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CRS Report for Congress

Access to Broadband Networks

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Summary

Debate has begun about what statutory and regulatory framework is most likely to foster innovation and investment both in physical broadband networks *and* in the applications that ride over those networks. Perhaps the most contentious element in that debate is whether competitive marketplace forces are sufficient to constrain the broadband network providers from restricting independent applications providers' access to their networks in a fashion that would harm consumers and innovation.

The telephone and cable companies are deploying wireline broadband networks with unique architectures. For example, Verizon is deploying optical fiber all the way to the customer premise, while AT&T is deploying fiber to a node and then using DSL over existing copper lines to reach the customer premise, and Comcast and other cable companies are deploying a hybrid fiber-coaxial cable network. But in each case, their broadband networks have the same basic structure, with three primary components — the broadband "last mile" grid to end-user customers, the company's proprietary IP network, and the company's facilities in what has traditionally been called the internet backbone (and is often referred to as the "public internet"). This report analyzes these three components to identify the parameters that network providers have within their control (such as their choices about network architecture, overall bandwidth capacity, bandwidth reserved for their own use, traffic prioritization, the terms and rates for access to their networks and for their retail services) that can affect how end users and independent applications providers can access their networks, how those parameters contribute to the management and operation of the network, and how those parameters might be used strategically to harm competition for, and consumers of, voice over internet protocol (VoIP), video, and other applications that ride over broadband networks.

The report then reviews the one bill introduced to date in the 110th Congress (S. 215) with provisions relating to access to broadband access networks as well as a number of bills that were introduced, but not enacted, in the 109th Congress, to assess their potential impact on broadband network providers' ability to manage their networks and to practice anticompetitive strategic behavior. These bills took a number of policy approaches — specifying particular consumer rights to broadband access, proposing variations on "network neutrality" rules that had provisions affecting the access of independent applications providers, as well as consumers, to broadband networks, and proposing modification of existing competition law (involving antitrust and unfair methods of competition) to explicitly address broadband access issues. This report will be updated as warranted.

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Access to Broadband Networks

Introduction

Debate has begun about what statutory and regulatory framework is most likely to foster innovation and investment both in physical broadband networks *and* in the applications that ride over those networks. Perhaps the most contentious element in that debate is whether competitive marketplace forces are sufficient to constrain the broadband network providers from restricting independent applications providers' access to their networks in a fashion that would harm consumers and innovation. Or is government intervention needed in the form of what has been referred to as "network neutrality," unfair competitive practices, or other nondiscrimination rules placed on the network providers?

This debate has been stimulated by some fundamental changes in the telecommunications market environment — several technology-driven, several market-driven, and one regulatory-driven.

- Digital technology has reduced the costs for those firms that already have single-use (for example, voice or video) networks to upgrade their networks in order to offer multiple services over their single platform. The cost for these previously single-service providers to enter new service markets has been significantly reduced,[1] inducing market convergence. Most notably, cable companies are upgrading their networks to offer voice and data services as well as video services, and telephone companies are upgrading their networks to offer video and data services as well as voice services.

- Despite these lower entry costs, however, wireline broadband networks require huge sunk up-front fixed capital expenditures. This may limit the number of efficient broadband networks that can be deployed in any market to two (the cable provider and the wireline telephone company) unless a lower cost alternative becomes available using wireless or some other new technology.[2]

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[1] See George Ford, Thomas Koutsky, and Lawrence Spiwack, "Competition After Unbundling: Entry, Industry Structure and Convergence," Phoenix Center Policy Paper Number 21, July 2005, available at [http://www.phoenix-center.org/pcpp/PCPP21Final.pdf], viewed on December 13, 2006.

[2] According to the most recent FCC report, *High-Speed Services for Internet Access: Status as of December 31, 2005,* July 2006, at Table 6, the vast preponderance of high-speed internet access lines were provided by local telephone companies or cable companies: of the 50.2 million total high-speed line (over 200 kilobits per second (kbps) in at least one

(continued...)

Although wireless technology may provide a third or even fourth alternative, it is not likely to be a ubiquitous option anytime soon.[3] The commercial mobile wireless (cellphone), WiFi, and WiMAX technologies still require significant further technical developments before they will be able to provide comparable service and operate at the necessary scale. Moreover, spectrum is just being made available for these technologies, and in many cases parties currently using that spectrum must be moved to other spectrum.

- The new broadband networks are able to deliver potentially highly valued services, such as voice over internet protocol (VoIP) and video over internet protocol (IP Video), that are qualitatively different than most of the services that have been provided over the internet in the past. Where services such as e-mail and website searches are not sensitive to "latency" — the amount of time it takes a packet of data to travel from source to destination — these new services are sensitive to delays in the delivery of packets of bits due to congestion or other problems.[4] As a result, the traditional internet

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[2] (...continued)
direction) in the U.S. in December 2005, 19.7 million were provided by Regional Bell Operating Companies, 2.9 million were provided by other incumbent telephone companies, and 27.6 million were provided via cable modems. Tables 3 and 6 of that report indicate that of the 42.9 million high-speed lines designed to serve primarily residential end users, 57.5% used cable modems and 40.5% were asymmetric digital subscriber lines (ADSL), and that the vast majority of the latter were provided by local telephone companies.

[3] See, for example, Robert D. Atkinson and Philip J. Weiser, "A 'Third Way' on Network Neutrality," The Information Technology and Innovation Foundation, May 30, 2006, at pp. 7-8, available at [http://www.itif.org/files/netneutrality.pdf], viewed on December 13, 2006.

[4] Latency is affected by physical distance, the number of "hops" from one internet network to another internet network that must be made to deliver the packets (since there can be congestion at each hand-off point), and voice-to-data conversion. Congestion that delays the transmission of packets can cause several problems. (The following is a distillation of a description for lay readers presented by Ed Felten in [http://www.freedom-to-tinker.com?p=983] and [http://www.freedom-to-tinker.com/?p=986], both viewed on December 13, 2006.) In effect, the internet (or a proprietary IP network) is as a set of routers connected by links. Packets of data get passed from one router to another, via links. A packet is forwarded from router to router, until it arrives at its destination. Typically, each router has several incoming links on which packets arrive, and several outgoing links on which it can send packets. When a packet shows up on an incoming link, the router will figure out on which outgoing link the packet should be forwarded. If that outgoing link is free, the packet can be sent out on it immediately. But if the outgoing link is busy transmitting another packet, the newly arrived packet will have to wait — it will be "buffered" in the router's memory, waiting its turn until the outgoing link is free. Buffering lets the router deal with temporary surges in traffic. The router will be programmed to determine which packets should be delayed and also, when the link is available, which buffered packet should be transmitted. That is, a packet prioritization scheme is devised. This could be a simple, first-in, first-out scheme or a favor-applications-sensitive-to-packet-delay scheme, or a pay-for-priority scheme, or something else. But if packets keep showing up faster than they can be sent out on some outgoing link, the number of buffered packets
(continued...)

"best effort" standard that does not guarantee that delays will not occur may be insufficient to meet customers' service quality requirements for these new latency-sensitive services.[5] More intensive network management may be needed to meet these quality of service (packet delivery) requirements.

- Equipment is being deployed in the broadband networks that can identify both the source of individual packets and the application to which individual packets are being put. With this equipment, network providers can give some packets higher priority than others, which can ensure that specific quality of service requirements are being met, but also could be abused to discriminate for or against particular applications or applications providers.

