Broadband Internet Access Services Order*, the FCC has taken additional steps to deregulate broadband services provided by local telephone companies. For example, the FCC has granted waivers giving Verizon, AT&T, and Qwest pricing flexibility for certain business-oriented broadband technologies subject to price cap regulation.[76] Most importantly, the FCC has granted waivers to both Verizon and AT&T deregulating the broadband services still subject to the *Computer Inquiry* rules following the *Wireline Broadband Internet Access Services Order* on the grounds that wireline broadband services face enough competition from other providers to justify no longer subjecting them to retail access requirements.[77] The net result is to eliminate the remaining retail access requirements on broadband services provided by local telephone companies.

The FCC's orders clearing a number of recent mergers reaffirmed its decision not to give content and applications providers nondiscriminatory access to last-mile broadband networks, concluding that competition was sufficiently robust to prevent network providers from discriminating against any particular content or applications and pointing to the lack of evidence in the record that any network provider had engaged in such practices.[78] The FCC has also issued rulings declaring that broadband over power line and wireless networks constitute

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[76] Petition for Waiver of Pricing Flexibility Rules for Fast Pack Services, Memorandum Opinion and Order, 20 F.C.C.R. 16840 (2005); SBC Communications Inc. Petition for Wavier of Section 61.42 of the Commission's Rules, 22 F.C.C.R. 7224 (2007); Qwest Petition for Waiver of Pricing Flexibility Rules for Advanced Communications Networks Services, 22 F.C.C.R. 7482 (2007).

[77] Petition of AT&T Inc. for Forbearance Under 47 U.S.C. § 160(c) from Title II and Computer Inquiry Rules with Respect to Its Broadband Services, Memorandum Opinion and Order, 22 F.C.C.R. 18705, 18718-19 ¶ 22, 18723-24 ¶ 30 (2007); Press Release, Fed. Commc'ns Comm'n, Verizon Telephone Companies' Petition for Forbearance from Title II and Computer Inquiry Rules with Respect to their Broadband Services Is Granted by Operation of Law (Mar. 20, 2006), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-264436A1.pdf.

[78] AT&T-BellSouth Order, *supra* note 9, at 5727-31 ¶¶ 116-120, 5742-46 ¶¶ 151-153; Adelphia Order, *supra* note 9, at 8296-99 ¶¶ 217-223; Verizon-MCI Order, *supra* note 9, at 18507-09 ¶¶ 139-142; SBC-AT&T Order, *supra* note 9, at 18365-68 ¶¶ 140-143.

information services.[79] Most recently, in March 2007, the FCC issued a notice of inquiry seeking specific examples of network providers disfavoring particular content and seeking comment on the impact of any such behavior on consumers.[80]

II. THE APPLICABILITY OF THE TRADITIONAL RATIONALES FOR REGULATING TELECOMMUNICATIONS TO LAST-MILE BROADBAND NETWORKS

Many of the proponents of open access to cable modem systems and network neutrality argue, at least in part, that the mandatory interconnection and nondiscrimination regime imposed on local telephone networks should be extended to last-mile broadband networks as well. Unfortunately, most of these proposals take this position without undertaking any extended analysis of whether the rationales used to justify mandating access to local telephone networks apply with equal force to broadband. Blind application of a regulatory regime developed for a different technology and different market conditions can lead to regulation that lacks any theoretical justification and can impede technological innovation and consumer welfare. Indeed, both the Supreme Court and the FCC have warned of the dangers of reflexively extending legacy regulation to broadband on the basis of "history, rather than on an analysis of contemporaneous market conditions."[81]

This Part seeks to address this issue directly by examining whether the rationales invoked to justify mandating access to local telephone networks apply to broadband. The specific rationales that we consider include natural monopoly, network economic effects, vertical

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[79] United Power Line Council's Petition for Declaratory Ruling Regarding the Classification of Broadband over Power Line Internet Access Service as an Information Service, Memorandum Opinion and Order, 21 F.C.C.R. 13281 (2006); Appropriate Regulatory Treatment for Broadband Access to the Internet over Wireless Networks, Declaratory Ruling, 22 F.C.C.R. 5901 (2007).

[80] Broadband Industry Practices, Notice of Inquiry, 22 F.C.C.R. 7894 (2007).

[81] Nat'l Cable & Telecomms. Ass'n v. Brand X Internet Servs., 545 U.S. 967, 1001 (2005); *accord* Wireline Broadband Internet Access Services Order, *supra* note 73, at 14879 ¶ 126 (quoting this language with approval).

exclusion, and the desirability of managed competition. Our analysis shows that the emergence of competition in last-mile broadband services has opened up the policy space in important ways that undercut many of the classic bases for regulation. In addition, the increased importance on investment incentives, the complexity of the relevant interfaces, and the rapid pace of technological change also effect fundamental changes to the policy analysis.

A. Natural Monopoly

One of the bedrock assumptions of telecommunications policy is that local telephone networks are natural monopolies. Natural monopoly represented one of the central justifications for early regulatory efforts in the 1920s[82] as well as the Communications Act of 1934.[83] Indeed, the entire telephone network was regarded as a natural monopoly until the 1960s.[84] Even after the FCC began to promote competition in complementary services, such telephone handsets and other customer premises equipment (CPE), long distance, and information services, policymakers continued to believe that local telephone service remained a natural monopoly.[85] As the FCC has noted, "At the time the *Computer Inquiry* rules were adopted, there was an

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82 S. REP. NO. 67-75, at 1 (1921).

83 *Hearings on S. 2910 Before the Senate Comm. on Interstate Commerce*, 73d Cong. 100 (1934) (testimony of AT&T President Walter Gifford), *reprinted in* A LEGISLATIVE HISTORY OF THE COMMUNICATIONS ACT OF 1934, at 119, (Max D. Paglin ed., 1989).

84 GERALD R. FAULHABER, TELECOMMUNICATIONS IN TURMOIL 107 (1987); PETER HUBER ET AL., FEDERAL TELECOMMUNICATIONS LAW § 2.1.1, at 84, § 2.1.2, at 86 (2d ed. 1999).

85 *See, e.g.*, Verizon Commc'ns Inc. v. FCC, 535 U.S. 467, 475-76 (2002) (noting that at the time of the breakup of AT&T, local telephone service was "thought to be the root of natural monopoly in the telecommunications industry"); United States v. W. Elec. Co., 673 F. Supp. 525, 537038 (D.D.C. 1987) (concluding that "[t]he exchange monopoly of the Regional Companies has continued because it is a natural monopoly"), *aff'd*, 894 F.2d 1387 (D.C. Cir. 1990); Implementation of the Local Competition Provisions in the Telecommunications Act of 1996, Notice of Proposed Rulemaking, 11 F.C.C.R. 14171, 14173-74 ¶ 4 (1996) (noting that the Communications Act of 1934 was grounded on the notion that local and long distance telephony constituted natural monopolies and that the breakup of AT&T continued to treat local telephone service as a natural monopoly); 2 ALFRED E. KAHN, THE ECONOMICS OF REGULATION: PRINCIPLES AND INSTITUTIONS 127 (1971) ("That the provision of local telephone service is a natural monopoly is generally conceded."); STEPHEN BREYER, REGULATION AND ITS REFORM 291 (1982) ("Local telephone service seems to be generally accepted as a natural monopoly.").

implicit, if not explicit, assumption that the incumbent wireline platform would remain the only network platform available to enhanced service providers."[86]

A given production technology is said to exhibit natural monopoly characteristics if it is *subadditive*, which occurs when a single firm can supply the entire market demand at lower cost than could two or more firms. A sufficient condition for subadditivity is when the economies of scale are so large that the average cost curve declines over the entire industry output. When average cost is declining, larger producers are able to produce at lower cost, which in turn allows them to underprice their competitors. The lower price allows them to capture a still larger share of the market, which causes the cost advantage enjoyed by the largest player to widen still further. This process will continue until all of other producers are driven from the market.

The classic source of scale economies in the telecommunications industry is the presence of large fixed costs. For example, spreading a $120 million sunk-cost investment across one million customers would require allocating an average of $120 in sunk costs to each customer. If the provider were able to reach one million additional customers, each consumer would have to pay only an average of $60 in order to cover sunk costs. Increasing the customer base an additional million to three million allows the fixed costs allocated to each customer to drop to $40. The addition of additional customers would cause the contribution that fixed costs make to average costs to decline still further, although the size of the decline will become smaller.

Stated slightly more generally, in typical markets the average cost curve is U-shaped. On the one hand, the amortization of fixed costs over increasingly large volumes places downward pressure on average cost, although the marginal impact of this effect will decay exponentially as

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[86] Wireline Broadband Internet Access Services Order, *supra* note 73, at 14877 ¶ 43; *accord* Nat'l Cable & Telecomms. Ass'n v. Brand X Internet Servs., 545 U.S. 967, 1001 (2005); Cable Modem Declaratory Ruling & NPRM, *supra* note 38, at 4825 ¶ 44; Wireline Broadband NPRM, *supra* note 67, at 3037 ¶ 36.

production increases. At the same time, the scarcity of factors of production and the principle of diminishing marginal returns places upward pressure on 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. If fixed costs are sufficiently large relative to demand, the former effect will dominate the latter over the entire range of industry output.

Natural monopoly gives rise to two normative implications. First, like all monopolists, natural monopolists tend to charge prices that are inefficiently high and to produce quantities that are inefficiently low. Second, because the market ultimately reaches equilibrium with only one producer, the fixed costs incurred by any subsequent entrant will inevitably end up being wasted, since only one set of capital assets will ultimately end up being used.

At the same time, the scale economies that lead to natural monopolies can be dissipated either if technology causes the fixed costs needed to create and operate a telecommunications network to fall. This may cause the average cost curve to shift inward to the point where more than one firm can operate on the increasing portion of the average cost curve, at which point competition becomes sustainable. Changes on the demand side can also dissipate natural monopolies. An increase in the total demand for the services provided by the network can shift the industry demand outward to the point where firms no longer operate on the declining portion of the average cost curve.

Commentators have long disputed whether local telephone networks constitute natural monopolies. Indeed, studies suggest that during the competitive era that flourished following the expiration of the original Bell telephone patents in 1896 and peaked in 1907, the diseconomies of scale in switching were so severe as to offset any scale economies resulting from the amortization of the fixed costs needed to established the network of wires used for the distribution of telephone service.[87] In more modern times, a vibrant empirical literature emerged debating whether local telephone networks were natural monopolies, with some studies concluding that local telephone service was subadditive[88] and others drawing the opposite conclusion.[89]

Because local distribution of cable programming required the deployment of a network of wires as extensive as that required to establish local telephone service, regulatory authorities and commentators have also regarded cable television as a natural monopoly.[90] Courts have followed suit, invoking the natural monopoly rationale when sustaining cable regulations against a variety of legal challenges.[91] Other scholars have questioned whether the cost functions of the cable industry exhibited sufficient natural monopoly characteristics to justify entry restrictions

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[87] *See* Daniel F. Spulber & Christopher S. Yoo, *Mandating Access to Telecom and the Internet: The Hidden Side of* Trinko, 107 COLUM. L. REV. 1822, 1891-93 (2007); Milton Mueller, *The Switchboard Problem: Scale, Signaling, and Organization in Manual Telephone Swathing, 1877-1897*, 30 TECH. & CULTURE 534 (1989).

[88] Abraham Charnes et al., *A Goal Programming/Constrained Regression Review of the Bell System Breakup*, 34 MGMT. SCI. 1 (1988); Lars-Hendrik Röller, *Proper Quadratic Cost Functions with an Application to the Bell System*, 72 REV. ECON. & STAT. 202 (1990); Lars-Hendrik Röller, *Modeling Cost Structure: The Bell System Revisited*, 22 APPLIED ECON. 1161 (1990); Wesley W. Wilson & Yimin Zhou, *Telecommunications Deregulation and Subadditive Costs: Are Local Telephone Monopolies Natural?*, 19 INT'L J. INDUS. ORG. 909 (2001); *see also* David Gabel & D. Mark Kennet, *Economies of Scope in the Local Telephone Exchange Market*, 6 J. REG. ECON. 381 (1994); F. Gasmi et al., *The Natural Monopoly Test Reconsidered: An Engineering Process-Based Approach to Empirical Analysis in Telecommunications*, 20 INT'L J. INDUS. ORG. 435 (2002).

[89] David S. Evans & James J. Heckman, *Multiproduct Cost Function Estimates and Natural Monopoly Tests for the Bell System*, *in* BREAKING UP BELL 127 (David S. Evans ed., 1983); David S. Evans & James J. Heckman, *A Test for Subadditivity with an Application to the Bell System*, 74 AM. ECON. REV. 615 (1984); Richard T. Shin & John S. Ying, *Unnatural Monopolies in Local Telephone*, 23 RAND J. ECON. 171 (1992); Sanford V. Berg & John Tschirhart, *A Market Test for Natural Monopoly in the Local Exchange*, 8 J. REG. ECON. 103 (1995).

[90] *See, e.g.*, CABINET COMMITTEE ON CABLE COMMC'NS, REPORT TO THE PRESIDENT 24, 43 (1974); G. KENT WEBB, THE ECONOMICS OF CABLE TELEVISION 106 (1983); U.S. Dep't of Justice, Press Release (Apr. 1, 1985), *quoted in* Glenn B. Manishin, *Antitrust and Regulation in Cable Television: Federal Policy at War with Itself*, 6 CARDOZO ARTS & ENT. L.J. 75, 87 (1987); Eli M. Noam, *Economies of Scale in Cable Television: A Multiproduct Analysis*, *in* VIDEO MEDIA COMPETITION: REGULATION, ECONOMICS, AND TECHNOLOGY 93 (Eli M. Noam ed., 1985).

[91] *See* Cmty. Commc'ns Corp. v. City of Boulder, 660 F.2d 1370, 1378-79 (10th Cir. 1981); Omega Satellite Prods. v. City of Indianapolis, 694 F.2d 119, 126 (7th Cir. 1982); Lamb Enters. v. Toledo Blade Co., 461 F.2d 506, 511 (6th Cir. 1972); Erie Telecomms., Inc. v. City of Erie, 659 F. Supp. 580, 586 (W.D. Pa. 1987), *aff'd*, 853 F.2d 1084 (3d Cir. 1988);Berkshire Cablevision of R.I., Inc. v. Burke, 571 F. Supp. 976, 985-86 (D.R.I. 1983); Hopkinsville Cable TV, Inc. v. Pennyroyal Cablevision, Inc., 562 F. Supp. 543, 547 (W.D. Ky. 1982); *see also* Affiliated Capital Corp. v. City of Houston, 735 F.2d 1555, 1563 (5th Cir. 1984) (accepting as true allegation that cable was a natural monopoly).

and rate regulation[92] and have debated whether some alternative institutional regime, such as franchise bidding, might redress any problems that might arise.[93] Some courts have followed suit, questioning whether cable television was a natural monopoly.[94] The three cases in which full trials were conducted on whether cable television constitutes a natural monopoly have split on the issue, with the one jury concluding that it was not a natural monopoly[95] and the other two juries drawing the opposite conclusion.[96]

Most importantly for our purposes, commentators began to suggest that intermodal competition from broadcasters and local telephone companies might provide sufficient competition to vitiate cable's natural monopoly status.[97] Consistent with this insight, a provision

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92 *See* Thomas W. Hazlett, *Private Monopoly and the Public Interest: An Economic Analysis of the Cable Franchise*, 134 U. PA. L. REV. 1335, 1364-75 (1986) (concluding that cable television is probably not a natural monopoly and that even if it is, the benefits from temporary competition probably outweigh the costs of restricting entry); William E. Lee, *Cable Franchising and the First Amendment*, 36 VAND. L. REV. 867, 880-88 (1983) (noting the lack of empirical proof that cable television is a natural monopoly and warning of the dangers of improper market definition); Bruce M. Owen & Peter R. Greenhalgh, *Competitive Considerations in Cable Television Franchising*, CONTEMP. POL'Y ISSUES, Apr. 1986, at 69 (concluding that the scale economies in cable are not sufficiently substantial as to preclude the possibility of competition).

93 *See* Richard A. Posner, *The Appropriate Scope of Regulation in the Cable Television Industry*, 3 BELL J. ECON. & MGMT. SCI. 98, 110-13 (1972) (arguing that periodic auctioning of cable franchises can replace rate regulation); Oliver E. Williamson, *Franchise Building for Natural Monopolies--In General and with Respect to CATV*, 7 BELL J. ECON. 73, 90-91 (1976) (identifying contracting problems with Posner's proposal and providing an empirical example in which franchise bidding was not superior to regulation); Mark A. Zupan, *The Efficacy of Franchise Bidding Schemes in the Case of Cable Television: Some Systemic Evidence*, 32 J.L. & ECON. 401 (1989) (discussing possible solutions to contracting problems and providing more systematic empirical evidence supporting for Posner's claim).

94 *See* Quincy Cable Television, Inc. v. FCC, 768 F.2d 1434, 1449-50 (D.C. Cir. 1985) (questioning the natural monopoly rationale for regulating cable); Cmty. Commc'ns Co. v. City of Boulder, 485 F. Supp. 1035, 1039-40 (D. Colo.), *rev'd*, 603 F.2d 704 (10th Cir. 1980), *rev'd*, 455 U.S. 40 (1982) (disagreeing that the evidence showed that cable television was a natural monopoly); *Cmty. Commc'ns Co.*, 603 F.2d at 712 (Markey, C.J., dissenting) (expressing his agreement with the district court's conclusion); *see also* Preferred Commc'ns, Inc. v. City of Los Angeles, 754 F.2d 1396, 1404 (9th Cir. 1985) (accepting as true allegation that sufficient economic demand existed to support more than one cable operator), *aff'd*, 476 U.S. 488, 493-94 (1986) (same); Tele-Commc'ns of Key West, Inc. v. United States, 757 F.2d 1330, 1335-36 (D.C. Cir. 1985) (same).