- Some new applications place very substantial bandwidth demands on the public internet and proprietary IP networks. For example, one industry analyst estimated that one particular application, BitTorrent software that uses file-sharing technology to download movies and other content, accounted for as much as 30% of all internet traffic at the end of 2004, and that peer-to-peer (P2P) applications, in general,

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[4] (...continued)
will grow and grow, and eventually the router will run out of buffer memory. At that point, if one more packet shows up, the router has no choice but to discard a packet. It can discard the newly arriving packet, or it can make room for the new packet by discarding something else. But something has to be discarded. The router will be programmed to determine which packets should be dropped, thus creating a second packet prioritization scheme. Again, this could be a simple, first-in, first-out scheme or a favor-applications-sensitive-to-dropped-packets scheme, or a pay-for-priority scheme, or something else. Dropped packets can be retransmitted, but for those applications, such as voice, that require the packets to arrive and be reassembled within a short period of time, such packet recovery might not occur in the timely fashion needed to retain service quality. With such congestion, at least two problems may occur. One problem is dropped packets. Some applications are more sensitive than others to dropped packets. A second problem is "jitter" caused by the delay of certain packets. Internet traffic is usually "bursty," with periods of relatively low activity punctuated by occasional bursts of packets. (For example, browsing the Web generates little or no traffic while reading the page, but a burst of traffic when the browser needs to fetch a new page.) Even if the router is programmed to minimize delay by only delaying low-priority packets when congestion absolutely requires such delay, if the high-priority traffic is bursty, then low-priority traffic will usually move through the network with little delay, but will experience noticeable delay whenever there is a burst of high-priority traffic. This on-again, off-again delay is called jitter. Jitter has no affect when downloading a big file, for which one's concern is the average packet arrival rate rather than arrival time of a particular packet. But the quality of applications like voice conferencing or VoIP — which rely on steady streaming of interactive, realtime communication — can suffer a lot if there is jitter.

[5] For simplification of exposition, this report will refer to those applications that are sensitive to dropped packets or to jitter or any other congestion-related transmission problem as "latency-sensitive" applications.

represented 60% of internet traffic.[6] BitTorrent has been used both for legitimate purposes and for the illegal downloading of copyrighted materials, but has now been accepted by some mainstream content providers. For example, Warner Brothers has announced plans to make hundreds of movies and television shows available for purchase over the internet using BitTorrent software.[7] Other major industry players, such as Microsoft and Sony, have introduced movie download services that use P2P technology.

- Although the telephone and cable companies are deploying different network architectures,[8] they are pursuing business plans and regulatory strategies with the same key elements:

  - They expect latency-sensitive video and voice services to be the "killer applications" that will generate the revenues needed to justify upgrade and buildout of their physical broadband networks.

  - To minimize customer churn[9] and to gain an advantage over providers of single services, they market bundles of voice, data, and video services, with discounts that are greater the greater the number of services purchased. (It is expected by many that this "triple-play" bundle will be expanded to a "quadruple-play" bundle with the addition of mobile wireless service.)

  - The set of services the telephone and cable companies plan to offer over their networks, despite having interactive components, follow the model of the customer being primarily a recipient of information, not a transmitter of information. Therefore the broadband network architecture they all are deploying is asymmetric — with significantly greater bandwidth available from the broadband provider to the customer than in the reverse direction.

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[6] "P2P in 2005," Presentation by Andrew Parker, co-founder and chief technology officer, CacheLogic. In a more recent interview, available at [http://cdn.sfgate.com/ blogs/sounds/ sfgate/chroncast/2006/08/04/TechTalk-20060807.mp3] (listened to on December 13, 2006), Mr. Parker stated that the traffic generated by two popular P2P applications, Kazaa and Gnutella, represented 40% of internet traffic.

[7] See Julie Bosman and Tom Zeller Jr., "Warner Bros. To Sell Movies and TV Shows on Internet," *New York Times*, May 9, 2006, at p. C3.

[8] See the discussion below in the section entitled "What Do Wireline Broadband Networks Look Like?"

[9] Customer churn is the number of customers who discontinue purchasing service from a provider within a period of time. It is typically measured as the churn rate — the percentage of customers who discontinue service during a period of time.

- The video and voice services they offer, as well as other end-to-end services they plan to offer in the future, require quality of service assurances that they claim are not available on the "public internet," but can be provided on their proprietary IP networks. In order to assure the quality of service of their own offerings, the broadband network providers all seek to manage bandwidth usage on their proprietary broadband networks by reserving a significant proportion of their network capacity for their own applications and by controlling the access that independent applications providers have to those networks through a variety of means, including charges for priority access.

- The Federal Communications Commission ("FCC" or "Commission") ruled in 2002 that cable modem service offered by cable companies, despite having a telecommunications component, is an information service and therefore not subject to the common carrier regulations imposed on telecommunications services in Title II of the Communications Act.[10] The FCC decision was upheld by the Supreme Court in June 2005.[11] Subsequently, the FCC ruled that DSL service offered by cable companies also is an information service.[12] As a result, neither cable modem service nor DSL service is subject to the interconnection, nondiscrimination, and access requirements of Title II.

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[10] *In the Matter of Inquiry Concerning High-Speed Access to the Internet Over Cable and Other Facilities; Internet Over Cable Declaratory Ruling; Appropriate Regulatory Treatment for Broadband Access to the Internet Over Cable Facilities,* 17 FCC Rcd. 4798, 4799 (March 15, 2002). In this decision, the FCC concluded that the telecommunications functionality in cable modem service is integral to the service, and not transparent to the consumer, and therefore cable modem service should be treated as a pure information service and not subject to the requirements imposed on telecommunications services under Title II of the Communications Act (47 U.S.C. 151 *et seq*.).

[11] *National Cable & Telecommunications Association v. Brand X Internet Services*, 125 S.Ct. 2688 (2005).

[12] *In the Matter of Appropriate Framework for Broadband Access to the Internet Over Wireline Facilities*, Report and Order and Notice of Proposed Rulemaking, 20 FCC Rcd. 14853 (September 23, 2005). The FCC used the same argument to support its DSL decision as it used in its cable modem decision. Not surprisingly, the United Power Line Council then petitioned the FCC to issue a declaratory ruling that broadband over power lines is an information service akin to cable modem and DSL service. (*In the Matter of the Petition of the United Power Line Council for a Declaratory Ruling Regarding the Classification of Broadband over Power Line Internet Access Service as an Information Service*, Petition for Declaratory Ruling, filed December 23, 2005, available at [http://www.uplc.utc.org/file_depot/0-10000000/0-10000/7966/conman/Petition+for+Declaratory+Ruling.pdf], viewed on December 13, 2006.) The FCC did so on November 3, 2006. (See "FCC Classifies Broadband Over Power Line-Enabled Internet Access as 'Information Service'," FCC News, November 3, 2006.)

Independent applications providers have voiced concern that the broadband network providers could abuse that control over network access to constrain — or entirely exclude — them from competing in the provision of applications, thereby undermining their ability to bring innovative applications to consumers. Some applications providers therefore have proposed enactment of statutory and regulatory requirements, such as nondiscriminatory access to broadband networks or network neutrality requirements. Others have been less confident about the ability to craft effective nondiscrimination or neutrality rules. They have suggested that government policy that promotes entry by broadband network providers that do not share the business plans of the cable and telephone companies might be a more effective way to foster innovation and investment in applications.[13] This might include prohibiting restrictions on municipal deployment of broadband networks, expediting the availability of spectrum for wireless broadband networks, and limiting the amount of such spectrum that can be acquired by companies owned by or in other ways affiliated with the wireline broadband providers. Current broadband network providers respond that, given existing market forces, they have neither the incentive nor the ability to constrain independent applications providers, that constraining their ability to manage their networks would discourage their investment in broadband networks, and that municipal networks enjoy an unfair advantage in capital markets.[14]

To date, the debate has proceeded on an abstract level. The purpose of this report is to provide a more concrete discussion of access to wireline broadband networks. To that end, this report provides a discussion of what broadband networks look like; how both consumers and independent applications providers gain access

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[13] For example, at the November 10, 2005, panel of academics at the "Peripheral Visionaries' VoIP Communications Policy Summit" conference sponsored by pulver.com, Susan Crawford of Cardozo Law School, argued that it is unlikely to be possible to craft legislative language that broadband network providers could not get around in the name of network management, and that instead the public policy focus should be on the "real problem" of lack of competitive alternatives to the cable and telephone networks.

[14] To further complicate the debate, there is a growing economic literature on "two-sided" markets, in which a network provider has two distinct sets of customers to whom it provides service and sets terms, conditions, and rates for network access — end users, who seek access to the network to receive services, and applications services providers, who seek access to the network in order to reach those end users. According to that literature, while additional access networks will increase the competitive options available to end users, they may not improve the market of independent applications providers that do not have the option of choosing among access networks for the best deal, but rather must connect to all of the access networks in order to reach their customers. See, for example, Jean-Charles Rochet and Jean Tirole, "Platform Competition in Two-Sided Markets," *Journal of the European Economic Association*, June 2003, Vol. 1, Issue 4, pp. 990-1029; Julian Wright, "Access Pricing under Competition: An Application to Cellular Networks," *Journal of Industrial Economics,* 2002, Vol. 50, Issue 3, pp. 289-315; Julian Wright, "The Determinants of Optimal Interchange Fees in Payment Systems," *Journal of Industrial Economics*, March 2004, Vol. 52, Issue 1, pp. 1-26; Julian Wright, "One-Sided Logic in Two-Sided Markets," *The Review of Network Economics*, March 2004, Vol. 3, Issue 1, pp. 42-63; Stephen C. Littlechild, "Mobile Termination Charges: Calling Party Pays versus Receiving Party Pays," *Telecommunications Policy*, 2006, Vol. 30, pp. 242-277; and Mark Armstrong, "Competition in Two-Sided Markets," *RAND Journal of Economics*, 2006, forthcoming.

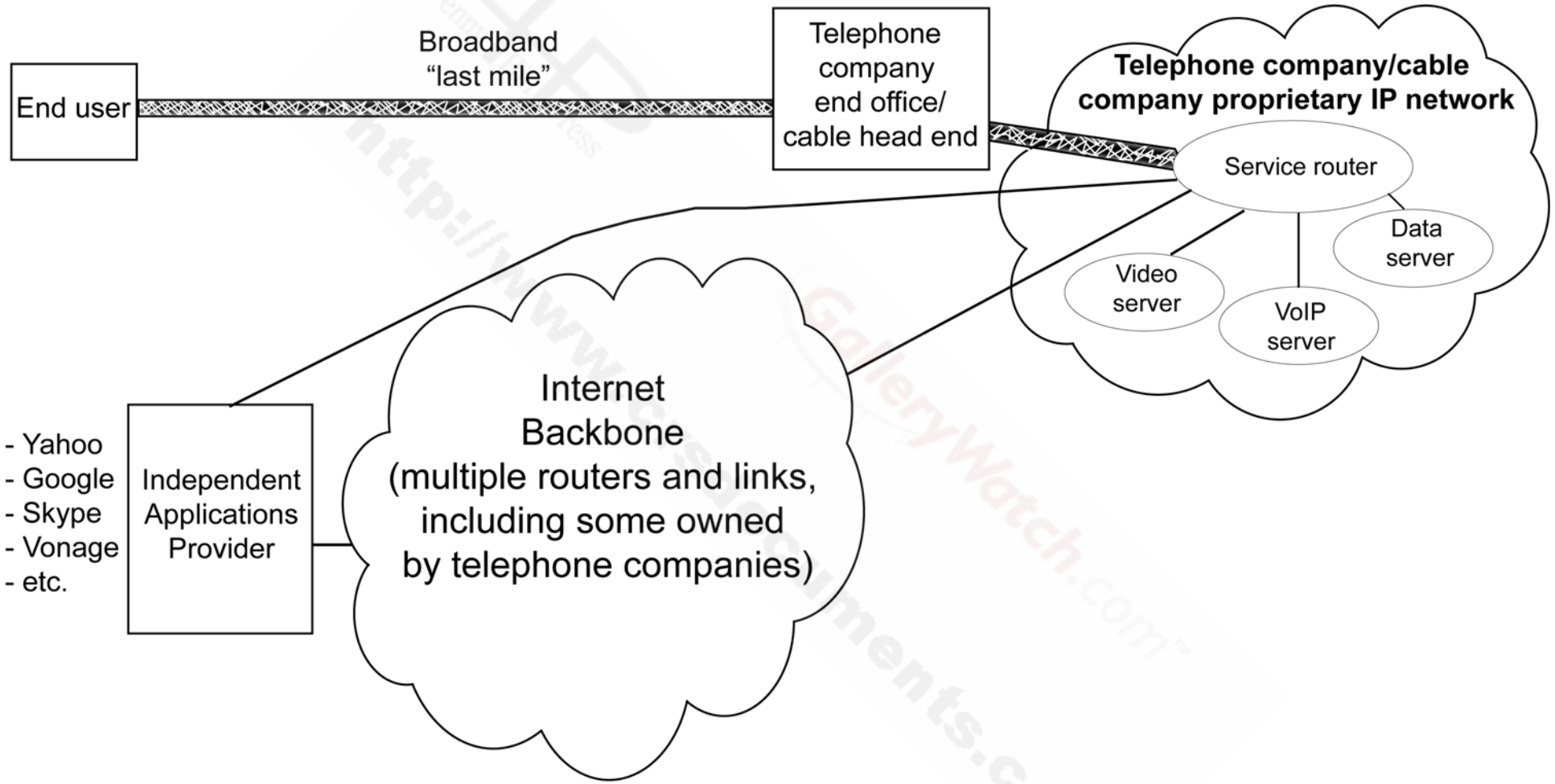
to these networks; and the parameters available to network providers (such as their choices about network architecture, overall bandwidth capacity, bandwidth reserved for their own use, traffic prioritization, the terms and rates for access to their networks and for their retail services) that can affect end users' and independent applications providers' access to those networks.

What Do Wireline Broadband Networks Look Like?

The cable and telephone companies' networks are not static; they continue to be upgraded. The various network providers are in different stages of deploying digital IP technology. They are each employing unique network architectures that build off their legacy networks and/or reflect their perceptions of the most cost-effective networks to deploy. Despite these differences, however, each of the networks has three primary components, as shown in **Figure 1**, a schematic representation of a wireline IP broadband network. These three components are the broadband "last mile" grid out to end-user customers; the company's proprietary IP network, with servers for the various applications feeding into a service router that controls the flow of traffic all the way to the customer premise; and the company's facilities in what has traditionally been called the internet backbone (and is sometimes referred to as the "public internet"). The latter connects to independent applications providers, though it is also possible for independent applications providers to connect directly to a broadband network provider's proprietary IP network, as shown in **Figure 1**. Many independent applications providers also have substantial internet facilities. For example, in order to minimize the number of times their content must be handed off from one internet backbone provider to another when responding to an end-user query, these applications providers "cache" their content close to their customers by maintaining multiple servers scattered around the country in which they maintain frequently-updated databases. Since it is possible that congestion could cause delay at any of those handoff points, caching data at multiple servers reduces the risk of service degradation.