95 Pac. W. Cable Co. v. City of Sacramento, 672 F. Supp. 1322, 1328, 1339, 1349 (E.D. Cal. 1987).

96 Nor-W. Cable Commc'ns P'ship v. City of St. Paul, No. 3-83 Civ. 1228, 1998 WL 241122 (D. Minn. June 10, 1988); Central Telecomms., Inc. v. TCI Cablevision, Inc., 610 F. Supp. 891, 901 & n.33, 908 (W.D. Mo. 1985), *aff'd*, 800 F.2d 711, 713-18 (8th Cir. 1986).

97 *See* GEORGE H. SHAPIRO ET AL. CABLESPEECH 8-13 (1983) (noting that competition from alternative broadcast technologies left cable's natural monopoly status "open to serious question"); Eli M. Noam, *Local Distribution Monopolies in Cable Television and Telephone Service: The Scope for Competition*, *in* TELECOMMUNICATIONS TODAY AND TOMORROW 351, 359-65, 376-86 (Eli M. Noam ed., 1983) (questioning the

of the Cable Communications Policy Act of 1984 authorized the FCC to determine when cable operators face effective competition sufficient to justify eliminating rate regulation.[98] The FCC concluded that such competition could come from broadcasters or from a second cable television system or some other multichannel competitor.[99] Congress rejected the FCC's conclusion that broadcasting could serve as effective competition, but ratified the decision that cable operators might face effective competition from other multichannel video providers.[100]

The insight that intermodal competition can eliminate natural monopoly has even stronger implications for broadband data networks. The shift to digital transmission has allowed networks that once were dedicated exclusively to voice or to video to compete with one another. Cable companies have begun to offer voice services and to promote them aggressively. Telephone companies have begun to offer multichannel television through VDSL and through fiber-based transmission networks, such as Verizon's FiOS service. Most importantly for our purposes, digitization has allowed both telephone and cable companies to compete directly with respect to last-mile broadband services. Thus, regardless of whether cable or conventional telephone was once a natural monopoly with respect to the services they used to provide,

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effectiveness of competition from other spectrum-based media, but concluding telephone companies could serve as effective competitors).

98 Pub. L. No. 98-549, sec. 2, § 623(b), 98 Stat. 2779, 2788 (codified as amended at 47 U.S.C. § 543(b)(1)).

99 FCC initially ruled that cable operators face effective competition whenever they face competition from at least three over-the-air broadcast stations, which effectively eliminated rate regulation for 96.5% of all cable systems. Implementation of the Provisions of the Cable Communications Policy Act of 1984, Report and Order, 50 Fed. Reg. 18,637, 18,648-50 ¶¶ 91-100 (May 2, 1985), *aff'd sub nom.* ACLU v. FCC, 823 F.2d 1554, 1564-65 (D.C. Cir. 1987). The FCC later raised the threshold of effective competition to six over-the-air stations, which effectively limited rate deregulation to 30% of all cable subscribers. Cable operators faced effective competition if another cable provider could provide service to 50% of the homes in any service area and actually provided service to 10% of those homes. Reexamination of the Effective Competition Standard for the Regulation of Cable Television Service Rates, Report and Order and Second Further Notice of Proposed Rulemaking, 6 F.C.C.R. 4545, 4547-51 ¶¶ 7-30 (1991).

100 Cable Television Consumer Protection and Competition Act of 1992, Pub. L. No. 102-385, sec. 3(a), § 623(*l*)(1), 106 Stat. 1460, 1470 (repealing regulations providing that broadcasting could constitute effective competition and raising the threshold of those actually served to 15%).

econometric studies confirm that consumers regard DSL and cable modem service as close substitutes for one another.[101]

The tendency toward natural monopoly created by the fixed costs is also substantially mitigated by the decommodification of telecommunications technologies and the increasing differentiation among the services provided by different network providers.[102] It has been recognized since Edward Chamberlin's seminal work on monopolistic competition[103] that product differentiation can allow markets to reach equilibrium with multiple producers even though each is producing on the declining portion of the average cost curve. In other words, so long as products are differentiated, the existence of unexhausted economies of scale need not necessarily force a market to collapse into a natural monopoly.

Technological improvements have also caused the fixed costs needed to provide broadband service to fall precipitously, which weakens the tendency toward natural monopoly. In addition, the emergence of wireless transmission implicates the theory of *contestable markets*, which takes issue the prior scholarship arguing that high fixed costs necessarily represent a barrier to entry.[104] Contestability theory draws on the insight that high fixed costs need not inexorably lead to natural monopoly if a new entrant can resell its assets should it have to exit. So long as fixed costs are not also *sunk costs*, any attempt by an existing player to charge supracompetitive prices will only invite hit-and-run entry by firms that gather the available profits and depart as soon as competition drives prices down to competitive levels.

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101 *See* Robert W. Crandall et al., *The Empirical Case Against Asymmetric Regulation of Broadband Internet Access*, 17 BERKELEY TECH. L.J. 954, 973 (2002); Jerry A. Hausman et al., *Cable Modems and DSL: Broadband Internet Access for Residential Customers*, 91 AM. ECON. REV. (PAPERS & PROC.) 302 (2001).

102 Christopher S. Yoo, *Beyond Network Neutrality*, 19 HARV. J.L. & TECH. 1, 27-33 (2005).

103 EDWARD HASTINGS CHAMBERLIN, THE THEORY OF MONOPOLISTIC COMPETITION 194-95 (8th ed. 1962).

104 *See* WILLIAM J. BAUMOL ET AL., CONTESTABLE MARKETS AND THE THEORY OF INDUSTRY STRUCTURE 279-303 (rev. ed. 1987).

Contestability theory underscores a critical difference between wireless and wireline transmission technologies. Because telephone wires have historically been useless for any other purpose, fixed cost investments in telephone wires can properly be regarded as sunk costs and thus a potential source of market failure. The same is not necessarily true for the infrastructure needed to construct a wireless transmission network. Wireless technologies require equipment located on transmission towers as well as the legal right to use particular portions of the electromagnetic spectrum. Since alternatives uses exist for both of these assets (either by other wireless telephone providers or by providers of wireless broadband or other spectrum-based services), investments in wireless network technologies are less likely to be regarded as sunk costs and thus less likely to give rise to the market failures associated with natural monopoly.

At the same time, the development of innovative new Internet-based services has caused the demand curve for broadband networks to shift outward, further ameliorating the tendency toward natural monopoly. This combination of reductions in fixed costs and increases the demand for network services tends to push markets for broadband services away from natural monopoly. Multiple facilities-based providers now vie to provide broadband communications to large business enterprises. In addition, intermodal competition from different wireline and wireless technologies is having the same effect on the residential and small business market as well.

It thus comes as little surprise that the FCC has specifically rejected the conclusion that last-mile broadband services constitute a natural monopoly. For example, its initial report on broadband deployment specifically found that “no competitor has a large embedded base of paying residential consumers” and “[t]he record does not indicate that the consumer market [for broadband services] is inherently a natural monopoly."[105] The D.C. Circuit emphasized the importance of taking intermodal competition into account when invalidating the FCC's *Line Sharing Order* on the grounds that fierce competition from cable modem service rendered the agency's conclusion that competitors would be impaired without access to the high-frequency portion of the loop unreasonable.[106] More recently, the FCC's *Wireline Broadband Internet Access Services Order* also noted that "broadband Internet access services have never been restricted to a single network platform," which stood "in stark contrast to the information services market at the time the *Computer Inquiry* obligations were adopted, when only a single platform capable of delivering such services was contemplated and only a single facilities-based provider of that platform was available to deliver them to any particular end users." Tendencies toward natural monopoly are further alleviated by the increase in demand created by innovative broadband service offerings, such as VoIP. The presence of such intermodal competition, combined with the growth of demand, eliminated the need for extending the access requirements imposed by the *Computer Inquiries* to broadband.[107]

In short, the emergence of intermodal competition eviscerates claims that any particular last-mile broadband service is a natural monopoly. Although cable modem service took the early lead, the FCC's most recent data indicates that DSL has eroded much of cable modem's early dominance, capturing 36% of the broadband market and growing at a rate of 36% at the end of 2006, compared to the 53% market share and growth rate of 21% achieved by cable modem service.[108] As noted earlier, wireless broadband has also emerged as another important

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105 First Section 706 Report, *supra* note 69, at 2423 ¶ 48.
106 U.S. Telecom Ass'n v. FCC, 290 F.3d 415, 428-29 (D.C. Cir. 2002).
107 Wireline Broadband Internet Access Services Order, *supra* note 73, at 4880 ¶ 47, 14894 ¶ 76.
108 High-Speed Services Dec. 2006 Report, *supra* note 1, at tbl.1.

competitor, having signed up 45 million subscribers as of September 2007.[109] The deployment of fiber-based technologies, WiFi mesh networks, satellite broadband networks, and other last-mile broadband technologies is likely to cause intermodal competition to intensify even further in the future.

Natural monopoly would thus appear to offer little promise as a justification for mandating access to last-mile broadband services. Even if competition is limited to a small number of players, as some studies have suggested,[110] the emergence of sustainable oligopolistic competition nonetheless alters the policy balance in significant ways. When policymakers are confronted with a choice between regulated and unregulated *monopoly*, the large welfare losses associated with monopoly pricing arguably justify regulation despite the well recognized defects and distortions that plague such regulation. When the decision is between regulated and unregulated *oligopoly*, the policy balance is quite different. Theoretical and economic research has shown that oligopolies, while still falling short of the competitive ideal, perform far better than monopolies to the point where incurring the costs of ex ante regulation is no longer justified.[111]

But perhaps the most revolutionary change from the perspective of natural monopoly theory is the emergence of wireless broadband technologies. When evaluated in terms of "high-speed lines," which the FCC defines as those capable of providing 200 kbps in at least one direction, wireless services have exploded from having no subscribers at the end of 2004 to

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109 *See supra* note 2 and accompanying text.

110 *See* Gerald R. Faulhaber & Christiaan Hogendorn, *The Market Structure of Broadband Telecommunications*, 48 J. INDUS. ECON. 305, 326 (2000).

111 *See* Howard A. Shelanski, *Adjusting Regulation to Completion: Toward a New Model for Telecommunications Policy*, 24 YALE J. ON REG. 55, 77-93 (2007); Nakahata, *supra* note 97, at 179.

capturing almost 35 million subscribers and 35% of the market by the middle of 2007.[112] Since that time, the number of subscribers to third-generation wireless broadband has continued to grown, reaching 45 million by September 2007.[113] The impending redeployment of spectrum reclaimed from broadcasters following the transition to digital television should increase the competitiveness of the space still further.[114] The resulting increase in intermodal competition should put to rest any further attempts to base broadband regulation on natural monopoly.

B. Network Economic Effects

Some commentators have invoked network economic effects as a justification for regulating access to last-mile broadband networks. The classic argument is that network economic effects can give the early leaders a decisive advantage. Because the value of the network increases with the number of others users connected to the network, new customers will flock to the technology that gets off to the fastest start, with the subsequent increase in network size causing the advantages created by network economic effects to increase still further. These demand-side scale economies cause the technology establishing the early lead to become "locked in," which in turn becomes a source of market power.

Some commentators have argued that network economic effects provide cable modem providers with a competitive advantage in precisely this manner. Given cable modem providers' early lead, the subsequent emergence of DSL and other technologies may not be sufficient to dislodge them. Once so entrenched, cable modem providers could deploy proprietary protocols

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[112] Fed. Commc'ns Comm'n, High-Speed Services for Internet Access: Status as of June 30, 2007, at tbl.1 (Mar. 2008), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-280906A1.pdf.

[113] Jim Ross, Casting the Mobile Net, *at* http://www.ctia.org/content/index.cfm/AID/11203 (last visited March 19, 2008).

[114] *See* Service Rules for the 698-746, 747-762 and 777-792 MHz Bands, Second Report and Order, 22 F.C.C.R. 15289 (2007).

that raise switching costs and permit them to exercise market power against unaffiliated content providers.[115] Other commentators have similarly emphasized how content and applications providers benefit from interoperable architectures that allow them to reach the widest possible customer base. The early lead established by cable modem providers can allow them to deploy proprietary protocols that can chill innovation by reducing the number of customers any content or application provider can reach.[116]

We discuss the theoretical limitations of the literature on network economic effects at length elsewhere[117] and only emphasize a few points here. As an initial matter, concerns about existing market shares are largely misplaced in markets undergoing rapid growth. As the theoretical literature emphasizes, equilibria in markets subject to network economic effects depend not on current market shares, but rather the market structure expected to result after the market has reached maturity. For growing markets, the fact that a particular network may currently dominate a market is thus of little consequence. People concerned about lock-in will focus on the network that will exist in the future, not the one that exists today.[118]

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[115] Jerry A. Hausman et al., *Residential Demand for Broadband Telecommunications and Consumer Access to Unaffiliated Internet Content Providers*, 18 YALE J. ON REG. 129, 161-62, 163-65 (2001).

[116] LAWRENCE LESSIG, THE FUTURE OF IDEAS 40-41, 156, 161-62, 171 (2002); 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, 932-33, 945-46, 950-54 (2001).

[117] *See* Christopher S. Yoo, *Vertical Integration and Media Regulation in the New Economy*, 19 YALE J. ON REG. 171, 278-82 (2002); Spulber & Yoo, *supra* note 3, at 921-22.

[118] *See* Michael L. Katz & Carl Shapiro, *Product Introduction with Network Externalities*, 40 J. INDUS. ECON. 55, 67, 73 (1992) (concluding that exponential market growth effectively prevents excess inertia); S.J. Liebowitz & Stephen E. Margolis, *Should Technology Choice Be a Concern of Antitrust Policy?*, 9 HARV. J.L. & TECH. 283, 292 (1996) ("Entrenched incumbents are less entrenched when consumers react to new sales . . . ."); Carl Shapiro, *Aftermarkets and Consumer Welfare: Making Sense of* Kodak, 63 ANTITRUST L.J. 483, 490 (1995) (A manufacturer will find installed-base opportunism less attractive, the greater is the growth rate of the market, the greater are its prospects to gain market share."). Liebowitz and Margolis elaborate:

> [T]here are additional conditions that can contribute to the ascendancy of the efficient standard. An important one is the growth of the activity that uses the standard. If a market is growing rapidly, the number of users who have made commitments to any standard is small relative to the number of future users. Sales of audiocassette players were barely hindered by their incompatibility with the reel-to-reel or eight-track players that preceded them. Sales of sixteen-bit

In addition, the market failures identified by the formal economic models depend on the assumption that the relevant markets are either dominated by a single firm or highly concentrated.[119] In the absence of such market structures, the primary impact of network economic effects is to provide powerful incentives for network owners to interconnect with one another even in the absence of regulation.[120] Competition among a sufficient number of equally sized players should be sufficient to eliminate any anticompetitive incentives to refuse to interconnect.[121]

Even if the market is sufficiently concentrated to raise concerns about monopolistic dominance and technological lock-in, it is far from clear that other features of the market and the structure of consumer preferences might not mitigate, if not eliminate, any adverse effects. For example, the market may also dislodge an existing network technology so long as the new technology provides additional value that exceeds the value derived from the size of old

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> computers were scarcely hampered by their incompatibility with the disks or operating systems of eight-bit computers. In each of these cases, rapid market growth was sufficient to overcome such incompatibility.

Liebowitz & Margolis, *supra*, at 312.

[119] *See* Stanley M. Besen & Joseph Farrell, *Choosing How to Compete: Strategies and Tactics in Standardization*, J. ECON. PERSP., Spr. 1994, 117, 119-29; Jacques Crémer, Patrick Rey, & Jean Tirole, *Connectivity in the Commercial Internet*, 48 J. INDUS. ECON. 433 (2000); Michael L. Katz & Carl Shapiro, *Technology Adoption in the Presence of Network Externalities*, 94 J. POL. ECON. 822 (1986).

[120] *See* Michael L. Katz & Carl Shapiro, *Systems Competition and Network Effects*, J. ECON. PERSP., Spring 1994, at 93, 105 (noting that "[i]n markets with network effects, there is natural tendency toward de facto standardization").

[121] Gerald R. Faulhaber, *Bottlenecks and Bandwagons: Access Policy in the New Telecommunications*, *in* 2 HANDBOOK OF TELECOMMUNICATIONS ECONOMICS 487, 501-02 (Samit K. Majumdar et al. eds., 2005) (pointing out that in mature markets consisting of a small number of firms of roughly equal size, "the only stable outcome (i.e., the market equilibrium) is for all firms to interconnect"); Michael L. Katz & Carl Shapiro, *Network Externalities, Competition, and Compatibility*, 75 AM. ECON. REV. 424, 429 (1985) (noting that "[a]s the number of firms becomes increasingly large," equilibrium in which all firms interconnect converges to perfectly competitive equilibrium); *see also* Nicholas Economides, *The Economics of the Internet Backbone*, *in* 2 HANDBOOK OF TELECOMMUNICATIONS ECONOMICS, *supra*, at 371, 390 (recognizing that network economic effects give firms strong incentives to interconnect).

network.[122] This particularly true, given that, after networks have captured a sufficient number of subscribers, the marginal benefit from adding another subscriber is likely to be low, which would greatly reduce the magnitude of any potential externality.[123]

In addition, heterogeneity of consumer preferences can mitigate the demand-side economies scale associated with network economic effects in much the same way that they can mitigate the supply-side economies of scale associated with large fixed costs.[124] As Michael Katz and Carl Shapiro have noted "Customer heterogeneity and product differentiation tend to limit tipping and sustain multiple networks. If the rival systems have distinct features sought by certain customers, two or more systems may be able to survive by catering to consumers who care more about product attributes than network size. Here, market equilibrium with multiple incompatible products reflects the social value of variety."[125]

Determining the optimal number of networks and the optimal timing of technological change requires a careful balance of the relevant costs and benefits. Furthermore, even proof of the existence of the necessary empirical preconditions for network-induced market failure would not necessarily support regulatory intervention. Consider, for example, the particular regulatory

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[122] Katz & Shapiro, *supra* note 120, at 106 (observing that new, incompatible standards may emerge despite the presence of network externalities if "consumers … care more about product attributes than network size"); STAN J. LIEBOWITZ & STEPHEN E. MARGOLIS, WINNERS, LOSERS AND MICROSOFT 19, 21-22 (rev. ed. 2001)) (noting that a "greater the gap in performance between the two standards, … the more likely that a move to the efficient standard will take place")..

[123] BRIDGER M. MITCHELL & INGO VOGELSANG, TELECOMMUNICATIONS PRICING: THEORY AND PRACTICE 55 (1991); A. de Fontenay & J.T. Lee, *BC/Alberta Long Distance Calling*, *in* ECONOMIC ANALYSIS OF TELECOMMUNICATIONS: THEORY AND APPLICATIONS 199 (Leon Courville et al eds. 1983); G. Yarrow, *Dealing with Social Obligations in Telecoms*, *in* REGULATING UTILITIES: A TIME FOR CHANGE? 67 (S. Sayer et al. eds., 1996); Robert Albon et al., Telecommunications Economics and Policy Issues 53 (Govt. of Australia, Productivity Commission Staff Information Paper, 1997) *at* http://www.pc.gov.au/ic/research/information/teleeco/teleeco.pdf; J.A. Breslaw, Network Externalities and the Demand for Residential Long Distance Telephone Service (Concordia Univ. Working Paper No. 1985-13, 1985).

[124] *See supra* notes 102-103 and accompanying text.

[125] Katz & Shapiro, *supra* note 120, at 106 (citing Joseph Farrell & Garth Saloner, *Standardization and Variety*, 20 ECON. LETTERS 71 (1986)); *see* also Liebowitz & Margolis, *supra* note 118, at 292 ("Where there are differences in preference regarding alternative standards, coexistence of standards is a likely outcome.").

decisions associated with any state-sponsored attempt to solve the problems of technological lock-in. Such intervention would necessarily require the government to replace clear winners in the technology marketplace with what it believed represented the superior technology. Moreover, in order to be effective, the government must do so at an early stage in the technology's development, when making such determinations is the most difficult. Regulators would also typically have to make such determinations on extremely thin information that in most cases would be provided by parties with a direct interest in the outcome of the regulatory process. In addition, decisionmakers would have to insulate themselves from the types of systematic biases traditionally associated with political decisionmaking processes. It is for these reasons that some of the most distinguished network economic effects theorists caution that governmental intervention might well make the problem worse, not better.[126]

The FCC has invoked many of these arguments when declining to mandate access to different types of networks. For example, the FCC has repeatedly refused to mandate wireless or backbone interconnection, reasoning that the fact that the market consisted of multiple players of roughly equal size already provided powerful incentives to interconnect.[127] In addition, the FCC's *Wireline Broadband Internet Access Services Order* took these considerations into account when it rejected arguments based on current market data as "limited and static" and incomplete for "fail[ing] to recognize the dynamic nature of marketplace forces." Emerging

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[126] *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, 200-03 (Jeffrey A. Eisenach & Thomas M. Lenard eds., 1999); Katz & Shapiro, *supra* note 120, at 112-13.

[127] *See, e.g.*, Developing a Unified Intercarrier Compensation Regime, Notice of Proposed Rulemaking, 16 F.C.C.R. 9610, 9656 ¶ 127 (2001) ("The backbones appear to be successfully negotiating interconnection agreements among themselves without any regulatory intervention, and we see no reason to intervene in this efficiently functioning market."); Interconnection and Resale Obligations Pertaining to Commercial Mobile Radio Services, Fourth Report and Order, 15 F.C.C.R. 13523, 13534 ¶ 28 (2000) ("In view of the growth of competition in the [wireless] market, . . . we continue to believe that the best way of achieving interconnection is through voluntary private agreements.").

markets like broadband are "more appropriately analyzed in view of larger trends in the marketplace, rather than exclusively through the snapshot data that may quickly and predictably be rendered obsolete as this market continues to evolve." In particular, at the time of the order, broadband penetration rates had only reach 20%, while industry analysts forecast that penetration would eventually reach 90%. Thus, it mattered little that the cable modem industry had taken the early lead. In addition, "emerging broadband platforms exert competitive pressure even though they currently have few subscribers compared with cable modem service and DSL-based Internet access service." Competition among current and emerging broadband platforms provided sufficient incentives to provide access in the absence of government intervention to justify deregulation of last-mile wireline broadband networks.[128]

C. Vertical Exclusion

The assumption that the telephone network was a natural monopoly gave rise to the related concern that the Bell System would use its control over the network to harm competition in vertically related markets. The specific concern was that telephone providers would discriminate against independent companies offering complementary services that competed with the Bell System's proprietary offerings. Vertical exclusion thus represented the driving force behind most of the major regulatory initiatives over the past half century. It formed the central motivation for the FCC's *Carterfone* rules, which opened up local telephone networks to competitively provided customer premises equipment. Concern that local telephone companies would use their monopoly control over the local loop to discriminate against unaffiliated enhanced and information service providers represented the analytical rationale for the

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[128] Wireline Broadband Internet Access Services Order, *supra* note 73, at 14880-85 ¶¶ 50-61, 14895 ¶ 79.

nondiscriminatory access requirements imposed by the *Computer Inquiries*. It also underlay the regulatory proceedings and private antitrust suit by MCI and the government antitrust suit that led to the breakup of AT&T, which opened up the Bell System's local telephone networks to competitive long distance services. It also provided the foundation for the provisions if the Telecommunications Act of 1996 requiring incumbent local telephone companies to provide access all essential elements of their networks on an unbundled basis.

The current policy debate focuses on whether the same reasoning should be extended from narrowband to broadband. Vertical exclusion also represents the central justification for proposals for open access to cable modem systems and undergirds the ongoing debate over network neutrality, which would give content and application providers nondiscriminatory access to all last-mile broadband networks.

The conventional wisdom with respect to vertical exclusion has undergone a sea change over the past half century.[129] While economic theorists during the 1950s and 1960s were quite hostile toward vertical integration and vertical contractual restraints, such as exclusive dealing and long-term contracts, that were tantamount to the same thing, vertical integration is now generally recognized to be less problematic than previously believed. On the contrary, it can often be quite economically beneficial. The driving force behind this transformation is the emergence of the so-called "one monopoly rent theorem," which holds that monopolists have little, if any, incentive to engage in vertical exclusion.[130] Because there is only one monopoly

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[129] For overviews of this transformation, see Yoo, *supra* note 117, at 187-205; Yoo, *supra* note 10, at 1885-87.

[130] For the seminal statements of the one monopoly rent theorem, see Ward S. Bowman, Jr., *Tying Arrangements and the Leverage Problem*, 67 YALE L.J. 19, 20-21 (1957); Aaron Director & Edward H. Levi, *Law and the Future: Trade Regulation*, 51 NW. U. L. REV. 281, 290 (1956).

profit available in any vertical chain of production, a monopolist can capture all of that profit without having to resort to vertical integration simply by charging the monopoly price.[131]

Even more importantly, it is impossible to state a coherent theory of vertical exclusion unless two structural preconditions are met. First, the firm must possess monopoly power in one market (typically called the *primary market*), since without such power the network owner would not have anything to use as leverage over the upstream market for complementary services.[132] Second, the market into which the firm seeks to exercise vertical exclusion (called the *secondary market*) must be concentrated and protected by entry barriers. If no such barriers to entry exist, any attempt to raise price in the secondary market will simply attract new competitors until the price drops back down to competitive levels.[133] Unless these structural preconditions are met, the most that vertical integration would do is rearrange distribution patterns.[134]

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[131] A simple numerical example, based on a classic opinion written by then-Chief Judge Stephen Breyer, illustrates the intuitions underlying the one monopoly rent theorem. *See* Town of Concord v. Boston Edison Co., 915 F.2d 17, 32 (1st Cir. 1990) (Breyer, C.J.). Suppose that a firm with a monopoly over refining ore into copper ingot sells its output into a competitive market in which firms fabricate the ingot into copper pipe. Suppose further that the cost of refining ore into ingot is $40, that the cost of fabricating the ingot into pipe is $35, and that the monopoly price for the final good is $100. If the monopolist were to vertically integrate into fabrication, it could charge $100 for the final good and thereby earn a profit of $25 per unit (i.e., $100 – $40 – $35). The monopolist need not vertically integrate to capture this profit, however. All it needs to do is price the ingot at $65, which would allow it to earn the same profit of $25 per unit (i.e., $65 – $40). Since the firms fabricating the ingot into pipe face competition, they will simply set their markup equal to their costs. This results in the price of the final good also being set at its profit-maximizing price of $100 (i.e., $65 + $35). Thus, under these circumstances, the monopolist gains nothing by vertically integrating into fabrication. All it needs to do to capture all of the available profit is to price the input so that the final good is priced at the monopoly level.

[132] *See, e.g.*, Director & Levi, *supra* note 130, at 290 ("Firms that are competitive cannot impose coercive restrictions on their suppliers or their customers as a means of obtaining a monopoly. They lack the power to do this effectively.").

[133] *See, e.g.*, ROGER D. BLAIR & DAVID L. KASERMAN, ANTITRUST ECONOMICS 416-17 (1985); Sam Peltzman, *Issues in Vertical Integration Policy*, *in* PUBLIC POLICY TOWARDS MERGERS 167, 174 (J. Fred Weston & Sam Peltzman eds., 1969).

[134] *See, e.g.*, GEORGE J. STIGLER, THE ORGANIZATION OF INDUSTRY 113-22 (1968); Director & Levi, *supra* note 130, at 293; Peltzman, *supra* note 133, at 169-70. The insight can be illustrated through an example based on one of the leading Supreme Court cases on vertical integration. *See* Brown Shoe Co. v. United States, 370 U.S. 294 (1962). Suppose that the market consists of ten shoe manufacturers each controlling ten percent of the market and one hundred independent shoe retailers each controlling one percent of the market. Suppose further that one of the manufacturers decides to stop distributing its products through independent retailers and instead purchases ten of the available shoe retailers and sells its shoes only through those outlets. Would this decision reduce competition in either the shoe manufacturing or shoe retailing? Although competing manufacturers (which comprise ninety percent

The theoretical literature acknowledges the existence of exceptions to the one monopoly rent theorem under which vertical integration can be profitable. As noted earlier, a monopolist subject to rate regulation may well find it profitable to integrate vertically. Gaining control of a second, unregulated level of production would allow the firm to earn the profits foreclosed by regulators.[135] In such cases, it is arguably appropriate to prohibit vertical integration in order to isolate and quarantine the monopolist. Such regulation is justified, however, only when any attempt to break up the monopoly would ultimately prove futile. As the market at issue becomes increasingly open to competition, both rate regulation and the concomitant prohibition of vertical integration become equally unwarranted.

At the same time, economic theorists increasingly recognized that vertical integration could yield substantial efficiencies. For example, if two layers of a vertical chain of distribution are monopolistic or oligopolistic, firms in each layer have the incentive to try to extract the entirety of the available supracompetitive returns, which would lead to an aggregate price that would be even higher than the monopoly price. Vertical integration can eliminate this so-called double marginalization problem, since a company that spans both layers would rationalize the

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of the market) will no longer be able to sell their products through the ten shoe retailers that now only sell shoes produced by the vertically integrated manufacturer, the remaining independent shoe retailers (which also comprise ninety percent of the market) should now have extra capacity from the withdrawal of sales from the vertically integrated manufacturer sufficient to provide distribution for all of the other manufacturers' output. In this case, vertical integration only serves to realign the patterns of distribution without affecting the market shares of either the manufacturers or the retailers. Nor is it likely that the vertically integrated manufacturer could foreclose the retail market by purchasing more than ten percent of the available retailing capacity. In the absence of entry barriers, any attempt to lock out other manufacturers by tying up retailers or to extract supracompetitive returns in the retailing market would only stimulate entry by new retail outlets that would be ready and willing to distribute the products of the other manufacturers.

135 *See, e.g.*, Bowman, *supra* note 130, at 21-23. For a detailed exposition of AT&T's use of this form of leverage to harm competition for long distance telephony, see Timothy J. Brennan, *Why Regulated Firms Should Be Kept Out of Unregulated Markets: Understanding the Divestiture in* U.S. v. AT&T, 32 ANTITRUST BULL. 741 (1987).

decisionmaking between the two levels of production and would avoid the uncoordinated action that would make the supracompetitive pricing even worse.[136]

In addition, to the extent that the inputs can be used in variable proportions, any attempt to charge supracompetitive prices for one input creates incentives for firms to substitute alternative inputs whenever possible. The resulting substitution creates an alternative potential source of inefficiency, as production processes deviate from the most efficient input mix. Allowing the provider of the monopolized input to vertically integrate into manufacturing can allow it to prevent inefficient input substitution.[137] The welfare implications of input substitution are ultimately ambiguous, since prohibiting input substitution enhances the monopolist's ability to exercise market power, which can create welfare losses sufficient to offset the welfare gains from preventing customers from deviating from the most efficient input mix.[138] Determining which of the two countervailing effects will dominate can be quite difficult.[139] The consensus is that any reduction in welfare from preventing input substitution is

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136 Joseph J. Spengler, *Vertical Integration and Antitrust Policy*, 58 J. POL. ECON. 347 (1950); *see also* Fritz Machlup & Martha Taber, *Bilateral Monopoly, Successive Monopoly, and Vertical Integration*, 27 ECONOMICA 101 (1960) (reviewing the early scholarship on successive monopoly theory).

137 L.W. McKenzie, *Ideal Output and the Interdependence of Firms*, 61 ECON. J. 785 (1951); Bowman, *supra* note 130, at 25-27; M.L Burstein, *A Theory of Full-Line Forcing*, 55 NW. U. L. REV. 62, 68, 76-83 (1960); John M. Vernon & Daniel A. Graham, *Profitability of Monopolization by Vertical Integration*, 79 J. POL. ECON. 924 (1971).

138 George A. Hay, *An Economic Analysis of Vertical Integration*, 1 IND. ORG. REV. 188 (1973); Richard Schmalensee, *A Note on the Theory of Vertical Integration*, 81 J. POL. ECON. 442, 448 (1973); Frederick R. Warren-Boulton, *Vertical Control with Variable Proportions*, 82 J. POL. ECON. 783, 794-96, 798, 799 (1974).

139 F.M. SCHERER & DAVID ROSS, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 523-24 (3d ed. 1990) ("The mathematical conditions underlying this result are complex."). Specifically, the welfare tradeoff described above turned largely on the elasticity of substitution and the elasticity of demand for the final good. Economists that have assumed that the final product market is perfectly competitive have disagreed over the range of elasticities that lead to a price increase. *Compare* George A. Hay, *An Economic Analysis of Vertical Integration*, 1 IND. ORG. REV. 188 (1973); Richard Schmalensee, *A Note on the Theory of Vertical Integration*, 81 J. POL. ECON. 442 (1973); *and* Frederick R. Warren-Boulton, *Vertical Control with Variable Proportions*, 82 J. POL. ECON. 783 (1974), *with* Parthasaradhi Mallela & Babu Nahata, *Theory of Vertical Control with Variable Proportions*, 88 J. POL. ECON. 1007 (1980); *and* Fred M. Westfield, *Vertical Integration: Does Product Price Rise or Fall?*, 71 AM. ECON. REV. 334 (1981). Scholars that have modeled the final product market as oligopolistic have reached similar disagreement. *Compare* Michael Waterson, *Vertical Integration, Variable Proportions and Oligopoly*, 92 ECON. J. 129, 139 (1982) (concluding that, if the final product market is oligopolistic rather than competitive, the impact on welfare depends on the elasticity of substitution), *with* Masahiro Abiru, *Vertical*

likely to be sufficiently small as not to pose a problem significant enough to be worth redressing.[140]

Finally, scholars building on Coase's seminal work on the theory of the firm[141] have demonstrated how vertical integration can reduce transaction costs. One example is the elimination of free riding. For example, suppose that a firm manufactures a technically complicated product that requires significant presale services (such as the demonstration of the product). Retailers will have the incentive to shirk in providing such services in the hopes that other retailers will bear the costs of providing such services. If all retailers respond to these incentives in the same way, the total amount of presale services will fall below efficient levels. A manufacturer facing the possibility of such free riding can either rely on a vertical contractual restraint that specifies the level of presale services that each retailer is required to offer or can vertically integrate into distribution. Either solution effectively aligns the retailers' incentives with the manufacturers'.[142]

Another oft-cited transaction cost efficiency associated with vertical integration stems from the existence of relationship-specific investments, which exist whenever the cost of a capital asset exceeds the value of its next-best use. Relationship-specific investments can create *appropriable quasi-rents*, because they allow others to hold up the investing party in an attempt to extract a greater proportion of the joint benefits. Firms confronting such risks can eliminate them either by entering into a vertical contractual restraint (such as an exclusive dealing,

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Integration, Variable Proportions, and Successive Oligopolies, 36 J. INDUS. ECON. 315, 324 (1988) (employing similar assumptions to conclude that price will fall and welfare will increase regardless of elasticity of substitution).