The schematic representation in **Figure 1** may help elucidate a number of policy-related discussions. For example, it may help discussants visualize where and how end users and independent applications providers gain access to the broadband network; where and how congestion occurs that threatens the quality of latency-sensitive services; and how a network provider's capacity, architecture, prioritization, and service offering decisions could affect independent applications providers.

Figure 1. Schematic Representation of a Wireline IP Broadband Network



Source: CRS from multiple sources.

The Broadband Last Mile

A wireline broadband network provider can choose among various network architectures for its last mile grid. A telephone company can choose to deploy optical fiber from its end office switch all the way to the home, or to the curb, or to a neighborhood node. If it brings the fiber to the curb or to a node, it can then complete the connection to the customer premise by attaching digital subscriber line (DSL) modems to the existing copper line running into the premise. For example, Verizon's Fios service deploys optical fiber all the way to the customer premise, while AT&T's Project Lightspeed deploys fiber to a neighborhood node and then uses existing copper lines and DSL modems to reach the customer.[15] Cable companies most often use hybrid fiber-coaxial cable (HFC) technology, deploying optical fiber from the cable company's head-end facility to a node and using coaxial cable from the node to the end-user premise. The fiber to the home architecture is much more costly to deploy, but can provide substantially more bandwidth than can be provided over a fiber/DSL or HFC last mile[16] and can have its bandwidth expanded more cheaply and easily as demand grows.

If a broadband network provider intends to offer multiple channel video service, it can choose between an architecture that "broadcasts" the signals of all the channels to the end-user premise (the cable company and Verizon approach) and an architecture that transmits to the end user only the particular video channel selected by the customer using her IP set-top box (the "call-up" approach used by AT&T). The "broadcast" approach requires more bandwidth.

Network providers have discretion over several other network parameters. For example, both the telephone and the cable companies have chosen to deploy asymmetric broadband networks that have far more bandwidth for the download of information to end-user customer premises than for the upload of information from end users. This architecture favors the development of applications that are one-to-many or client-server in design. Applications that would require end-user customers to deliver content as quickly as they receive it are limited by asymmetric bandwidth. Asymmetric network architecture supports the cable and telephone companies' triple-play business plans, which focus on end users as receivers, rather than transmitters, of information. This is almost certainly consistent with current demands of most customers. If customer demand were to move toward applications and services requiring more symmetric downloading and uploading capability — perhaps as a result of heightened popularity for interactive games or peer-to-peer distribution of videos and other files — the current asymmetric architecture might constrain the growth of these applications, but it also might create market forces for entry of a third broadband provider with a more symmetric network or for the incumbents to modify their networks to meet the new demand.

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[15] AT&T has indicated that, as it builds out its Lightspeed network, it may serve those customers in new housing developments under construction by deploying optical fiber all the way to their premises. These may represent as many as 5% of AT&T customers.

[16] The actual amount of bandwidth provided by fiber, fiber/copper, or HFC will depend on a number of factors, including how much of the optical fiber is "lit" by electronics and the type of modems used.

A network provider can make other decisions about its last mile network that will affect the bandwidth available to end users. Whether its last mile architecture is all fiber, fiber and copper, or fiber and coaxial cable, it can choose to deploy electronics that determine the bandwidth capacity of the line into the end-user premise. In addition, it can partition the bandwidth capacity of the line into the end-user premise, reserving some portion or portions of the total bandwidth for specific applications. For example, a provider might reserve a portion of the bandwidth for its own applications or for those of an independent applications provider that pays for priority access to the end user.

Each network provider can make its own decisions about these technical parameters, subject to market constraints (though currently not subject to regulatory constraints). For example, Verizon's fiber-to-the-home last mile architecture could potentially provide almost limitless bandwidth if all the fiber strands were "lit," but demand cannot justify the deployment of the electronics needed for such unlimited capacity. As currently configured, Verizon's Fios offering lights just three of the many fiber strands in the optical fiber that comes to the customer premise. These lit strands are called lasers. One of these lasers is reserved for the "broadcast" downloading of all the video channels offered in Verizon's video service. The second laser brings 100 megabits per second (mbps) of bandwidth into the customer premise for downloading packets of all other "incoming" traffic — incoming web pages, e-mails, and other data received as part of internet access service, incoming voice packets, incoming video-on-demand programming,[17] and incoming special services. The third laser is used for uploading packets of all outgoing traffic (associated with these internet access, voice, video-on-demand, and special virtual private network services).

A Verizon end user does not purchase or use the full 100 mbps of bandwidth in the download laser, though that much bandwidth comes into her premise on that laser. Nor does she purchase or use all of the bandwidth in the upload laser. Rather, she purchases specific services that use up to a ceiling level of bandwidth in those lasers. For example, an end user can choose internet access service options with 5, 15, or 30 mbps of downstream bandwidth and with 2 or 5 mbps of upstream bandwidth.[18] The end user also can purchase Verizon's video-on-demand service and/or Verizon's voice service, and have these delivered over the download and upload lasers; or she can purchase an independent applications providers' video-on-demand and/or voice services and have these delivered over the download and upload laser. The remainder of the bandwidth on those lasers — typically 70 mbps of

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[17] Verizon's video-on-demand service is provided separately from the rest of its multi-channel video service offering because video-on-demand requires communication between the end user and the video-on-demand server in Verizon's proprietary IP network to call up the specific program from the thousands of programs available, whereas the multi-channel video service simply "broadcasts" all the channels in the service to the end-user premise, with no need for prior communication from the end user.

[18] These were the service options listed on Verizon's website, on December 13, 2006, for those residential households located in Fairfax County, VA for which Verizon's Fios service was available. The pricing of these options is discussed below in the section entitled How Might Strategic Broadband Network Provider Behavior Harm Consumers?

bandwidth on the download laser and substantial bandwidth on the upload laser — are available for special services for that end user. But the end user cannot directly purchase that bandwidth for its own use; rather an independent applications provider that would like to offer a special service to the end user would purchase the bandwidth from Verizon and then recover its costs in its charges to the end user for the service provided over that bandwidth. More specifically, Verizon would require the independent applications provider to purchase an end-to-end connection from its location to the end-user premise. Verizon has characterized these as virtual private network (VPN)-like services that allow the independent applications provider to avoid congestion in the public internet and provide a guaranteed quality of service.

This end-to-end connection is shown in **Figure 1** by the link that goes directly from the independent applications provider to the service router in the broadband network provider's proprietary IP cloud and then through the broadband last mile to the end user. Although this VPN-like service shares the download and upload lasers with internet access and other services, Verizon is able to manage the traffic on the lasers to assure that the quality of service for that special service is not degraded by other traffic on those lasers (and, as will be discussed below, the special service packets are accorded priority as they are transmitted across servers and links within Verizon's proprietary IP network). Special services that might be provided over such a VPN-like link could range from home monitoring of medical patients by physicians to high definition video streaming. With respect to the services that Verizon itself offers over the three lasers (currently, video, voice, video-on-demand, and internet access services), customers can choose to purchase one or more of the services; discounts are provided for purchasing multiple services. But a Fios customer who does not receive any special VPN-like services could not use the extra bandwidth on the download and upload lasers for its own purposes, such as extra bandwidth for internet access. Nor could an end user who does not purchase Verizon's video service purchase the bandwidth on the video laser for other purposes.

AT&T will be serving most of its Project Lightspeed end-user customers with its last mile network comprised of fiber to the node and a DSL link to the customer premise. The link can provide up to 25 mbps of bandwidth into the premise. Of that bandwidth, 19 mbps currently are reserved for AT&T's video service. Of the remaining 6 mbps of bandwidth, the customer can purchase 1.5 mbps service, 3 mbps service, or 6 mbps service for internet access and voice services. AT&T's proprietary ethernet IP network controls the bandwidth to each premise, based on the level of bandwidth the end user has purchased. AT&T's network is capable of reassigning some of the 19 mbps currently reserved for the proprietary video service to other uses. It would be technically possible for a customer to order additional bandwidth on demand — for example, 10 mbps of bandwidth for three hours for a particular application; this capability is called "turbocharging." But AT&T is concerned that last mile congestion that harms service quality could occur if a household attempted to use AT&T's video service and also an internet application requiring more than 6 mbps of bandwidth at the same time. Therefore AT&T does not currently offer a turbocharge (bandwidth-on-demand) service.

According to CableLabs, the industry research consortium that has developed the Data Over Cable Service Interface Specifications (DOCSIS) that define interface standards for cable modems and supporting equipment, typically a few hundred cable

end-user subscribers get internet access by sharing a 6 megahertz (MHz) downstream channel (from the cable network to the customer) and one or more upstream channels (from the customer to the cable network).[19] The downstream channel occupies the space of a single television transmission channel in the cable operator's channel lineup and can provide up to 40 mbps of bandwidth. The cable modems that are most widely deployed in cable networks today (which meet DOCSIS 1.0 and 1.1 specifications) allow upstream channels to deliver up to 10 mbps of bandwidth. Cable companies are now deploying cable modems that meet DOCSIS 2.0 standards that allow upstream channels to deliver up to 30 mbps. DOCSIS 3.0, currently in the late stages of development, will allow several downstream and several upstream channels to be bonded together to multiply the bandwidth delivered to each customer.

Comcast has announced that it is rolling out a free feature, called "Powerboost," that will give end users a temporary turbocharge, doubling speeds for many downloads.[20] Comcast currently has one service offering of 6 mbps downstream/384 kbps upstream and a second offering of 8 mbps downstream/768 kbps upstream for internet access and voice service. With the Powerboost feature, customers of these offerings would be able to enjoy downstream speed bursts of 12 and 16 mbps, respectively. The remainder of the bandwidth capacity of the hybrid fiber/coaxial cable lines into their premises would continue to be reserved for video channels. Comcast does not guarantee these speeds for its internet access service. Since many customers share a single channel, the actual speed available to an individual customer at any specific point in time will depend on the level of usage by neighboring customers who share the channel.

Broadband Network Providers' Proprietary IP Networks

As shown in **Figure 1**, independent applications providers can access a broadband network either through the internet backbone or through a direct connection to a service router in the network provider's proprietary IP network.

The broadband network providers are constructing proprietary IP networks that have the intelligence needed to manage overall traffic flow in their networks as well as the flow of traffic to individual end users. Typically, the network providers are deploying these IP networks in each of the metropolitan areas in which they offer service. As shown in **Figure 1**, traffic will arrive at the service router from a number of sources — from the internet backbone, directly from an independent applications provider, or from the network provider's own video, voice, or data server.[21] The

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[19] See "DOCSIS Project Primer," a document prepared by the CableLabs consortium and last updated October 23, 2006, available at [http://www.cablemodem.com/primer/], viewed December 13, 2006.

[20] See, for example, Dionne Searcey and Sarmad Ali, "Comcast to Speed Downloads to Some Movie, Music Files," *The Wall Street Journal*, June 1, 2006, at p. D3.

[21] For ease of presentation, the schematic diagram in **Figure 1** does not attempt to show every link into a broadband network. The voice, data, and video servers are each shown in the diagram with only a link to the service router, but each of these applications servers will also have other links to the sources of voice, data, and video information transmitted. For

(continued...)

service router, communicating with other portions of the proprietary IP network, is programmed to determine the route the incoming traffic will take to reach the end user and to prioritize traffic in order to determine which packets may be delayed or dropped during periods of congestion. This task includes setting the priority algorithm employed at the router to determine which packets are delayed or dropped when congestion occurs. It is possible that a prioritization algorithm could reserve certain links for particular prioritized packets, such that even if there is bandwidth available on those links for non-prioritized packets, such non-prioritized packets cannot be transmitted over those links. For example, as discussed earlier, Verizon has indicated that, as part of its Fios service, a customer can purchase a path or laser that would be dedicated to delivery of a VPN-type end-to-end service, such as a medical monitoring service. Verizon has not clarified whether some of the links — or, at least, some partitioned portion of the bandwidth in those links — would be entirely reserved for such VPN service (denying any other packets access to that bandwidth) or if the packets associated with the VPN service simply would be given the highest priority at the service router, with the bandwidth in those links used for lower priority packets when there are no VPN packets.

The proprietary IP network also manages and controls the traffic flow through the broadband last mile to the end user. It has the intelligence to, among other things, partition the last mile, make available to the end user only the bandwidth purchased by that end user, slow down traffic that may be moving too fast for the bandwidth capability of the last mile, and prioritize traffic moving onto the last mile.[22]

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[21] (...continued)
example, the video server will be connected (by satellite, terrestrial, and broadcast connections) to the sources of the video programming provided by the network provider. Similarly, since lots of voice traffic continues to flow over the traditional public switched telephone network (PSTN), there will continue to be traffic that comes from the PSTN directly into the telephone company's end office in analog format, but that traffic may then be digitized and routed by the telephone company's proprietary IP network.

[22] Prioritization may play an important network management role as peer-to-peer (P2P) applications become more common. One characteristic of P2P networking is to distribute files as broadly through the network as possible, rather than maintaining files at central servers, so that files can be obtained quickly and with less risk from failure at a single mode. Many P2P applications are constructed to identify all the places where a particular file is located, identify which of those places are served by significant uploading bandwidth, and then obtain the file from those locations. These applications tend to place a burden on last mile networks and proprietary IP networks with large upload capacity. But increasing bandwidth capacity at those locations where P2P applications are creating congestion only creates the feedback effect of making those locations even more attractive for P2P applications. One solution that has been proposed by broadband network providers is for the network manager to be able to employ prioritization in a fashion that slows down P2P packets in order to allow other traffic to flow at these P2P-created congestion points and to discourage the cycle of increases in upload bandwidth intended to reduce congestion automatically attracting additional P2P traffic that creates new congestion. This would help broadband providers manage their networks. But it might diminish efficiencies of P2P networking. Such prioritization is inconsistent with one of the fundamental principles articulated by most proponents of "network neutrality" — that all packets should be treated the same, or that, at the least, all packets associated with the same type of application should
(continued...)

Embedded in the proprietary IP network also is the capability to temporarily turbocharge end user lines to accommodate bandwidth-intensive applications or to allow for flexible partitioning of the last mile so that bandwidth that is normally partitioned and reserved for a specific use might be made available to accommodate a different use.[23]

These proprietary IP networks consist of a physical (transmission) network layer, a logical layer (usually the transmission control protocol/internet protocol suite of protocols (often referred to as TCP/IP), which itself consists of several layers), an applications layer, and a content layer.[24] It is technically possible for an independent applications provider to gain access to a broadband network at various layers, with that provider providing more or less of its own intelligence depending on the layer at which access occurs. Some independent applications providers have alleged that they have been denied access at a layer that would allow them to use their own IP capabilities to differentiate their products from those of the network provider — for example, to offer unique filtering services that might be desired by families who want more restrictive program filters than those offered by the broadband network or to offer robustly secure internet service with special intrusion detectors capable of stopping DOS attacks that the broadband network provider might not offer.[25] These independent providers claim that, instead, they were given access only in a fashion that would allow them to resell Verizon's Fios product offering. Verizon responds that, with the advent of its video service, it had to direct data associated with the video service separately from data associated with information service provider (ISP) service, and this required a change in the way it provided independent ISPs access to its network.[26] The independent ISPs question whether such a change was really needed to upgrade the network or whether it was a strategic decision that undermines their ability to differentiate their applications from Verizon's.