140 Martin K. Perry, *Vertical Integration: Determinants and Effects*, *in* 1 HANDBOOK OF INDUSTRIAL ORGANIZATION 183, 192 (Richard Schmalensee & Robert D. Willig eds., 1989) ("[I]t is not clear that variable proportions raises a major policy issue on vertical integration."); David Reiffen & Michael Vita, *Is There New Thinking on Vertical Mergers?*, 63 ANTITRUST L.J. 917, 923 (1995) ("The variable proportions models of vertical integration seldom have been regarded as providing a sound basis for guiding vertical merger enforcement policy.").

141 R.H. Coase, *The Theory of the Firm*, 4 ECONOMICA 386 (1937).

142 Lester G. Telser, *Why Should Manufacturers Want Fair Trade?*, 3 J.L. & ECON. 86 (1960).

requirements, or long-term contract) or by vertically integrating. Either solution eliminates the incentives for engaging in opportunistic behavior designed to affect the division of profits between the two firms.[143] Although a lively debate has emerged over the frequency with which vertical integration will represent the preferred solution over a vertical contractual restraint,[144] both sides agree about the potential benefits associated with some greater exercise of vertical control.

Determining whether a particular form of vertical integration will enhance or reduce economic welfare is thus an empirical question that turns on the particular market structure and the nature of the available efficiencies. Although some have questioned whether the empirical literature is sufficiently developed to support any clear policy inferences,[145] recent surveys of the empirical literature on vertical integration and vertical restraints found that the existing studies

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[143] Benjamin Klein, Robert G. Crawford, & Armen A. Alchian, *Vertical Integration, Appropriable Rents, and the Competitive Contracting Process*, 21 J.L. & ECON. 297 (1978).

[144] The classic example discussed in the literature is GM's 1926 acquisition of one of its component manufacturers, Fisher Body. Klein, Crawford, and Alchian argue that the shift from wooden to metal automobile bodies required Fisher Body to make a relationship-specific investment in new metal stamping technology unique to GM's cars that created the possibility that GM would act opportunistically against Fisher Body after the investment costs had already been sunk. To mitigate this risk, GM and Fisher Body entered into a long-term exclusive dealing agreement that was well designed to protect Fisher Body against opportunistic behavior by GM, but not well designed to protect GM against opportunistic behavior by Fisher Body. A dramatic increase in the demand for metal-bodied automobiles put GM in the position of being held up by Fisher Body. Unable to manage its relationship with its input supplier through contractual devices, GM was left with no choice but to vertically integrate backwards into body fabrication by acquiring Fisher Body. Klein et al., *supra* note 143, at 308-10.

Other scholars, including Coase himself, have disputed this account. The claims about Fisher Body have been quite controversial. These critics argue that vertical contractual restraints were more than sufficient to protect GM's interests and point out that at the time that Fisher Body supposedly acted opportunistically, GM already owned sixty percent of Fisher Body's common stock. R.H. Coase, *The Nature of the Firm: Meaning*, 4 J.L. ECON. & ORG. 19 (1988); R.H. Coase, *The Acquisition of Fisher Body by General Motors*, 43 J.L. & ECON. 15 (2000); Robert F. Freeland, *Creating Holdup Through Vertical Integration: Fisher Body Revisited*, 43 J.L. & ECON. 33 (2000); Ramon Casadesus-Masanell & Daniel F. Spulber, *The Fable of Fisher Body*, 43 J.L. & ECON. 67 (2000). Klein, in turn, responded by arguing that the relevant quasi-rents resulted from firm-specific human (rather than physical) capital and by placing greater emphasis on Fisher Body's supposed refusal to locate its plants near GM's. Benjamin Klein, *Vertical Integration as Organizational Ownership: The Fisher Body-General Motors Relationship Revisited*, 4 J.L. ECON. & ORG. 199 (1988); Benjamin Klein, *Fisher-General Motors and the Nature of the Firm*, 43 J.L. & ECON. 105 (2000).

[145] *See* Timothy J. Muris, GTE Sylvania *and the Empirical Foundations of Antitrust*, 68 ANTITRUST L.J. 899, 910-11 (2001); Michael S. Jacobs, *An Essay on the Normative Foundations of Antitrust Economics*, 74 N.C. L. REV. 219, 250-58 (1995); William H. Page, *The Chicago School and the Evolution of Antitrust: Characterization, Antitrust Injury, and Evidentiary Sufficiency*, 75 VA. L. REV. 1221, 1242, 1252 (1989).

overwhelmingly support for the proposition that vertical integration and vertical restraints tend to promote, rather than harm, competition.[146]

Scholarship associated with the "post-Chicago" school of antitrust law and economics has used game theory to study the impact of vertical exclusion when markets function imperfectly. These tools enabled them to identify circumstances under which vertical integration can harm competition. Interestingly, these models presuppose the existence of dominant-firm and oligopoly market structures in the primary market, which necessarily presuppose that both the primary and secondary markets are highly concentrated and protected by entry barriers.[147] In the absence of such structural features, these formal models recognize that vertical integration may be just as likely to lower price and increase welfare and that the ability of existing players or new entrants to expand their outputs will be sufficient to defeat any attempt to increase price above competitive levels.[148] Furthermore, these models concede that vertical integration may lead to efficiencies sufficient to offset any concomitant anti-competitive effects and that whether

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[146] *See* James C. Cooper et al., *Vertical Antitrust Policy as a Problem of Inference*, 23 INT'L J. INDUS. ORG. 639 (2005) (surveying seventeen empirical studies of vertical exclusion and finding that only one found consumer harm and that even in that case the magnitude of the harm was quite small); Francine LaFontaine & Margaret Slade, *Exclusive Contracts and Vertical Restraints: Empirical Evidence and Public Policy*, *in* HANDBOOK OF ANTITRUST ECONOMICS 391 (Paolo Buccirossi ed., forthcoming 2008), *available at* http://www2.warwick.ac.uk/fac/soc/economics/staff/faculty/slade/wp/ecsept2005.pdf. (surveying eleven published empirical studies and finding that privately imposed vertical restraints often promoted consumer welfare, further finding that government prohibition of vertical restraints never promoted consumer welfare, and calling the support for the proposition that privately imposed vertical restraints do not harm consumers to be "quite striking," "consistent and convincing," and "compelling").

[147] *See* Oliver Hart & Jean Tirole, *Vertical Integration and Market Foreclosure*, BROOKINGS PAPERS ON ECONOMIC ACTIVITY: MICROECONOMICS 205 (1990); Janusz A. Ordover et al., *Equilibrium Vertical Foreclosure*, 80 AM. ECON. REV. 127 (1990); Michael H. Riordan, *Anticompetitive Vertical Integration by a Dominant Firm*, 88 AM. ECON. REV. 1232 (1998); Michael H. Riordan, & Steven C. Salop, *Evaluating Vertical Mergers: A Post-Chicago Approach*, 63 ANTITRUST L.J. 513 (1995); Michael A. Salinger, *Vertical Mergers and Market Foreclosure*, 103 Q.J. ECON. 345 (1988); Steven C. Salop & David T. Scheffman, *Raising Rivals' Costs*, 73 AM. ECON. REV. 267, 268 (1983).

[148] Riordan & Salop, *supra* note 147, at 532-33;. Salinger, *Vertical Mergers in Multi-Product Industries and Edgeworth's Paradox of Taxation*, 39 J. INDUS. ECON. 545 (1991).

a particular instance of vertical integration impedes or promotes competition depends on which of these two effects dominates.[149]

There is another line of analysis line of authority that draws on Michael Whinston's seminal analysis of tying to suggest that vertical integration could lead to dynamic anticompetitive effects.[150] Most of the scenarios analyzed by Whinston presuppose the satisfaction of the structural preconditions identified above by assuming that the primary market is a monopoly and the secondary market is subject to scale economies. Whinston does, however, consider at least one scenario in which the firm engaged in tying faces a degree of competition. Interestingly, although under these circumstances tying can lead to foreclosure, its impact on welfare is ultimately ambiguous. As a result, Whinston explicitly recognized that his model's ambiguous welfare implications, as well as the fact that his model "ignore[s] a number of other possible motivations" for tying, undermined its ability to serve as a basis for a practical legal standard.[151] Dennis Carlton and Michael Waldman's extension of Whinston's work similarly emphasizes the ambiguity of the welfare implications and cautions against proscribing practices based on the theoretical possibility of harm without any evaluation of the potential

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149 *See* Hart & Tirole, *supra* note 147, at 212; Michael W. Klass & Michael A. Salinger, *Do New Theories of Vertical Foreclosure Provide Sound Guidance for Consent Agreements in Vertical Merger Cases?*, 40 ANTITRUST BULL. 667, 673, 679-82 (1995); Riordan & Salop, *supra* note 147, at 522-27, 544-51, 564; Salinger, *supra* note 147, at 349-50, 354-55; Ian Ayres, Vertical Integration and Overbuying: An Analysis of Foreclosure Via Raised Rivals' Costs 17-20, 23-24 (Am. Bar Found. Working Paper No. 8803, 1988); *see also* Thomas G. Krattenmaker & Steven C. Salop, *Anticompetitive Exclusion: Raising Rivals' Costs to Achieve Power Over Price*, 96 YALE L.J. 209, 277-80 (1986) (conducting a similar analysis with respect to vertical restraints).

150 *See* Michael D. Whinston, *Tying, Foreclosure, and Exclusion*, 80 AM. ECON. REV. 837 (1990); Dennis Carlton & Michael Waldman, *The Strategic Use of Tying to Preserve and Create Market Power in Evolving Industries*, 33 RAND J. ECON. 194 (2002). For an argument in favor of network neutrality based on these models, see Barbara van Schewick, *Toward an Economic Framework for Network Neutrality Regulation*, 5 J. ON TELECOMM. & HIGH TECH. L. 329, 353-56 (2007). For useful analyses of the limitations of these models, see Cooper et al., *supra* note 146, at 646-48; Alexander C. Larson, *Antitrust Tie-In Analysis After* Kodak*: A Comment*, 63 ANTITRUST L.J. 239, 255-57 (1994).

151 Whinston, *supra* note 150, at 832-34, 855-56.

efficiencies.[152] Thus, by their own terms, these models provide no support for treating vertical practices as illegal per se. Instead of embracing per se illegality, these models endorse the more case-specific analysis associated with the rule of reason.

Thus, although the post-Chicago literature has effectively rebutted the Chicago School's calls for per se legality, it has done little to disturb the basic conclusions that vertical integration is unlikely to harm competition unless the relevant markets are concentrated and protected by entry barriers or that vertical integration may yield efficiencies. The impact of this critique has been quite influential. Supreme Court doctrine[153] and the conventional wisdom among antitrust scholars[154] have now largely abandoned its hostility toward vertical integration.

Most importantly, the same forces that are increasing the competitiveness of every portion of the telecommunications industry is eliminating the plausibility that any network provider will have a dominant market position to use as leverage over an adjacent market. The foregoing discussions of the natural monopoly and network economic effects justifications for regulating last-mile broadband networks demonstrate how emergence of intermodal competition is in the process of abrogating the structural preconditions that must be met in order to state a plausible claim of vertical exclusion. Indeed, the D.C. Circuit emphasized the emergence of intermodal competition between cable modem and DSL providers when striking down the FCC's *Line Sharing Order*. The availability of broadband access from other providers meant that the dangers of vertical exclusion were not substantial enough to justify incurring the costs needed to

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[152] Carlton & Waldman, *supra* note 150, at 215-16.

[153] *See* Yoo, *supra* note 117, at 186-87, 200-02 (tracing how Supreme Court doctrine has become more hospitable toward vertical integration over time); Yoo, *supra* note 10, at 1885-87 (same).

[154] *See, e.g.*, 3A PHILLIP E. AREEDA & HERBERT HOVENKAMP, ANTITRUST LAW ¶ 758, at 27-32 (1996); 4 PHILLIP AREEDA & DONALD F. TURNER, ANTITRUST LAW ¶ 1004, at 222 (1980); HERBERT HOVENKAMP, FEDERAL ANTITRUST POLICY § 7.6b, at 301-02 (2d ed. 1999); Richard S. Markovits, *Tie-ins, Leverage, and the American Antitrust Laws*, 80 YALE L.J. 195, 199-205 (1970); Oliver E. Williamson, *Delimiting Antitrust*, 76 GEO. L.J. 271, 282 (1987).

mandate UNE access to the high frequency portion of the loop.[155] The FCC endorsed this conclusion in its *Triennial Review Order*, in which it eliminated line sharing and refused to mandate UNE access to the hybrid copper/fiber loops used in DLC systems.[156]

The FCC drew similar conclusions in the *Wireline Broadband Internet Access Services Order*, which eliminated the *Computer Inquiry* rules with respect to last-mile broadband technologies used to provide Internet service. As the FCC noted, the broadband market is characterized by vibrant intermodal competition between cable modem and DSL providers. In addition, those providers faced the real prospect of entry and increased penetration by satellite, fixed wireless, and other alternative transmission technologies. In the face of such competition, last-mile broadband providers have little to gain from engaging in vertical exclusion. On the contrary, the FCC concluded that the desire to spread fixed costs over the largest revenue-base possible gives them powerful incentives to maximize the traffic on their networks by accommodating as many unaffiliated content and applications providers as possible.[157]

In addition, the FCC recognized the economic consensus recognizing that vertical integration and vertical restraints can yield substantial efficiencies that must be taken into account in any vertical analysis. As the FCC noted, regulations designed to prevent vertical exclusion by drawing a distinction between transmission and enhanced services was preventing the realization of certain technological efficiencies resulting from integrated provision of broadband services. Indeed, the *Computer Inquiry* rules were based on the now outmoded belief that "because computer processing occurred at the network's edge or outside the network, the major innovation would occur there too." The rules thus "reflect[ed] a fairly static picture of

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155 U.S. Telecom Ass'n v. FCC, 290 F.3d 415, 428-29 (D.C. Cir. 2002).
156 Triennial Review Order, *supra* note 70, at 17136 ¶ 263, 17151-52 ¶ 292.
157 Wireline Broadband Internet Access Services Order, *supra* note 73, at 14884-87 ¶¶ 56-64, 14892-94 ¶¶ 74-76.

network development, and an assumption that a line could be drawn between the network functions and computer processing without impeding technological innovation." Technology had invalidated this distinction. Indeed, in the current environment, "[i]nnovation can occur at all network points and at all network layers as well as in non-network applications and equipment. Continued application of the *Computer Inquiry* rules . . . would prevent much of this innovation from occurring."[158]

The manner in which technology is in the process of increasing the competitiveness of all segments of the telecommunications industry and the real efficiencies from vertically integrated provision already identified by the FCC has effectively undercut the threat of vertical exclusion as a justification for regulating telecommunications networks. Continued imposition of measures designed to prevent vertical exclusion thus only imposed regulatory costs, deterred innovation, and threatened to prevent the network from evolving toward new architectures that depend on a tighter integration of the network's functionality and its transmission capabilities. Although these insights suggest that vertical exclusion does not pose sufficient concern to justify imposing ex ante prophylactic regulation in the absence of demonstrated harm to competition, the theoretical literature does identify some circumstances in which vertical exclusion can plausibly occur. The existence of those circumstances counsels in favor of an ex post regulatory regime in which access can be mandated in individual cases following a demonstration of actual economic harm, in much the same manner that the FCC imposed liability in *Madison River*.[159]

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158 *Id.* at 14890 ¶ 70.

159 *See* Yoo, *supra* note 102, at 75-76; Yoo, *supra* note 10, at 1899-900.

D. Managed Competition

On occasion, regulatory authorities have intervened even when competition was possible. Throughout much of the late 19th and 20th centuries, regulation was often imposed to redress the problems caused by "ruinous," "excessive," or "destructive" competition.[160] The concern was that industries characterized by high fixed costs would be plagued by excess capacity, as a surfeit of new entrants rushed in to invest in a new technology without anticipating the level of investment made by other competitors. Once having sunk the fixed costs needed to enter, producing firms would not exit the industry so long as they could charge prices sufficient to cover their marginal costs. The resulting competition would drive prices down to marginal cost, which would prevent firms from generating sufficient revenue to recover their capital investments. Some sort of coordinated action, either through collusion or government regulation, was viewed as the only viable solution to endemic overproduction and eventual collapse into a natural monopoly.[161]

Scholars commenting on the cable television industry have sometimes expressed concern about the ruinous competition that would result from "overbuilding," which occurs when a second cable company enters an area already served by an incumbent and begins to compete with it.[162] The concern was that the duplication of fixed costs would lead to higher rates. Judge Posner echoed these concerns in a 1982 opinion upholding a city's decision to issue an exclusive cable franchise. Posner reasoned, "This duplication may lead not only to higher prices to cable

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[160] For an overview of the intellectual history of ruinous competition, see HERBERT HOVENKAMP, ENTERPRISE AND AMERICAN LAW, 1837-1936, at 309-22 (1991).