The Internet Backbone

As explained in footnote 4, the internet largely consists of a number of routers with links leading into and out of those routers. Traditionally, traffic has traversed the internet based on a best effort standard in which packets are not prioritized, although routers do need some basis for determining which packets to delay or to drop during periods of congestion.

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[22] (...continued)
be treated the same.

[23] Not every proprietary IP network will necessarily have these capabilities, but announcements by the various broadband network providers suggest that such capabilities are technically possible.

[24] See, for example, Richard S. Whitt, "A Horizontal Leap Forward: Formulating a New Communications Public Policy Framework Based on the Network Layers Model," 56 *Federal Communications Law Journal* 587 (2004).

[25] See Louis Trager, "ISPs Accuse Verizon of Double-Cross on FiOS Wholesaling," *Communications Daily*, November 3, 2005.

[26] Untitled article, *Communications Daily*, November 8, 2005, at p. 8.

The two largest telephone companies, AT&T and Verizon, are among the largest providers of internet backbone facilities. Other companies with substantial internet backbone companies include Sprint-Nextel, Level3, and Qwest. The cable companies have very limited internet backbone facilities.

There is some question as to whether the telephone companies consider their internet backbone facilities to be part of their proprietary networks, in which they would program their routers to prioritize packets. Referring again to **Figure 1**, AT&T and Verizon have made it clear that they intend to program the service routers in their proprietary IP networks to prioritize incoming packets. But AT&T and Verizon own routers and links in the internet backbone, as well, and they have not clarified whether they intend to program those routers to prioritize packets too.

This distinction could have important public policy implications. If the telephone companies were to, in effect, extend their proprietary IP network into the traditional internet backbone by programming prioritization into their routers in the internet backbone, then if and when congestion occurred at any of the telephone companies' internet backbone routers, non-prioritized packets might be delayed or even dropped. If it were possible and relatively inexpensive to identify the telephone companies as the source of these delayed or dropped packets and to route traffic away from those prioritizing routers, non-telephone company internet backbone providers might be able to expand their capacity and attract customers and traffic away from the telephone companies' internet backbone facilities. But these efforts, if doable, would not be costless. Some independent applications providers — and their customers — could well be harmed by degraded service. (It also is possible that the cable companies, to the extent they use the public internet to offer their applications, could be harmed, since they do not have their own internet backbone facilities.)

If, on the other hand, the telephone companies only prioritized packets once those packets were at the service routers in the telephone companies' private IP networks, then such prioritization is unlikely to degrade the quality of service within the internet backbone itself. Even if the telephone companies chose to focus their investments on their proprietary networks and chose not to upgrade their internet backbone facilities, as long as there continued to be demand for transport over the public internet, then the many non-telephone company providers of internet backbone facilities would still have the incentive to expand and upgrade their internet backbone facilities.

Parameters Available to Broadband Network Providers That Can Affect End Users' and Independent Applications Providers' Access to These Networks

Broadband network providers have many parameters within their control that can affect end users' and independent applications providers' access to these networks. These include:

- the choice of the last-mile network architecture: fiber to the home, fiber to the curb or node (hybrid fiber-DSL), or hybrid fiber-coaxial cable.

- the choice between "broadband" last-mile architecture that transmits all the multiple channel video signals all the way to the end-user premise and "call-up" architecture that only transmits to the end-user premise the particular video channel selected by the customer at the set-top box.

- the choice between more or less symmetry in the network, in terms of bandwidth capacity for an end user to download (receive) a file transmitted over the network vs. bandwidth capacity to upload (send) a file transmitted over the network.

- the choice between deploying a network with very great bandwidth and limited ability to manage traffic congestion (presumably because the bandwidth will be sufficient to minimize congestion) and deploying a network with less bandwidth, but a greater need and ability to manage traffic through prioritization and other capabilities.

- the choice of electronics deployed in the network to turn potential bandwidth capacity into actual available capacity. This includes choices about both the optical fiber strands (lasers) to light and the capability and number of cable or DSL modems deployed.

- the choice of whether and how to partition the bandwidth in both the last-mile connections and the links in the proprietary IP network. This includes choices about how much bandwidth to partition for particular prioritized uses, what those prioritized uses are, and whether the partitioning is flexible (i.e., able to be changed when actual usage patterns result in unused bandwidth in a partitioned portion of a link reserved for prioritized packets while congestion is creating delay or other latency problem for the non-prioritized packets using the non-partitioned portion of the link).

- the choice of where and how to prioritize packets. This includes choices about whether to prioritize packets only within the broadband network provider's proprietary broadband network or also at routers in the internet backbone; what basis to use for delaying individual packets when there is congestion; and what basis to use for dropping individual packets when a router's memory is full.

- the choice of what to include in specific service offerings and the prices for those service offerings. This involves both service offerings to end users and service offerings to independent applications providers. It includes choices about how many services to bundle together, whether to make services available only as part of a bundle, whether to offer different bandwidth options, what those

> bandwidth options are, what the prices are for each service offering and option, whether to charge end users or independent applications providers for bandwidth, the price to end users and/or independent applications providers for bandwidth relative to the price of the network provider's end-user service offerings, any usage restrictions in the service offerings for either end users or independent applications providers, the tier or level in the IP network at which independent applications providers gain access, the extent to which an independent applications provider can employ its own IP capability as well as the IP capability in the broadband network to offer service, and the quality of service guarantees in service offerings for independent applications providers.

These parameters are interactive. For example, the greater the bandwidth capacity of the network, the less the need for partitioning or prioritizing traffic or for imposing any use restrictions.

The specific choices that broadband network providers make about these parameters will be driven by several forces — the relative costs of the network architecture options, the actual and perceived demand for (and price sensitivity of) the various service offerings, the actual and potential competition for the provision of both broadband network services and applications, statutory or regulatory constraints (if any), and, to the extent the network providers enjoy some degree of market power, strategic considerations.

How Might Strategic Broadband Network Provider Behavior Harm Consumers?

Generally, broadband network providers will not want to take actions that restrict the availability or quality of applications that end users can obtain over their networks. Such restrictive behavior would reduce overall demand for the broadband network and also increase incentives for competitive entry. At the same time, to the extent that the broadband network providers seek to maximize their revenues for what they perceive as the killer broadband applications — voice and video service today, perhaps interactive games or other applications in the future — they will have an incentive to build, operate, and manage their broadband network in a fashion that favors their own applications over competitors' applications. With only limited alternatives to the cable and telephone broadband duopoly for the foreseeable future, and with the cable and telephone companies both pursuing largely the same business plan, the broadband providers might have both the incentive and the ability to exploit their control over access to end users to restrict competition (and the innovation it might bring) and harm consumers. This strategic behavior could occur in several ways.

Given its control over the bandwidth capacity of its network and the partitioning of that bandwidth, if the network provider were to reserve a substantial portion of the bandwidth (in the last-mile network as well as in the links of its proprietary IP network) for its own latency-sensitive services, in order to assure a particular quality

of service for those services, that might leave too little bandwidth available for independent applications to assure an equal quality of service for those independent applications. Or there might not be sufficient bandwidth available for multiple independent applications providers to simultaneously serve a single premise or for the provision of certain bandwidth-intensive applications from independent providers.

For example, streaming a high definition television (HDTV) channel currently requires approximately 20 mbps of bandwidth, though advances in compression technology are likely to reduce the required bandwidth to 10 mbps in the near future. If a broadband network provider reserved most of the bandwidth into a customer's premise for its own video service, leaving at most 6 mbps available for the internet access needed to receive independent applications, competitive provision of HDTV would be curtailed. This might, or might not, represent anticompetitive strategic behavior. If the broadband provider has deployed fiber to the home, bringing 100 mbps to the end user premise, and then limits its internet access service offering to 6 mbps, while providing multiple HDTV channels over its own video service, this might suggest an anticompetitive strategic partitioning decision. On the other hand, if the broadband provider has deployed a fiber-DSL hybrid network that only brings 25 mbps to the premise, and its own partitioned video service does not offer HDTV capability (or only limited HDTV capability), then if its internet access service is only 6 mbps, this might reflect network limitations rather than, or as well as, strategic behavior. In either situation, however, if it were technically and economically feasible to partition the bandwidth flexibly, so a customer could use 10 mbps of the bandwidth coming to its premise for either the broadband network's HDTV service offering or an independent application provider's HDTV service offering, the consumer is likely to enjoy greater choice in applications. But even this result is not unambiguous. In a household with multiple high definition television sets, if that household were simultaneously streaming multiple HDTV programs from both the network provider and from an independent provider, flexible partitioning might allow all the programs to be viewed, but not be able to ensure the maintenance of HDTV quality for either program.[27]

Given that the broadband network providers are providers of both end user services and input (network access) services required by their independent applications competitors, they may have the opportunity to set prices for their network access and applications services in a strategic fashion. Consider, for example, the prices that Verizon currently charges its Fios customers for internet access. Verizon offers three options: up to 5 mbps download speed and 2 mbps upstream speed for $34.95, up to 15 mbps download and 2 mbps upload for $49.95, and up to 30 mbps download and 5 mbps upload for $179.95.[28] There are several

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[27] But this does highlight how partitioning places constraints on the end user's ability to receive multiple HDTV programs simultaneously from one or more independent applications providers, even if that end user has purchased a bundled service offering with total bandwidth capable of providing multiple HDTV programs simultaneously.

[28] These were the service and price options listed on Verizon's website, on December 13, 2006, for those residential households located in Fairfax County, VA for which Verizon's (continued...)

possible explanations for the huge jump in price for the 30 mbps service. One explanation might be that Verizon would have to incur substantial costs increasing the capacity of its last mile network (and perhaps its proprietary IP network) to handle those bandwidth-intensive applications that would require 30 mbps of download bandwidth. In this case, the high price would accurately reflect actual underlying costs. A second possible explanation might be that the customers with such substantial bandwidth needs tend to be insensitive to price and thus will pay very high prices, or are part of a category of customers (such as business customers) who have traditionally been charged higher rates. Then, the high price would represent a way to perform efficient price discrimination to recover fixed network costs. A third possible explanation might be that Verizon faces potentially strong competition from independent applications providers for the provision of bandwidth-intensive applications, such as HDTV, and by pricing the 30 mbps of internet access service needed for those services at $179.95, while charging a lower prices for its own HDTV or other bandwidth-intensive applications, it could practice strategic behavior that places its competitors in an anticompetitive price squeeze.

More generally, access to the bandwidth provided by broadband networks is a necessary input into the provision of broadband applications. The broadband providers have announced that they seek compensation for such broadband access in two ways — in charges to end users for specific quantities of bandwidth access and in charges to independent applications providers for prioritized access to the broadband network (intended to guarantee service quality, typically comparable to the quality the broadband network providers provide themselves for their own applications). For a particular application, if the difference between the price that the network provider charges end users for its own application service and the "imputed" cost of access to the broadband network that it would have to pay if it were an independent applications provider offering that application (that is, the charges that the network provider imposes on end users and independent applications providers for the bandwidth needed to offer that application) is less than the non-bandwidth-related costs for the network provider to offer that application, then the network provider is placing the independent applications provider in a price squeeze because even if that independent provider were just as efficient as the network provider it would be placed at a competitive disadvantage simply due to the network provider's pricing decisions. This would allow the network provider to succeed in the applications market despite being a less efficient provider.

Legislative Proposal in the 110th Congress Relating to Access to Broadband Networks

To date, only one bill (S. 215) has been introduced in the 110th Congress that has provisions relating to access to broadband networks. Under S. 215, each broadband service provider would have the duty to:

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[28] (...continued)
Fios service was available.

- enable any content application, or service made available via the internet to be offered, provided, or posted on a basis that (A) is reasonable and nondiscriminatory, including with respect to quality of service, access, speed, and bandwidth; (B) is at least equivalent to the access, speed, quality of service, and bandwidth that such broadband service provider offers to affiliated content, applications, or services made available via the public Internet into the network of such broadband service provider; and (C) does not impose a charge on the basis of the type of content, applications, or services made available via the internet into the network of such broadband service provider;
- only prioritize content, applications, or services accessed by a user that is made available via the internet within the network of such broadband service provider based on the type of content, applications, or services and the level of service purchased by the user, without charge for such prioritization; and
- not install or utilize network features, functions, or capabilities that impede or hinder compliance with this section.

S. 215 is identical to a bill (S. 2917) that had been introduced in the 109th Congress. For simplicity of presentation and to provide context and facilitate comparison of alternative proposals, a more detailed discussion of S. 215 is presented in the next section of this report, which compares the provisions of a number of bills relating to access to broadband networks that had been introduced (though none were enacted) in the 109th Congress. Since S. 215 would impose certain requirements on broadband access network providers that are generically known as "network neutrality" requirements, the bill is discussed along with other legislative proposals with network neutrality requirements.

Legislative Proposals in the109th Congress (None of Which Were Enacted) Relating to Access to Broadband Networks

In addition to S. 2917, there were a number of bills introduced in the 109th Congress that included provisions relating to access to broadband networks. None of these bills was enacted.

The FCC Broadband Policy Statement

H.R. 5252, which was passed by the full House, would have explicitly authorized the FCC (at Sec. 201) to enforce the broadband policy statement, and the principles incorporated therein, that the Commission adopted as general principles on August 5, 2005. These principles are:

- consumers are entitled to access the lawful internet content of their choice.
- consumers are entitled to run applications and use services of their choice, subject to the needs of law enforcement.

- consumers are entitled to connect their choice of legal devices that do not harm the network.
- consumers are entitled to competition among network providers, application and service providers, and content providers.

H.R. 5252 would have explicitly prohibited the FCC from adopting or implementing rules or regulations regarding enforcement of the broadband policy statement, except to adopt procedures for the adjudication of complaints.

These principles are quite general and susceptible to alternative interpretations. They would prohibit a broadband network provider from entirely blocking a particular application, such as a competitor's VoIP service. They would not explicitly prohibit a broadband network provider from prioritizing packets or reserving significant portions of bandwidth for its own applications or for the applications of a preferred independent provider, even if such behavior harmed the quality of service of one or more independent applications providers or effectively precluded independent applications providers from the market. Nor would they explicitly prohibit a broadband network provider from setting charges for network access in a fashion that would place independent applications providers in an anticompetitive price squeeze. Arguably, the fourth principle — consumer entitlement to competition among application and service providers — could be the basis for a complaint against such behavior. No standards were provided, however, for determining what level of competition a consumer is entitled to. For example, the FCC might view the duopoly provision of applications, by the telephone and cable companies, as providing sufficient competition to meet this principle, even if independent applications providers were harmed, or even excluded from the market, by the behavior.