[161] *See* New York v. United States, 331 U.S. 284, 346 (1947); ICC v. Inland Waterways Corp., 319 U.S. 671, 688 n.24 (1943); New State Ice Co. v. Liebmann, 285 U.S. 262, 292-94 (1932) (Brandeis, J., dissenting).

[162] *See, e.g.*, R.C. Johnson & R.T. Blau, *Single versus Multiple-System Cable Television*, 18 J. BROAD. 323, 325 (1974); A.K. Smiley, Direct Competition Among Cable Television Systems (U.S. Dept. of Justice Econ. Analysis Group Paper No. 86-9, June 5, 1989).

television subscribers, at least in the short run, but also to higher costs to other users of the public ways, who must compete with the cable television companies for access to them. An alternative procedure is to pick the most efficient competitor at the outset, give him a monopoly, and extract from him in exchange a commitment to provide reasonable service at reasonable rates."[163]

Ruinous competition has been heavily criticized as a basis for governmental intervention. For example, then-Harvard law professor and now-Justice Stephen Breyer dismissed the rationale as an "empty box" with no particular economic meaning or content.[164] These criticisms have been echoed both by economists[165] and by the Supreme Court.[166] The reasoning is simple. The existence of excess capacity simply leads incumbent firms to forego making new investments until the market returns to long-run equilibrium. Although producing firms might suffer substantial losses in the short run, the ensuing competition would yield substantial benefits to consumers, while simultaneously identifying the most efficient firm from among the contenders and providing for an empirical test of whether a particular market was in fact a natural monopoly. The only justification would be to protect the investors in these companies, which would violate the standard admonition that regulators should protect competition, not competitors.

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163 Omega Satellite Prods. Co. v. City of Indianapolis, 694 F.2d 119, 126 (7th Cir. 1982) (Posner, J.).

164 BREYER, *supra* note 85, at 29-35.

165 *See, e.g.*, John Maurice Clark, *A Contribution to the Theory of Competitive Price*, 28 Q.J. ECON. 747 (1914). Frank Knight, *Cost of Production and Price Over Long & Short Periods*, 29 J. POL. ECON. 304 (1921); 2 F.W. TAUSSIG, PRINCIPLES OF ECONOMICS 53-54 (3d ed. 1922); J.M. CLARK, STUDIES IN THE ECONOMICS OF OVERHEAD COSTS (1923); CARL KAYSEN & DONALD TURNER, ANTITRUST POLICY 195-97 (1959); Roger G. Noll, *Economic Perspectives on the Politics of Regulation*, *in* 2 HANDBOOK OF INDUSTRIAL ORGANIZATION, *supra* note 140, at 1253, 1257.

166 *See* Arizona v. Maricopa County Medical Soc'y, 457 U.S. 332, 346 (1982); Nat'l Soc'y of Prof'l Eng'rs v. United States, 435 U.S. 679, 689-90 (1978); United States v. Container Corp. of Am., 393 U.S. 333, 338 n.4 (1969); Fashion Originators' Guild of Am. v. FTC, 312 U.S. 457 (1941); United States v. Socony-Vacuum Oil Co., 310 U.S. 150, 220-24 (1940); United States v. Trans-Mo. Freight Ass'n, 166 U.S. 290 (1897). *But see* Appalachian Coals, Inc. v. United States, 288 U.S. 344 (1933) (holding that competing coal producers could form an agreement to promote efficiency so long as the intent was not to unreasonably restrain trade).

Drawing on these insights, commentators have challenged claims of ruinous competition in cable television, arguing that overbuilding leads to lower, not higher, prices.[167] However questionable this conclusion might have been at the time, any claims of ruinous competition have been undercut by the emergence of apparently sustainable intermodal competition from DBS. As suspect as claims of ruinous competition were with respect to cable television, they appear to be even less plausible with respect to broadband. Academic studies have long indicated the viability of competition among multiple last-mile broadband providers.[168] The FCC has concluded, moreover, that DSL and cable modem providers are already engaged in vigorous competition and that the continuing growth of the market is likely to support entry by additional broadband technologies.[169] The large investments currently being made in 3G, WiMax, WiFi, broadband over power line, and other alternative broadband technologies underscore the widespread nature of the belief in the viability of alternative broadband platforms.

Even after the collapse of ruinous competition as a basis for regulation, policymakers have sometimes advocated a transitional form of managed competition. The classic situation is when a change in technology or demand opens a market previously dominated by one player to competition, although such competition may take some time to emerge and the dominant player will continue to be able to exercise market power for quite some time. When this occurs, policymakers have sometimes imposed asymmetric regulation on the dominant player either to prevent it from charging supracompetitive rates or from engaging in predatory actions to protect its market position. Although somewhat inconsistent with the growing embrace of a policy of

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167 *See, e.g.*, Thomas W. Hazlett, *Duopolistic Competition in Cable Television: Implications for Public Policy*, 7 YALE J. ON REG. 65 (1990); Stanford L. Levin & John B. Meisel, *Cable Television and Competition: Theory, Evidence and Policy*, 15 TELECOMM. POL'Y 519 (1991).

168 Faulhaber & Hogendorn, *supra* note 110, at 326 (offering formal model calibrated with on engineering data indicating that demand is sufficient to sustain up to three broadband providers for 70% of U.S. households).

169 Wireline Broadband Internet Access Services Order, *supra* note 73, at 14884-85 ¶¶ 56-59.

open competition, the hope was that such asymmetric regulation would protect against anticompetitive excesses by the dominant firm while simultaneously nurturing the new entrants' ability to survive.

Indeed, former FCC Chief Economist William Rogerson offered just such an argument when he proposed subjecting the legacy technology (DSL) to access regulation without imposing such regulation on the new technology (cable modem service). Rogerson argues that DSL can be deployed simply by adding additional equipment to the end of the loop without making substantial investments in the loops themselves. As a result, the adverse impact of DSL regulation on investment incentives would be minimal. Rogerson recognizes that once telephone-based technologies move beyond reconditioning existing lines and begin to require capital investments in new facilities, mandating access would cause an unacceptable deterrence to investment. The problem is even more acute with respect to cable modem service, which requires larger investments and upgrades to physical plant.[170]

When entry by alternative network capacity is feasible, policymakers must focus on more than simply allocating the network that exists today. They must also focus on the equally (if not more) important question of how to create incentives to invest in new network technologies that will comprise the optimal network of tomorrow. In other words, they must take care not to place too much focus on *static efficiency* and pay too little attention to *dynamic efficiency*.

When competitive entry is possible, the traditional regulatory tools can have a detrimental impact on incentives to invest in alternative network technologies. Consider first rate regulation. So long as competitive entry remains feasible, supracompetitive returns should

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[170] *See* William P. Rogerson, *The Regulation of Broadband Telecommunications, the Principle of Regulating Narrowly Defined Input Bottlenecks, and Incentives for Investment and Innovation*, 2000 U. CHI. LEGAL. F. 119, 122-23.

not prove sustainable over the long run, and prices should tend toward competitive levels. In the short run, however, shifts in demand, changes in technology, and other exogenous changes can cause markets to deviate from their long-run equilibrium position. When that it is the case, prices that permit short-run supracompetitive returns allocate the scarce network resources, signal industry participants that the market is in short-run disequilibrium, and provides incentives to invest in additional network capacity.

The emphasis on short-run economic profits is sometimes mistakenly compared to the type of competition proposed by Joseph Schumpeter, in the market is dominated by a series of monopolists and firms compete by vying to discover the next breakthrough innovation that will give them a cost or quality advantage decisive enough to allow them to displace the current monopolist and dominate the market in its place.[171] This argument ignores the key role that short-run supracompetitive returns play in horizontal competition within a market, in which multiple players offer substitute products to consumers and in which any supracompetitive returns will prove transient and quickly dissipated. In fact, using regulation to prevent the earning of supracompetitive returns would eliminate the primary impetus for competitive entry, in which case the supply curve would never shift outwards in order to bring the market back into long-run equilibrium.[172] This tendency to forestall competitive entry also implicitly presumes that rate regulation will persist indefinitely. Such a surrender to the monopoly only makes sense if competitive entry is infeasible.

Mandating access to the existing network creates similar disincentives to investments in alternative transmission technologies. Since any benefits gained from investments in capital or research must be shared with competitors, forcing a monopolist to share its resources discourages

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[171] JOSEPH A. SCHUMPETER, CAPITALISM, SOCIALISM AND DEMOCRACY 84 (1942).
[172] Yoo, *supra* note 102, at 58-60.

incentives to improve their facilities and pursue technological innovation. In addition, denying providers of complementary services guaranteed access to the existing network gives them powerful incentives to enter into strategic partnerships with firms interested in constructing alternative network capacity in competition with the existing network. Using regulation to provide those same providers with guaranteed access to the existing networks would destroy any incentives to enter into such arrangements. In effect, forcing a monopolist to share an input rescues other firms from having to supply the relevant input for themselves. A growing body of empirical scholarship suggests that mandating access to last-mile broadband networks has deterred investment in precisely this manner.[173]

This analysis underscores the extent to which debates over access to networks have all too often focused on the wrong policy problem. One of the key insights of vertical integration theory is that markets yield efficient outcomes only if every link of the chain of production is

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173 *See* Debra J. Aron & David E. Burnstein, *Broadband Adoption in the United States: An Empirical Analysis*, *in* DOWN TO THE WIRE: STUDIES IN THE DIFFUSION AND REGULATION OF TELECOMMUNICATIONS TECHNOLOGIES (Allan L. Shampine ed., 2003); Bronwyn Howell, *Infrastructure Regulation and the Demand for Broadband Services: Evidence from OECD Countries*, 47 COMM. & STRATEGIES 33 (2002) (employing bivariate analysis to find no detectable positive effect of unbundling on broadband uptake); Johannes M. Bauer et al., Effects of National Policy on the Diffusion of Broadband in OECD Countries 15 (Jan. 25, 2005) (unpublished manuscript presented at the UFL-LBS Workshop on "The Future of Broadband: Wired and Wireless") (finding variable representing unbundling and two other policy attributes not statistically significantly related to broadband diffusion), *available at* http://bear.cba.ufl.edu/centers/purc/documents/bauer-kim-wildman-ufl-2005.pdf; Inmaculada Cava-Ferreruela & Antonio Alabau-Munoz, Key Constraints and Drivers for Broadband Development: A Cross-National Analysis (Sept. 4-7, 2004), (unpublished manuscript presented at the 15th Biennial Conference of the International Telecommunications Society, Berlin, Germany) (finding unbundling statistically significantly related to broadband diffusion under a bivariate analysis, but not statistically significantly related to broadband diffusion under multivariate analysis), *available at* http://userpage.fu-berlin.de/~jmueller/its/conf/berling04/Papers/cava-ferreruela_alabau-munoz.pdf; Martha Garcia-Murillo & David Gabel, International Broadband Deployment: The Impact of Unbundling 14-15 (2003) (paper presented at 31st Telecommunications Policy Research Conference) (finding unbundling statistically significantly related to broadband diffusion under a bivariate analysis, but not statistically significantly related to broadband diffusion under multivariate analysis), *available at* http://tprc.org/papers/2003/234/IntrntBrdbndDeploy.pdf; Thomas Hazlett & Coleman Bazelon, Regulated Unbundling of Telecommunications Networks: A Stepping Stone to Facilities-Based Competition? 16-19 (Oct. 4, 2005) (unpublished manuscript presented at the 33rd Telecommunications Policy Research Conference) (analyzing subscribership data to conclude that unbundling does not drive broadband competition), available at http://mason.gmu.edu/~thazlett/pubs/Stepping%20Stone%20TPRC.10.04.05 %20.pdf; Jung Hyun Kim et al., Broadband Uptake in OECD Countries: Policy Lessons from Comparative Statistics Analysis (unpublished manuscript presented at the 31st Research Conference on Communication, Information and Internet Policy, Sept. 20, 2003), *available at* http://tprc.org/papers/2003/203/Kim-Bauer-Wildman.pdf.

sufficiently competitive. As a result, competition policy should focus on identifying the link that is the most concentrated and the most protected by entry barriers and design regulations to increase its competitiveness. This implies that regulatory decisions should be guided by their ability to support and stimulate competition in the last mile, which remains the portion of the industry that is the most concentrated and the most protected by barriers to entry. Most access proposals are instead intended to preserve and foster competition in markets for complementary services such as applications and content, which are the portions of the industry that are already the most competitive and sufficiently unprotected by entry barriers as to be likely to remain that way. Although the promotion of competition in complementary services was arguably an appropriate second-order policy goal when the first-order policy goal of promoting competition in the last-mile was likely to prove futile, the growing feasibility of last-mile competition strongly supports refocusing broadband policy back onto the first-order concerns.

Indeed, the ensuing reductions in incentives to invest in alternative transmission technologies could have the unfortunate effect of cementing the existing last-mile oligopoly into place, which would somewhat perversely turn access regulation into the source of, rather than the solution to, market failure. It is conceivable that investment disincentives could be minimized if policymakers engaged in asymmetric regulation that freed new entrants from rate and access regulation while continuing to subject the dominant player to such restrictions. If entry is truly feasible, it is not entirely clear whether such regulation would be economically necessary. In addition, administering such a regime would require policymakers to make difficult determinations about when the market became sufficiently competitive to deregulate the activities of the formerly dominant player. Such a determination is likely to be particularly difficult in technologically dynamic industries like broadband, in which consumer demand is changing rapidly and in which the prospects of developing new ways either to circumvent or to compete directly with the alleged bottleneck are the highest.

The foregoing analysis underscores the extent to which regulators seeking to impose rate or access regulation must thread a very narrow needle even under the best of circumstances. Any such intervention would only yield economic benefits if it forced prices closer to competitive levels. If the regulated price is set too high, the regulatory intervention would have no beneficial effect. If set too low, the intervention would deter investment while effectively forcing the incumbent network owner to cross subsidize providers of complementary services and new entrants. And any such intervention would be completely unnecessary to the extent that competitive entry into last-mile transmission is feasible. The alternative would be to allow the short-run supracompetitive returns to stimulate entry by alternative last-mile providers. By the standards imposed under modern competition policy, the availability of three (or perhaps four) last-mile options should be sufficient to dissipate any concerns about anticompetitive pricing in the last-mile or vertical exclusion in complementary services. It is for this reason that courts and policymakers have been reluctant to compel access to a resource is available from another source, even if it is only available at significant cost and in the relatively long run.[174]

[174] *See* Nat'l Cable & Telecomm. Ass'n v. Brand X Internet Servs., 545 U.S. 967, 1001-02 (2005) (upholding the FCC's decision that the availability of broadband services from other sources justified refusing to impose access requirements on cable modem systems); AT&T Corp. v. Iowa Utils. Bd., 525 U.S. 366, 388-89 (1999) (rejecting the imposition of UNE access when the network elements are available from alternative sources); U.S. Telecom Ass'n v. FCC, 290 F.3d 415, 428-29 (D.C. Cir. 2002) (rejecting order requiring unbundling of DSL-compatible portion of telephone lines due to the order's failure to take into account competition from cable modem systems); Areeda & Hovenkamp, *supra* note 154, ¶ 773b2, at 200-03 (limiting compelled access to essential facilities to situations in which the facility cannot be obtained from another source); John T. Soma et al., *The Essential Facilities Doctrine in the Deregulated Telecommunications Industry*, 13 BERKELEY TECH. L.J. 565, 594-96, 612 (1998).

Although some scholars have asserted that because the dynamic efficiency gains will be compounded over time, they will necessarily exceed the short-run static efficiency losses,[175] this approach seems too simplistic. Whether the dynamic efficiency gains will dominate the static efficiency losses depends on the relative magnitude of the gains and losses, the speed of entry, and the appropriate discount rate.

That said, a number of institutional considerations militate in favor of the dynamic efficiency side of the balance. For example, calibrating the prices needed to implement rate regulation and access regulation will necessarily require the government to engage in an exquisite exercise in line drawing that requires a careful and fact-intensive balance of opposing considerations. This is made all the more complicated by the rapid pace with which the underlying technology and the demands that consumers are placing on the network are changing. The fact that regulatory processes invariably take several months to complete makes it inevitable that, even under the best of circumstances, rate and access regulation will be subject to a degree of regulatory lag. In the worst case, as many noted commentators have observed, it can cause regulation to endure long after technological change has eroded its justifications.[176] On the other hand, promoting dynamic efficiency allows regulatory authorities to focus on stimulating entry by new network platforms, which should represent a policy goal that is considerably easier to implement. Perhaps even more importantly, promoting entry has embedded within it a built-in exit strategy. Once a sufficient number of broadband network platforms exist, regulatory

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[175] *See* WALTER G. BOLTER ET AL., TELECOMMUNICATIONS POLICY FOR THE 1980'S, at 360 (1984); Janusz Ordover & William Baumol, *Antitrust Policy and High-Technology Industries*, OXFORD REV. ECON. POL'Y, Winter 1988, at 13, 32.

[176] BREYER, *supra* note 85, at 286-87; 2 KAHN, *supra* note 85, at 127; Richard A. Posner, *Natural Monopoly and Its Regulation*, 21 STAN. L. REV. 548, 611-15 (1969).

intervention will no longer be necessary. This stands in stark contrast with rate regulation and access-oriented solution, which implicitly presume that regulation will continue indefinitely.

It is for these reasons that managed competition has been heavily criticized. Even the more limited, asymmetric approach to managed competition has been heavily criticized by scholars favoring both regulatory and deregulatory approaches.[177] The only scenario in which such asymmetric regulation even arguably makes sense is if the market is already dominated by an incumbent that does not have to make large capital investments. That is not the case with broadband, in which the market leader is a relative newcomer that must undertake extensive investments before it is able to provide service. As noted earlier, even DSL, the supposed legacy technology, must undertake extensive investments close to those undertaken by cable modem providers before providing service.[178] The magnitude of these capital investments is likely to grow still larger as local telephone companies improve their performance by deploying more remote terminals to further shorten the distance between end users and the DSLAMs and begin to deploy higher bandwidth technologies like VDSL. The continuing importance of investment incentives for both DSL and cable modems undercuts the case for asymmetric regulation. Implementing access regimes on even a portion of the industry would also run afoul of the problems that have long confronted direct regulation of rates. Even worse, asymmetric regulation threatens to put the government in the position of favoring one transmission technology over the other.

Such asymmetric regulation would also be inconsistent with regulatory precedent. The FCC has repeated emphasized the importance of maintaining technological neutrality and of

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[177] *See* Crandall et al., *supra* note 101; Lemley & Lessig, *supra* note 116, at 927-28; Glen O. Robinson, *On Refusing to Deal with Rivals*, 87 CORNELL L. REV. 1177, 1226 (2002).

[178] *See supra* notes 170 and accompanying text; *see also* LESSIG, *supra* note 116, at 155 (observing that DSL requires capital investments that are comparable to those required for cable modem service).

regulating in a consistent manner across platforms.[179] The FCC noted that it developed its previous asymmetric regulatory efforts, which distinguished between dominant and nondominant carriers, at a time when the telecommunications industry "was in the early stages of evolving from one 'where service was provided largely on a monopoly basis to one where a degree of competition [existed] for the provision of some communications services.'"[180] The FCC further noted:

> [T]his market environment differs markedly from the dynamic and evolving broadband Internet access marketplace before us today where the current market leaders, cable operators and wireline carriers, face competition not only from each other but also from other emerging broadband Internet access service providers. This rapidly changing market does not lend itself to conclusions about market dominance the commission typically makes to determine the degree of regulation to be applied to well-established, relatively stable telecommunications service markets. On the contrary, any finding about dominance or non-dominance in this emerging broadband Internet access service market would be premature.[181]

Indeed, the FCC noted that even if it were to apply its traditional dominance/nondominance analysis to broadband, the fact that cable modem systems had established the early lead dictated that it would conclude that DSL was nondominant.[182] Thus, if anything, the asymmetric regulation would apply to the newly emerging technology and would exempt the more established technology, in direct opposition to the way that asymmetric regulation is usually applied.

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Thus, close analysis reveals that the rationales traditionally employed to justify regulating local telephone networks offer little support for imposing similar regulation on last-mile

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[179] *See, e.g.*, Wireline Broadband Internet Access Services Order, *supra* note 73, at 14878 ¶ 45; Cable Modem Declaratory Ruling & NPRM, *supra* note 38, at 4802 ¶ 6; Wireline Broadband NPRM, *supra* note 67, at 3023 ¶ 6.

[180] Wireline Broadband Internet Access Services Order, *supra* note 73, at 14898 ¶ 84 (footnote omitted) (quoting Policies and Rules Concerning Rates for Competitive Common Carrier Services and Facilities Authorizations Therefor, Notice of Inquiry and Proposed Rulemaking, 77 F.C.C.2d 308, 309 (1979)).

[181] *Id.*

[182] *Id.* at 14898 n.253.

broadband networks. While the invocation of regulatory precedents that have been successful in the past carries considerable rhetorical appeal, policymakers should subject any proposal to extend legacy regulation to any new technologies to close scrutiny to ensure that the underlying technology and economics are sufficiently similar to warrant such an extension.

III. EVALUATING THE DIFFERENT TYPES OF ACCESS TO BROADBAND NETWORKS

The other major omission in the debate over the regulation of last-mile broadband networks is the failure to incorporate a theory of network configuration. Most of the existing commentary tends to discuss access to the network as a whole without analyzing the type of access being sought and the different ways it can affect the network. Other commentary has taken the other extreme and focused too narrowly on individual network elements. Following the regulatory approach taken by the FCC, the central concern of this line of commentary is resolving the proper way to determine the costs of the particular network elements. This has the effect of treating each network element as if it existed in isolation without taking into account how the relationship between individual elements and the rest of the network can cause the impact of different types of access to vary widely.

Most importantly, both approaches fail to capture the fact that networks are complex systems whose elements interact in ways that can be sharply discontinuous and hard to predict. The absence of a theory of network configuration that captures the ways that network elements can interact with one another makes it impossible to assess how altering the costs of particular elements and introducing additional flows into a network can affect network design, capacity, and reliability. It also prevents any realistic assessment of the impact that different types of access can have on transaction costs.

In this Part, we analyze access through the lens of a conceptual framework that we have developed based on a branch of mathematics known as graph theory captures one of the key attributes that characterizes networks, i.e., the manner in which the whole exceeds the sum of the parts. Section A begins by laying out the basic concepts of network analysis. Section B then deploys the five-part system for classifying different types of access that we have developed to show how the various types of access to last-mile broadband networks have different affects on network cost, capacity, reliability, and transaction costs.

A. Fundamental Principles in the Economics of Networks

Graph theory reduces networks into two types of elements.[183] *Nodes* are points from which network flows begin, end, or redirected. Nodes are connected by *links*. The nodes in a last-mile broadband network include the servers that provide Internet applications and content, the host computers operated by the end users who are the ultimate consumers of applications and content, and the routers in the middle of the network that determine along which path particular traffic will flow. The links in a last-mile broadband network are the wires (or, in the case of the wireless Internet, the spectrum channels) that interconnect these servers, host computers, and routers. The cost, capacity, and location of each link and node can vary.

Depicting networks as systems of links and nodes makes it possible to analyze how to design network to deliver the highest levels of performance at the lowest cost. For example, the architecture that connects all of the nodes in a network with the fewest links is known as a *spanning tree*. For a network of n nodes, there exist n^{n-2} possible spanning trees, where n is

183 For our initial discussion of these principles, see Spulber & Yoo, *supra* note 4, at 1693-1707.

greater than or equal to two.[184] Algorithms exists that make it possible to sort through all of the possible spanning trees to identify the *minimum spanning tree*, which is the network design that connects all of the nodes in the network at the least cost.[185] In addition, network owners have the option of deploying higher volume server or transmission technologies if the reduction in variable cost and improvement in performance is large enough to justify incurring the additional capital expense. Together these concepts help determine the least-cost architecture for delivering different amounts of network capacity.[186]

Network performance is determined not only by its cost and capacity; it also depends on the network's reliability, typically measured by its ability to guarantee certain minimum levels of bandwidth. One of the limitations of cost-minimizing architectures like minimum spanning trees is that every pair of nodes is connected by a single path. As a result, cost-minimizing architectures are vulnerable to congestion, since the saturation of any network element will force the packets into a queue. The resulting delays will necessarily degrade network performance. Ensuring minimum levels of reliability becomes more difficult as the variability of the relevant traffic flows increases. Network owners can increase network reliability by adding additional links that create *cycles*, which exist when more than one path exists connecting two nodes. Although the introduction of such redundancy increases network cost, it also promotes network reliability by allowing traffic to be rerouted along different paths should any particular pathway become congested.[187]

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184 *See* Arthur Cayley, *A Theorem on Trees*, 23 Q.J. PURE APPLIED MATHEMATICS 376 (1889).

185 *See, e.g.*, R.C. Prim, *Shortest Connection Networks and Some Generalizations*, 36 BELL SYS. TECH. J. 1389 (1957).

186 *See* Spulber & Yoo, *supra* note 4, at 1701-03.

187 *See id*. at 1699-701.

Analyzing networks in this manner permits network owners to choose architectures that deliver the levels of network capacity and reliability that customers demand at the lowest cost. Mandating access to the network can adversely affect each of these dimensions. For example, access mandates can alter the volume and patterns of network traffic, either by introducing new additional traffic into the network or by diverting traffic outside the network to the point where the network owner no longer finds it beneficial to employ higher-volume, cost-reducing technologies. In addition, certain types of access can reduce the effective capacity of particular network elements by occupying some of its functionality. The net effect can alter the costs of operating the network as well as the network's optimal configuration.[188]

Graph theory also shows how networks can ameliorate some of these problems. To the extent that some resources are slack, the network can reroute traffic along other pathways to compensate for any unexpected changes in network volume or the capacity of particular network elements. Redirecting traffic in this manner can increase the cost of operating the network and can increase congestion (and therefore degrade network performance) in those portions of the network through which traffic is rerouted, even in areas of the network that may be located far from the node from which access is sought. Graph theory thus captures how imposing an access requirement can have a dramatic impact on portions of the network that are discontinuous with the portion of a network affected by the access requirement. In so doing, it reflects the insight that networks are complex systems that can only be understood by taking into account the relationship between each component and the other components of the network, as well as the projected traffic flows.

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[188] *See id.* at 1698-99, 1709, 1717.

As a theoretical matter, graph theory could be used as a basis for calculating prices directly based on the capacity of each network element and the flows being introduced into the system.[189] The best real-world examples of such a system are the Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs) in the electric power industry, which use a graph theoretical model known as locational marginal pricing to manage network traffic.[190] For example, a leading RTO known as PJM monitors more than 1,200 electric generators that introduce flows into the network as well as more than 6,000 transformer substations through which flows exit the network. PJM uses the information it receives to establish a day-ahead market, in which market participants submit offers and bids for purchasing electricity for each hour of the following day, as well as a real-time spot market, to compensate for deviations from the day-ahead forecast resulting from system changes, such as unexpected changes in the weather (which can affect both the demand for power as well as the carrying capacity of the transmission lines).[191] The resulting prices can vary widely over the course of the day.[192] As a result, RTOs and ISOs typically update their spot prices every five minutes.[193]

Internet traffic is likely to be much more difficult to manage than traffic through an electric power grid. As an initial matter, the Internet typically involves a much greater number of sources and sinks than is an electric power grid. In addition, the burstiness of Internet traffic dictates that the volume function is less likely to be well behaved and that spot prices would have to be updated much more frequently for the Internet than for electric power. Perhaps most importantly, unlike the electric grid, which is a one-way network, in the Internet different nodes

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189 *See* Spulber & Yoo, *supra* note 4, at 1719-21.

190 *See* ISO/RTO Council, The Value of Independent Regional Grid Operators (Nov. 2005), *available at* http://www.pjm.com/documents/downloads/reports/20051114-irc-white-paper-final.pdf.

191 *See* PJM Interconnection, Backgrounder on PJM Interconnection 3 (May 19, 2006), *available at* http://www.pjm.com/about/downloads/media-kit-backgrounder.pdf.

192 *See* William Hogan, *Getting the Prices Right in PJM: What the Data Teach Us*, ELEC. J., Aug. 1998, at 61.

193 *See* ISO/RTO Council, *supra* note 190, at 24.

may constitute both sources and sinks. Although a two-way network may be solved mathematically, any further increase in the dimensionality of the traffic renders the problem intractable.[194]

To say that graph theory cannot be used to generate broadband prices is not to say that it might not yield valuable intuitions. For example, graph theory can model how different types of access requirements can have a differential impact on transaction costs. According to the Coasean theory of the firm, every entity decides whether to perform particular production functions internally or to contract them out based on which solution minimizes transaction costs.[195] Access mandates disrupts the firm's natural boundaries by forcing the network to externalize functions that it would otherwise perform internally. In addition, the fact that access necessarily presupposes that some traffic will originate and terminate outside of the network will make it more difficult for the network owner to obtain the information about projected network flows needed to determine the optimal network design. The fact that this information is held by the network owner's competitors also raises the possibility that the party seeking access may attempt to use its control of that information to its strategic advantage.

Many of the insights of how mandating network access affects network cost, capacity, reliability, and transaction costs can be captured by classifying access regimes into the five categories depicted in Figure 1: (1) retail access, (2) wholesale access, (3) interconnection access, (4) platform access, and (5) unbundled access. Networks components owned and

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194 *See* Spulber & Yoo, *supra* note 4, at 1703 n.33.
195 *See* Coase, *supra* note 141, at 394-98.

operated by the network owned are represented as solid lines and nodes, while the portions of the network obtained through access requirements are depicted by dotted lines.[196]

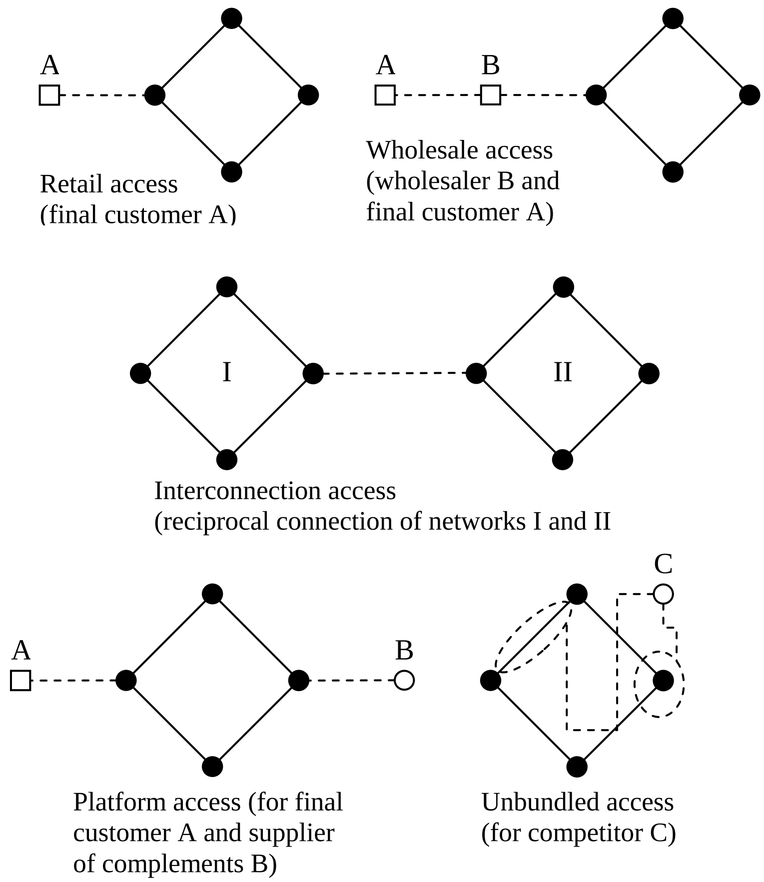

Figure 1. The Five Forms of Access to Networks.

The categories vary with the type of entity (e.g., customers, competitors, or providers of complementary services), as well as the extent of the network to whom access is provided. A close analysis of the different types of access reveals that each has a different impact on network cost, capacity, reliability, and transaction costs. A better understanding of how the impact of

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196 *See* Daniel F. Spulber & Christopher S. Yoo, *Network Regulation: The Many Faces of Access*, 1 J. COMPETITION L. & ECON. 635, 638-39 (2005).

each type of access varies provides insights into the relative costs and benefits associated with each type of access.

B. Applying the Framework to Last-Mile Broadband Networks

1. Retail Access

Retail access represents perhaps the most common form of access imposed on telecommunications providers. It provides every end user the right to benefit from the network's services on the same terms and conditions as other end users. Retail access is usually accompanied with direct regulation of retail rates.

One of retail access's principal effects would be to limit last-mile broadband providers' ability to manage their networks. A network owner will create sufficient capacity to satisfy projected volume and the level of reliability that customers demand. Because no forecast is ever perfect, network demand will sometimes exceed projected levels. The best long-run solution would be to expand capacity to meet the increased demand. Because broadband capacity cannot be expanded instantaneously, the best long-run solution may be unavailable in the short run.

When expanding capacity is impossible, network owners face three options: they can preserve network performance by refusing to serve additional customers, they can ration existing network capacity by allowing prices to rise, or they can allow service to degrade (either by allowing the increased congestion to slow down network performance or by reducing network service in other ways) until demand shifts back into line with the available capacity. Retail access renders the first two of these options impossible, leaving the network with no option but to reduce the quality of network services even when doing so would harm consumers and lead to inefficiencies.

Direct regulation of rates can also be the source of significant inefficiencies. The traditional formula is

$$R = O + B \times r$$

where R is the total revenue that the telephone company is allowed to generate, O is the operating expense, B is the depreciated capital investment in the network (also known as the rate base), and r is the risk-adjusted cost of capital (also known as the rate of return). Individual rates are determined by dividing the revenue requirement by the expected volume.

Regulatory authorities have long struggled over whether the rate base should be calculated based on historical cost or replacement cost.[197] This task becomes all the more complicated if regulators base the cost calculation not the structure of the actual network, but rather on the structure of a hypothetical network configured according to the best available technology. Cost-plus rate setting regimes also fail to provide incentives for network owners to economize and, to the extent that they only allow rates of return to be earned on the rate base, can introduce a bias toward capital intensive solutions.[198] Experience with cable television has revealed the difficulties of regulating retail rates when the quality of the product being regulated varies,[199] as will be the case with respect to broadband.

The implementation of rate regulation also harms the competitive process in other ways. The process of developing and filing tariffs and shepherding them through any challenges that arise during the regulatory approval process necessarily increases transaction costs and causes delay. Furthermore, by forcing advance disclosure of rates, retail access forces all firms to give

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197 *See, e.g.*, Mo. *ex rel.* Sw. Bell Tel. Co. v. Pub. Serv. Comm'n, 262 U.S. 276, 292-308 (1923) (Brandeis, J., concurring in the judgment) (providing a classic statement in this debate).

198 *See* Harvey Averch & Leland L. Johnson, *Behavior of the Firm Under Regulatory Constraint*, 52 AM. ECON. REV. 1052 (1962).

199 *See* THOMAS W. HAZLETT & MATTHEW L. SPITZER, PUBLIC POLICY TOWARD CABLE TELEVISION 2, 69-177, 208 (1997); Gregory S. Crawford, *The Impact of the 1992 Cable Act on Household Demand and Welfare*, 31 RAND J. ECON. 422, 444-45 (2000).

their competitors advance notice of any changes in business strategies. In addition, rate regulation facilitates collusion by making information about price more transparent, by making products more homogeneous, and by providing for a mechanism for enforcing any deviations from the established price. The enforced uniformity inherent in retail access also reduces network owners' ability to tailor product offering to individual customers' particular needs. Furthermore, it has long been understood that deadweight loss can be minimized in high fixed cost industries by allocating greater proportions of those fixed costs to those customers that are least price sensitive (and thus will reduce their consumption the least in response to pricing above marginal cost).[200] The nondiscrimination aspects of retail access foreclose such welfare enhancing possibilities.

Perhaps most importantly, retail access can dampen incentives to invest in last-mile broadband technologies. As noted earlier, regulators must thus thread a very narrow needle if retail access is to have any beneficial effect.[201] Prices that are set too high will have no effect. Prices that are set too low will reduce incentives for incumbents and competitors alike to invest in upgrading existing networks and to investment in last-mile technologies. Establishing rates that mimic the market-based pricing would be difficult under the best of circumstances. It borders on the impossible with respect to technologies that are undergoing rapid innovation and differentiation and that are growing ever more complex.

Most importantly, the presence of intermodal competition largely obviates the need for regulatory authorities to assume the burdens of implementing retail access. It is for this reason that commentators have generally opposed mandating retail access to last-mile broadband

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[200] F.P. Ramsey, *A Contribution to the Theory of Taxation*, 37 ECON. J. 47, 58-59 (1927).
[201] *See supra* note 174 and accompanying text.

networks.[202] Indeed, it does not appear that the FCC has ever attempted to mandate retail access to last-mile broadband services. Nor does it appear that state or local authorities have attempted to do so. Indeed, even when attempting to impose other types of access mandates, state authorities affirmatively disclaimed any attempt to regulate the reasonableness of retail rates.[203]

2. Wholesale Access

Wholesale access is a right given to a network owner's competitors to purchase services normally sold by the network at retail and resell them to end users. The FCC initially imposed wholesale access on DSL. For example, the *Computer Inquiries* required incumbent local telephone companies offering enhanced services to make the transmission component of its offering available to unaffiliated enhanced service providers on a tariffed basis.[204] Furthermore, the *Advanced Services Second Report and Order* ruled that the resale requirements of the 1996 Act applied to DSL services offered to end users regardless of whether DSL was classified as telephone exchange service or exchange access. This in essence authorized competitors to lease DSL service from the incumbent local telephone company at their retail rate less the costs of marketing, provisioning, billing, and customer service usually incurred by the incumbent, but avoided when service is provided through a reseller.[205] Wholesale access was also available through special access tariffs of the type approved by the FCC with respect to GTE.[206]

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[202] *See* Crandall et al., *supra* note 101, at 984.

[203] Cal. ISP Ass'n v. Pac. Bell Tel. Co., Decision 03-07-032, 2003 WL 21704389, at *1 (Cal. Pub. Utils. Comm'n July 10, 2003).

[204] Amendment of Sections 64.702 of the Commission's Rules and Regulations (Third Computer Inquiry), Report and Order, 104 F.C.C.2d 958, 1035-42 ¶¶ 147-166 (1986) [hereinafter Computer III Phase I Order], *vacated and remanded sub nom.* California v. FCC, 905 F.2d 1217 (9th Cir. 1990).

[205] Deployment of Wireline Services Offering Advanced Telecommunications Capability, 65 Fed. Reg. 6912 (rel. Nov. 9, 1999) (final rule) (full FCC order available at 1999 WL 1016337), *pet. for review denied sub nom.* Ass'n of Commc'ns Enters. v. FCC, 253 F.3d 29 (D.C. Cir. 2001). DSL services offered at retail stand in stark contrast to DSL services offered to ISPs, which the FCC ruled were not subject to the 1996 Act's wholesale access mandate. Indeed, it is hard to understand how wholesale access prices to such services would be calculated. The

The FCC's *Wireline Broadband Internet Access Services Order* abolished both sets of wholesale access requirements. As an initial matter, the conclusion that DSL and other forms of wireline broadband represented information services and not telecommunications services rendered the 1996 Act wholly inapplicable. At the same time, the FCC also exempted DSL and other wireline broadband technologies used for Internet access from the access requirements imposed by the *Computer Inquiries*.[207]

The situation is quite different with respect to cable. As the FCC has noted, "cable operators . . . have never been required to make Internet access transmission available to third parties on a wholesale basis."[208] As noted earlier, the FCC took somewhat inconsistent positions during its merger reviews, acceding to requests to mandate multiple ISP access during the America Online-Time Warner merger, while rejecting calls to give unaffiliated ISPs wholesale access to cable modem systems when approving the AT&T-TCI, AT&T-MediaOne, Comcast-AT&T and Adelphia transactions.[209] The agency addressed the issue more definitively in its *Cable Modem Declaratory Ruling*, when it refused to mandate wholesale access to cable modem systems.[210]

The FCC's reluctance to mandate wholesale access to last-mile broadband systems is understandable. Because total demand under wholesale access depends not only on the retail price, but also on the price of wholesale access, its net impact on network demand is ambiguous.

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statute provides that resale prices equal retail prices less "any marketing, billing, collection, and other costs that will be avoided." 47 U.S.C. § 252(d)(3). DSL services are offered to ISPs without marketing, billing, collection, ordering, repair, and other similar costs, because those services are expected to be provided by the ISP. There would thus be no avoided costs to deduct from the full price, in which case the resale price would be the same as the retail price.

206 GTE DSL Order, *supra* note 50.

207 Wireline Broadband Internet Access Services Order, *supra* note 73, at 14862-65 ¶¶ 12-17, 14876-98 ¶ 41-85.

208 *Id.* at 14887 ¶ 64.

209 *See supra* notes 34-36 and accompanying text.

210 Cable Modem Declaratory Ruling & NPRM, *supra* note 38, at 4825 ¶ 43.

The resulting increase or decrease in traffic can adversely affect network cost, capacity, and reliability. Forcing networks to externalize marketing, provisioning, and billing functions also forces networks to deviate from the transaction cost minimizing institutional structure that represents the natural boundaries of the firm.

Indeed, last-mile broadband providers already face powerful incentives to provide wholesale access. As the FCC noted, the benefits from spreading fixed costs over a larger customer base give network owners a strong motivation to offer wholesale access voluntarily. Indeed, all of the major wireline broadband providers negotiate private wholesale access contracts on a regular basis and have indicated their intention to continue doing so in the future. Competitive forces already operating in the broadband market thus alleviated any need for the FCC to compel wholesale access or to oversee the terms under which wholesale access occurs.[211]

In addition, wholesale access hurts dynamic efficiency by eliminating demand from complementary service providers who represent the natural strategic partners for those seeking to construct alternative network capacity. The FCC noted in its *Wireline Broadband Internet Access Services Order*, "Because our rules require a particular type of generalized wholesale offering, they may reduce incentives for ISPs to seek alternative arrangements from other broadband Internet access platform providers and for those other providers to offer such arrangements." The greater flexibility and reduction in risk stemming from eliminating wholesale access also increases incentives for existing players to invest in upgrading their networks.[212]

Perhaps most problematic is the fact that the type of competition induced by wholesale access provides few consumer benefits. Under wholesale access, all of the competing ISPs

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211 *Id.* at 14865 ¶ 19, 14877-78 ¶ 44, 14887 ¶ 64, 14891 ¶ 72, 14892-94 ¶¶ 74-76.
212 Wireline Broadband Internet Access Services Order, *supra* note 73, at 14886 ¶ 63, 14891 ¶ 72, 14905 ¶ 97.

employ the same equipment and thus provide the same speed, services, and access to content. Resellers thus cannot compete in terms of cost, network features, or quality of service impossible. Instead, the only way in which they can compete is through their willingness to accept thinner margins.[213]

It is for this reason that most commentators have found little value in the type of competition induced by wholesale access.[214] The paucity of consumer benefits underscores the extent to which wholesale access represents something of a competition policy anomaly. 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. Wholesale 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 is infeasible, as was the case when wholesale access to last-mile broadband networks was first mandated. As the FCC noted, the emergence of competition from alternative broadband technologies essentially renders wholesale access untenable.[215] The limited benefits can no longer offset the significant costs and the adverse impact on the incentives to invest in new network capacity.

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

214 *See* Herbert Hovenkamp, *Antitrust and the Regulatory Enterprise*, 2004 COLUM. BUS. L. REV. 335, 369-70; Paul L. Joskow & Roger G. Noll, *The Bell Doctrine: Applications in Telecommunications, Electricity, and Other Network Industries*, 51 STAN. L. REV. 1249, 1281-82 (1999); Susan Ness, *The Law of Unintended Consequences*, 58 FED. COMM. L.J. 531, 535 (2006); Gregory L. Rosston & Roger G. Noll, *The Economics of the Supreme Court's Decision on Forward Looking Costs*, 1 REV. NETWORK ECON. 81, 88-89 (2002).

215 Wireline Broadband Internet Access Services Order, *supra* note 73, at 14884-85 ¶¶ 56-59.

3. Interconnection Access

Interconnection access refers to reciprocal connections between two networks competing to offer similar services to the same customers as the network owner. It gives each provider the right to handoff traffic originating on its own network for termination on the other provider's network. It also obligates the provider to terminate traffic originating on the competitor's network. These mandated reciprocal connections combine the two smaller networks to form a larger network.

Interconnection access is considerably more disruptive to network management than retail or wholesale access. As was the case with wholesale access, the net impact of interconnection access on network demand is ambiguous, although for a very different reason. Increasing the number of subscribers increases the value of the network, which in turn can cause network demand to increase. At the same time, interconnection access necessarily presumes that some network traffic will originate and terminate on other networks. The resulting diversion of network traffic places downward pressure on network demand. The overall impact of interconnection on network demand depends on which of these two effects dominates.

The resulting change in network demand in turn affects the optimal network configuration. As noted earlier, network owners use forecasts of the magnitude, distribution, and variability of demand to design their networks so as to minimize cost, maximize capacity, and optimize reliability. In the process, the network owner must decide where to place its links and nodes and whether it can aggregate sufficient volume to justify making capital expenditures in cost-reducing transmission technologies. Regardless of whether interconnection access increases or decreases demand, any unanticipated deviations in the level of network traffic alters the optimal network configuration, which in turn affects network cost and performance.

Interconnection access also affects network design in other ways. Unlike retail and wholesale access, which only introduces traffic at locations where the network already serves customers, interconnection access requires networks to accept traffic at locations where the network was not previously offering service, although those interfaces are likely to be at major nodes. Interconnection access thus requires network owners to develop systems to provision and meter usage at new points within its network. Introducing new flows in the middle of the network also can be more difficult to manage than flows introduced at traditional customer locations. In addition, interconnection access increases transaction costs by forcing network owners to obtain the information they need to make these decisions from their competitors rather than through direct observation.

The architecture of the Internet is such that last-mile providers generally do not interconnect with one another directly. Instead, DSL and cable modem providers serving the same area typically interconnect indirectly through the Internet backbone. This greatly minimizes many of the problems traditionally associated with interconnection access. Scholars concerned about promoting interconnection access have nonetheless raised the concern that backbone providers might strategically engage in discriminatory interconnection or refuse to interconnect altogether in ways that are privately beneficial, but economically harmful.[216]

As a recent working paper issued by the FCC Office of Plans and Policy notes, a wide variety of legitimate reasons exist for refusing to interconnect with all other backbones in a nondiscriminatory manner. For example, peering between a backbone with a national presence on both coasts and a regional backbone with a presence on only one coast would allow the

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[216] Economides, *supra* note 121; James B. Speta, *A Common Carrier Approach to Internet Interconnection*, 54 FED. COMM. L.J. 225, 268-79 (2002); Kevin Werbach, *Only Connect*, 22 BERKELEY TECH. L.J. (forthcoming 2007); Hal R. Varian, *How to Strengthen the Internet's Backbone*, WALL ST. J., June 8, 1998, at A22.

regional backbone to free ride on the national backbone's infrastructure investments. Asymmetries in the size of the traffic being conveyed can lead to similar problems.[217]

As noted earlier, network economic effects subject network providers to powerful incentives to interconnect with one another.[218] In addition, market structure plays a critical role in determining the competitive impact of a refusal to interconnect. Specifically, the models in the refusal to interconnect to harms competition assume the existence of a dominant player. The backbone market has historically been comprised of five players of roughly equal size.[219] When the market is structured in this manner, refusals to interconnect cannot plausibly lead to anticompetitive harms, since the demand-side economies of scale created by network economic effects would place any network that refused to interconnect at a decisive competitive disadvantage.[220]

It is for this reason that the FCC has traditionally declined to mandate interconnection access among backbone providers. As the agency noted in its 2001 *Intercarrier Compensation NPRM*, "The backbones appear to be successfully negotiating interconnection agreements among themselves without any regulatory intervention, and we see no reason to intervene in this efficiently functioning market."[221] The FCC followed similar reasoning in its orders clearing the Verizon-MCI, SBC-AT&T, and AT&T-BellSouth mergers, ruling that competition among five backbone providers of roughly equal size was sufficient to obviate the need to mandate

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217 *See* Michael Kende, The Digital Handshake: Connecting Internet Backbones 18-20 (Fed. Commc'ns Comm'n Off. of Plans & Pol'y Working Paper No. 32, Sept. 2000), *available at* http://www.fcc.gov/Bureaus/OPP/working_papers/oppwp32.pdf

218 *See supra* notes 120-121 and accompanying text.

219 Kende, *supra* note 217, at 7.

220 Faulhaber, *Bottlenecks and Bandwagons*, *supra* note 121, at 501-02; Economides, *supra* note 121, at 390 (recognizing that network economic effects give firms strong incentives to interconnect); Katz & Shapiro, *supra* note 121, at 429 (noting that "[a]s the number of firms becomes increasingly large," equilibrium in which all firms interconnect converges to perfectly competitive equilibrium).

221 Developing a Unified Intercarrier Compensation Regime, Notice of Proposed Rulemaking, 16 F.C.C.R. 9610, 9656 ¶ 127 (2001).

interconnection access.[222] Conversely, in approving the WorldCom-MCI merger, the FCC raised the concern that the merger would give one company a sufficiently dominant market share to allow it to harm competition. As a result, the FCC conditioned its approval of the merger on the divestiture of MCI's backbone assets. Once those assets had been spun off, the agency saw no reason to mandate interconnection access. The spinoff of MCI's backbone business ensured that the backbone market would remain sufficiently competitive to obviate the need for any direct regulation of interconnection.[223]

Competition among backbone providers has thus been sufficient to obviate any need to mandate interconnection access among broadband providers. Any move toward concentration in the backbone market is better solved through taking steps to ensure the market remains unconcentrated than by mandating interconnection access in the last-mile.

4. Platform Access

Platform access occurs when the government creates a standard and requires networks to provide nondiscriminatory service to anyone presenting data configured in accordance with that standard. The FCC has mandated platform access to last-mile broadband networks as part of its *Computer Inquiries*, in which it required the leading local telephone companies to "make available standardized hardware and software interfaces that are able to support transmission, switching, and signaling functions identical to those utilized in the enhanced service provided by the carrier." The *Computer Inquiries* also required the major local telephone companies to offer tariffs providing for nondiscriminatory access to the network to any firm presenting its data

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[222] AT&T-BellSouth Order, *supra* note 78, at 5731 ¶ 129, 5734-36 ¶¶ 140-144; Verizon-MCI Order, *supra* note 78, at 18496 ¶ 118; SBC-AT&T Order, *supra* note 78, at 18354 ¶ 117.

[223] Application of WorldCom, Inc. and MCI Communications Corp. for Transfer of Control of MCI Communications Corp. to WorldCom, Inc., Memorandum Opinion and Order, 13 F.C.C.R. 18025, 18108-11 ¶¶ 150-151, 18115 ¶ 155 (1998).

configured in accordance with that standardized interface.[224] Many industry players and public interest groups are advocating imposing platform access to broadband networks through the cluster of policy proposals that fall under the banner of network neutrality.

By increasing the availability of complementary goods, platform access typically causes network demand to increase, which in turn affects the network's optimal configuration, capacity, and reliability. As noted earlier, the normal way for network owners to protect network performance should network demand exceed expectations is to deny service to new customers. As is the case with respect to other forms of access, mandating platform access forecloses this option and forces the network either to permit network performance to degrade or to maintain excess capacity as insurance against this possibility. Either solution necessarily raises costs and/or reduces consumer benefits.

The inability to deny service to any complementary service provider becomes particularly troublesome once one acknowledges how sensitive network performance is to the magnitude and variability of demand. The introduction of particular traffic affects the network in nonuniform ways. Not only can it cause local congestion in the areas near where the traffic enters the network. As noted earlier, networks' ability to route traffic along other paths can cause the introduction of traffic in one location to impair performance in portions of the network that are located far from where the additional traffic is introduced. The impact on network performance thus depends not only on the magnitude and variability of the flows being introduced into the network through platform access. It also depends on the configuration of the entire network, including the arrangement of elements in areas of the network quite distant from the access point, as well as the magnitude and the variability of the flows being introduced into the network by

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[224] Computer III Phase I Order, *supra* note 204, at 1039 ¶¶ 157-158.

other parties. The greater the variability of the flows, the bigger the adverse impact on network performance.

These qualities make platform access to last-mile broadband networks particularly problematic. Internet traffic is notoriously "bursty," in that it often involves the brief introduction of a high volume of traffic followed by an extended period of little or no traffic. This is particularly true for certain types of applications and contrasts sharply with the flows in other types of networks, in which flows tend to be steadier and tend to change more gradually. The classic response to these problems is for the network owner to exercise discretion in the types of application and content providers it allows to access the network as well as the precise locations at which it permits such access to occur. Platform access prevents them from exercising such discretion.

The implementation of platform access necessarily gives rise to other economic harms. For example, platform access presumes that network owners must provide access to any content or application provider that presents data in a standard format. In the extreme case, the government requires all networks to conform to that standard and prohibits networks from deviating from it. Although the standardization of the Internet architecture is often praised as an unmitigated good, conventional economic theory underscores the existence of an optimal level of standardization, determined by the tradeoff between the value of larger network size created by network economic effects and the value that end users place on the different types of services. If consumer preferences are relatively homogeneous, one would expect the entire network to coalesce around a single standard. As consumer preferences become increasingly heterogeneous, one would expect the optimal number of networks to begin to exceed one. By artificially limiting the level of nonstandardization, platform access can prevent the network from reaching the optimal level of standardization.

Platform access is also subject to a number of practical problems. Once the government designates a standard, network owners cannot implement any changes to that standard until those changes have been approved by the government. Imposing platform access thus inevitably causes a degree of delay in the speed with which the network can adapt to changes in technology. In addition, platform access requires the government to designate particular locations within the network where platform access can occur. The logical course of action is for the government to choose locations at natural interfaces between different segments of the industry. The problem is that technological change can cause natural interfaces to shift or to collapse altogether. Such problems are likely to loom particularly large in industries like broadband which are undergoing rapid technological change.

Consider the transformation that occurred when end users shift from narrowband, in which end users reach through dial-up services, to broadband connections such as DSL or cable modem service. Long-haul transmission is provided by backbones, which provide high-speed connections among a dozen or so network access points located at key locations throughout the country. Under a narrowband architecture, end users connect to the Internet through their local telephone system, which routed Internet-bound calls to locations in individual cities spread throughout the country in the same manner that it routed conventional telephone calls. The local telephone company did not need to maintain any packet-switching capability of its own. The only difference between Internet-bound calls and conventional calls was that the former consisted of data packets encoded in an analog format by the dial-up modem and the latter consisted voice traffic. With respect to either, the local telephone company simply served as a pass through. The key function served by ISPs was to convert the analog signal into a digital signal and to provide the connection between the modem banks dispersed in communities throughout the country and the limited number of network access points served by the backbones. ISPs perform a number of other functions, including supplying e-mail servers, hosting end users' webpages, offering proprietary content, and caching the popular content locally so that customers can access it more easily.

The arrival of broadband technologies has effected some fundamental changes in the Internet's architecture. 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 must maintain equipment to segregate the two different communication streams. 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. Once broadband networks were required to maintain their own data networks, it was a relatively simple matter for them to displace the ISP and instead negotiate their own interconnection agreement with a backbone provider. Indeed, given that last-mile providers already had to perform most of the functions previously provided by ISPs, in many cases it would likely be more efficient to have the last-mile provider carry out the functions previously performed by the unaffiliated ISP.

The efficiency of having last-mile providers perform the functions previously performed by ISPs is demonstrated dramatically by the manner in which the multiple ISP access mandated during the AOL-Time Warner merger has been implemented. 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 networks and backbone access facilities within AOL-Time Warner's headends. Instead, traffic bound for these unaffiliated ISPs 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. 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 is more efficient.

In other words, the technological structure of the narrowband made the interface between local telephone systems and ISPs a natural boundary between two different providers. The architectural changes wrought by the digitization of last-mile broadband technologies caused what was once a natural interface between market players point to collapse. By requiring network owners to maintain standardized interfaces, platform access runs the risk of locking existing interfaces into place long after technological changes have rendered such an interface obsolete.

Platform access can also increase transaction costs. Government establishment of a standardized interface requires considerable time and effort both by regulatory authorities and by interested parties participating in the process. To the extent that the standard developed by the government differs from the current network architecture, last-mile broadband providers will also have to incur the costs needed to reconfigure their equipment to make it compatible with the standard. In addition, because a network owner can render a platform access mandate a nullity simply by charging excessive prices to providers of complementary services with which it does not wish to do business, platform access necessarily envisions some oversight and enforcement of the nondiscrimination. The complexity of the interface means that the means for potential discrimination are likely to be myriad, which in turn means that regulatory authorities are likely to have to oversee an extremely large proportion of the dimensions of the business relationship.

Imposing platform access can also adversely affect dynamic efficiency. By guaranteeing content and applications providers access to the existing network, platform access deprives new entrants seeking to construct alternative last-mile platforms of their natural strategic partners.

Despite the seriousness of the costs of mandating platform access, it is still conceivable that such regulation might create sufficient benefits to justify its imposition. The problem with this argument is that last-mile broadband providers already possess powerful incentives to open their networks to a wide range of content and applications providers. The likelihood that the goals of platform access will be accomplished even in the absence of government intervention undercuts the case for imposing it as a regulatory mandate.

The FCC embraced much of this reasoning in its *Wireline Broadband Internet Access Services Order*. The FCC noted how platform access can adversely affect network architecture. The imposition of a standardized interface can create equipment configuration costs. Forcing network owners to reengineer general use equipment to conform to the standard requires the network owner to confront the unattractive choice between either foregoing the benefits of the equipment's full functionality or deferring deployment until the equipment is reengineered to be compatible with the standard. In addition, consumer demand and technological improvements were pushing the industry "toward equipment that integrates information service and transmission capabilities in a manner that allows functions to be performed at multiple points within a broadband network and closer to the end user than ever before." The FCC warned that its “rules should not force technological development in another, less efficient direction” by insisting on the separation of functionality and transmission that platform access presumes.[225]

Platform access also impedes the network’s ability to evolve to meet the needs of the increasingly heterogeneous demands of end users. As the FCC noted, standardization hinders network owners’ ability to respond to individual requests for new or modified features. Refusing to impose platform access would allows for more technological innovation than “‘cookie-cutter’ common carrier offerings” implicit in any nondiscriminatory access mandate.[226]

Indeed, the FCC noted that the *Computer Inquiries* reflected “a fairly static picture of network development” in which innovation occurred at the network’s edge or outside the network altogether and in which “a line could be drawn between the network functions and computer processing without impeding technological innovation.” Policy should adapt to reflect the insight that “innovation can occur at all network points and at all network layers as well as in non-network applications and equipment.”[227]

The FCC also expressed concern about how platform access increases transaction costs. As an initial matter, the agency took seriously concerns expressed about “the inherent regulatory delay that occurs through the network change disclosure process, the web positing requirements, and tariffing requirements” as well as the costs of determining the proper regulatory classification under the *Computer Inquiry* regimes as well as the steps needed to comply with those restrictions.[228]

In addition, the FCC noted how platform access “deter[s] broadband infrastructure investment by creating disincentives to the deployment of facilities capable of providing

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225 Wireline Broadband Internet Access Services Order, *supra* note 73, at 14889 ¶ 67.
226 *Id.* at 14892 ¶ 72, 14900 ¶ 88.
227 *Id.* at 14890 ¶ 70.
228 *Id.* at 14890-91 ¶ 71.

invocative broadband Internet access services." The FCC found "this negative impact on deployment and innovation particularly troubling in view of Congress' clear and express policy goal of ensuing broadband deployment, and its directive that we remove barriers to that deployment." Giving network owners greater flexibility in their dealings with providers of complementary services will allow them to "take more risks in investing in and deploying new technologies."[229] In addition, the fact that network owners are already confronted with powerful incentives to make transmission capacity available to providers of complementary services absent regulation cut against the need for imposing platform access. Indeed, such incentives are likely to become even stronger as content and applications providers develop and deploy VoIP and other innovative broadband service offerings.[230]

5. Unbundled Access

Unbundled access is a right given to competitors to individual components of the incumbent's network. Cable modem systems have never been subject to unbundled access requirements. As we described above, the FCC initially subjected DSL systems to limited unbundling requirements, but has eliminated most of those requirements over time.

Unbundled access disrupts network management to a greater degree than any other form of access. Unbundled access simultaneously supports complementary services, which tends to increase network demand, while diverting some traffic outside of the network, which tends to reduce network demand. As a result, its net impact on the demand for network resources is ambiguous. Network owners depend on forecasts of demand when deciding on the configuration that provides the greatest capacity and the optimal level of reliability at the lowest cost. The

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229 *Id.* at 14865 ¶ 19, 14877-78 ¶ 44, 14891 ¶ 72.
230 *Id.* at 14877 ¶ 44, 14892-94 ¶¶ 74-76.

ambiguous impact of unbundled access on network demand makes such forecasts considerably more uncertain. The mandatory carriage aspect of unbundled access also prevents the network owner from protecting network performance by responding to any unexpected increases in demand by refusing carry additional traffic.

Unlike other forms of access, unbundled access has the potential to introduce flows deep in the heart of the network at points that may not represent natural points of interface with other providers. As a result, the pattern of flows associated with unbundled access often bears little resemblance to the pattern of flows for which the network was designed. In addition, tying up isolated elements of the network can cause network performance to degrade in ways that are often quite unexpected. Not only can it increase congestion in the portion of the network adjacent to the elements to which network access is sought. As our discussion of the max-flow/min-cut theorem illustrates, the fact that networks attempt to minimize such distortions by rerouting traffic through other portions of the network means that unbundled access can create new bottlenecks in areas of the network that are located far from the elements to which competitors obtain unbundled access. Thus unbundled access can adversely affect network performance in ways that are sharply discontinuous and unpredictable.

Unbundled access can also greatly increase the transaction costs of network management. At a minimum, placing some of the traffic outside of the network prevents the network owner from observing the information regarding the magnitude and variability of network traffic directly. Instead, such information is only available from the network's competitors, who are likely to be under no regulatory obligation to share that information and may have strategic incentives to withhold it. In addition, unbundled access forces network owners to develop new processes and equipment for provisioning and metering access at just about any points within its network even if it has never provided service at those points in the past and has no plans to do so in the future.

In addition, unbundled access can have a devastating impact on incentives to invest in alternative network capacity. Giving competitors the right to access elements of the existing network at cost effectively destroys their incentive to invest in third-generation wireless networks and other broadband technologies, particularly if the network owner is not allowed to charge its actual cost and is instead required to charge the cost of a hypothetical network providing the same service using the most efficient technology currently available. Requiring that any successful improvements to the existing networks be shared also substantially dampens incumbents' incentives to invest in upgrading their own networks.

This is particularly true when the success of various improvements is highly variable and hard to anticipate. Consider, for example, an incumbent that is considering whether to upgrade its network in a way that is likely to be successful in some geographic areas, but not in others in ways that are unpredictable. Absent unbundled access, the network owner could forego determining in which geographies the innovation the innovation was likely to prove successful and instead focus on the average success rate across all geographies and undertake the investment as long as that average success rate exceeds its investment hurdle. The situations changes dramatically once unbundled access is imposed. Unbundled access gives competitors the opportunity to obtain access to only those geographies that prove economically successful and to ignore those that do not. This leaves the network owner with two relatively unattractive possibilities. First, it can spend additional resources to determine in advance which geographies are likely to prove more successful. Even if it is successful in making this determination, unbundled access guarantees that any economic benefits it obtains from these investments will be quickly dissipated. Second, it can forego the investment altogether. Either decision will have an adverse impact on network investment.

Justice Breyer invoked these considerations with respect to narrowband technologies in his separate opinion in *Iowa Utilities Board*:

> [A] sharing requirement may diminish the original owner's incentive to keep up or to improve the property by depriving the owner of the fruits of value-creating investment, research, or labor. . . . [One cannot] guarantee that firms will undertake the investment necessary to produce complex technological innovations knowing that any competitive advantage deriving from those innovations will be dissipated by the sharing requirement.[231]

A majority of the Court echoed the same concerns in *Trinko*. The Court noted, "Compelling such firms to share the source of their advantage . . . may lessen the incentive for the monopolist, the rival, or both to invest in those economically beneficial facilities."[232] Furthermore, the Court recognized how unbundled access requires undertaking the difficult task of "identifying the proper price, quantity, and other terms of dealing," a task made all the more difficult by the fact that disputes over access to telecommunications networks "are highly technical" and "likely to be extremely numerous, given the incessant, complex, and constantly changing interaction of competitive and incumbent LECs implementing the sharing and interconnection obligations."[233]

The D.C. Circuit extended this reasoning to last-mile broadband networks when striking down the FCC's *Line Sharing Order*. The court noted that "mandatory unbundling comes at a

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231 AT&T Corp. v. Iowa Utils. Bd., 525 U.S. 366, 428-29 (1999) (Breyer, J., concurring in part & dissenting in part) (citation omitted); *accord* Verizon Commc'ns Inc. v. FCC, 535 U.S. 467, 550-51 (2002) (Breyer, J., concurring in part & dissenting in part) (noting that compelling incumbents to share the cost-reducing benefits of a successful innovation destroys the incumbent's incentives to innovate in the first place).

232 Verizon Commc'ns Inc. v. Law Offices of Curtis V. Trinko, LLP, 540 U.S. 398, 407-08 (2004).; *accord id.* at 408, 414 (emphasizing "the uncertain virtue of forced sharing" and how mandating access under section 2 "seem[ed] destined to distort investment").

233 *Id.* at 408, 414; see also *id.* (noting that policing access "'can be difficult' because the means of illicit exclusion, like the means of legitimate competition, are myriad'" (quoting United States v. Microsoft Corp., 253 F.3d 34, 58 (D.C. Cir. 2001) (en banc))).

cost, including disincentives to research and development by both ILECs and CLECs and the tangled management inherent in shared use of a common resource." In addition, the existence of intermodal competition from cable modem providers eliminated the need to impose unbundled access.[234]

The FCC relied on many of these same insights in its *Triennial Review Order*, which eliminated UNE access to the high frequency portion of the loop, fiber loops, and packet switching equipment. Extending unbundled access to last-mile broadband networks "would blunt the deployment of advanced telecommunications infrastructure by incumbent LECs and the incentive for competitive LECs to invest in their own facilities."[235] The FCC repeatedly acknowledged that the market for last-mile broadband services had grown increasingly competitive.[236] Competition is better than unbundling because of the difficulties in allocating shared costs and resources.[237]

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A more sophisticated understanding of the interactions between various network elements thus provides a basis for identifying and categorizing the various types of access and sheds new light on the differential impact that each type of access has on network cost, capacity, reliability, and transaction costs. Indeed, our analysis underscores how the lack of a theory of network configuration has limited the insight provided previous analyses and raises serious doubts about whether mandating any of these forms of access would represent good policy.

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234 290 F.3d 415, 428-29 (D.C. Cir. 2002).

235 Triennial Review Order, *supra* note 70, at 17149 ¶ 288; *accord id.* at 17153 ¶ 295.

236 *Id.* at 17134 ¶ 259, 17135-56 ¶¶ 262-263, 17151-52 ¶ 292, 17321-22 ¶ 538.

237 *Id.* at 17135 ¶ 260.

CONCLUSION

The emergence of last-mile broadband networks over the past decade has been accompanied by calls for mandating access those networks. The persistence with which calls for access have arisen and the fervor with which they are advanced makes it unlikely that this issue is going to fade any time in the foreseeable future.

The existing debate has overlooked key differences in the technological and economic environment that characterize the transition from narrowband and broadband. The digitization of network traffic has allowed a vibrant intermodal competition to emerge that undercuts the rationales traditionally invoked to justify regulating previous telecommunications networks. In addition, the magnitude of the capital investments required by the deployment of broadband has placed renewed emphasis on the need to preserve investment incentives and the importance of promoting dynamic efficiency. Together, these insights strongly indicate the inappropriateness of bringing broadband within the ambit of regulatory regimes previously developed to govern narrowband communications.

In addition, previous analyses have failed to incorporate any theory of network configuration that reflects the interactions between different components that cause networks to behave in unpredictable ways. Using graph theory to model networks captures the extent to which networks constitute complex systems that can only be understood in light of precise manner in which the various network elements are configured, as well as the magnitude and the variability of the traffic flowing through the network at any given time. In addition, this analytical framework allows us to identify five different types of access—retail access, wholesale access, interconnection access, platform access, and unbundled access—and to assess how each type affects network performance. Although the precise impact of each type of access varies, the strength of intermodal competition, the importance of preserving incentives, and the adverse impact that each type of access has on network management provide powerful reasons against mandating any of these types access to last-mile broadband networks.