Internet Consumer Bill of Rights

The Internet Consumer Bill of Rights, incorporated in section 903 of H.R. 5252 as amended by the Senate Commerce Committee (originally introduced as S. 2686), would have required each internet service provider to allow each subscriber to:

- access and post any lawful content of that subscriber's choosing;
- access any web page of that subscriber's choosing;
- access and run any voice application, software, or service of that subscriber's choosing;
- access and run any video application, software, or service of that subscriber's choosing;
- access and run any search engine of that subscriber's choosing;
- access and run any other application, software, or service of that subscriber's choosing;
- connect any legal device of that subscriber's choosing to the internet access equipment of that subscriber, if such device does not harm the network of the internet service provider; and
- receive clear and conspicuous information, in plain language, about the estimated speeds, capabilities, limitations, and pricing of any internet service offered to the public.

This bill of rights addresses only consumer access to those applications, services, or devices that independent providers are able to offer. If, as a result of a network provider's prioritization, partitioning, and/or pricing decisions, an independent applications provider were not able to offer an application — or could only offer an application that is inferior in quality or higher in price than the competing service offered by the broadband network provider — the independent applications provider would have no recourse. The consumer would not have been denied access to an offered application. Arguably, under the Internet Consumer Bill of Rights, a consumer who, because of partitioning, could not purchase sufficient bandwidth to support the bandwidth-intensive offering of an independent applications provider, but could purchase from her broadband network provider a competing bandwidth-intensive service offering, could bring a complaint that she has been denied access to an application of her choosing. But, unlike the FCC principles, the Internet Consumer Bill of Rights does not include a consumer right to competitive options, and thus would not address anticompetitive behavior or unfair practices on the part of a broadband network provider.

Network Neutrality

Network neutrality has been a buzz-phrase in the on-going debates, though there is not a single, agreed-upon definition of network neutrality. Indeed, there continue to be questions about what constitutes "neutrality" and to which "networks" such neutrality would apply. For most proponents, network neutrality requires all packets to be treated the same way or, at the least, all packets providing a particular application (such as voice or video) to be treated the same way. Some proponents who would allow for prioritization among applications nonetheless would not allow broadband network providers to charge independent applications providers for such prioritization. Network neutrality proposals include provisions relating to consumer access similar to those found in the FCC principles and Internet Bill of Rights, but in addition have provisions relating to nondiscriminatory or neutral access to broadband networks or the internet by independent applications providers. Three such proposals were incorporated in legislation introduced in the 109th Congress — the Network Neutrality Act of 2006 (H.R. 5273), the Internet Non-Discrimination Act of 2006 (S. 2360), and the Internet Freedom Preservation Act (S. 2917). S. 2917 was reintroduced in the 110th Congress as S. 215.

Under H.R. 5273, each broadband network provider would have had the duty to:

- offer, upon reasonable request to any person, a broadband service for use by such person to offer or access unaffiliated content, applications, and services;
- not discriminate in favor of itself in the allocation, use, or quality of broadband services or interconnection with other broadband networks;
- offer a service such that content, applications, or service providers can offer unaffiliated content, applications, or services in a manner that is at least equal in the speed and quality of service that the operator's content, applications, or service is accessed and offered,

and without interference or surcharges on the basis of such content, applications, or services;
- if the broadband network provider prioritizes or offers enhanced quality of service to data of a particular type, prioritize or offer enhanced quality of service to all data of that type (regardless of the origin of such data) without imposing a surcharge or other consideration for such prioritization or quality of service; and
- not install network features, functions, or capabilities that thwart or frustrate compliance with the requirements of objectives of this section.

Under S. 2360, a network operator would have had the duty to:

- not discriminate in favor of itself or any other person, including any affiliate or company with which such operator has a business relationship, in (A) allocating bandwidth; and (B) transmitting content or applications or services to or from a subscriber in the provision of a communications;
- not assess a charge to any application or service provider not on the network of such operator for the delivery of traffic to any subscriber to the network of such operator;
- offer communications such that a subscriber can access, and a content provider can offer, unaffiliated content or applications or services in the same manner that content of the network operator is accessed and offered, without interference or surcharges;
- treat all data traveling over or on communications in a nondiscriminatory way;
- offer just, reasonable, and nondiscriminatory rates, terms, and conditions on the offering or provision of any service by another person using the transmission component of communications; and
- provide nondiscriminatory access and service to each subscriber.

Under S. 2917 (S. 215 in the 110th Congress), each broadband service provider would have the duty to:

- enable any content application, or service made available via the internet to be offered, provided, or posted on a basis that (A) is reasonable and nondiscriminatory, including with respect to quality of service, access, speed, and bandwidth; (B) is at least equivalent to the access, speed, quality of service, and bandwidth that such broadband service provider offers to affiliated content, applications, or services made available via the public Internet into the network of such broadband service provider; and (C) does not impose a charge on the basis of the type of content, applications, or services made available via the internet into the network of such broadband service provider;
- only prioritize content, applications, or services accessed by a user that is made available via the internet within the network of such broadband service provider based on the type of content,

applications, or services and the level of service purchased by the user, without charge for such prioritization; and
- not install or utilize network features, functions, or capabilities that impede or hinder compliance with this section.

These three network neutrality proposals had similarities and differences. S. 2360 appeared to be the most restrictive. It would have prohibited a network provider from prioritizing traffic. Thus, the service router could not be programmed to favor the packets of latency-sensitive applications, such as voice or video service. The proposal also would have prohibited a network provider from charging an independent applications provider for the delivery of traffic. All such charges would have to be imposed directly on end users. It also appeared to prohibit a network provider from reserving bandwidth for its own, or any other provider's, applications.[29] Referring to **Figure 1**, under S. 2360 an independent applications provider could still choose to purchase a direct connection to the service router in the network provider's proprietary IP network, rather than routing its traffic through the internet backbone. But at that service router, all packets would have to be given the exact same priority, whatever the particular type of service that packet was providing, and whether that packet was carrying bits from the network provider's own application, bits from the application of an independent applications provider that had a direct connection to the service router, or bits from the application of an independent service provider that had transmitted those bits through the internet backbone. In addition, neither the links transmitting the packets from the service router to the broadband providers end office/headend nor the last mile connection to the end-user premise could be partitioned in a fashion that would favor the broadband network's applications, for example, by limiting the amount of bandwidth available for independent applications in a way that would not ensure the same quality of service for independent applications and the broadband provider's applications.

H.R. 5273 and S. 2917 (S. 215 in the 110th Congress) appeared to be less restrictive. They would have allowed the network provider to prioritize traffic (under H.R. 5273, prioritization could take the form of offering enhanced quality of service to data of a particular type; under S. 2917 (S. 215 in the 110th Congress), prioritization could be based on the type of content, applications, or services and the level of service purchased by the user), but all traffic for a given application would have to be assigned the same priority and there could be no surcharge imposed for prioritization. Referring to **Figure 1**, an independent applications provider could still choose to purchase a direct connection to the service router in the network provider's proprietary IP network, rather than routing its traffic through the internet backbone. At that service router, prioritization could occur, to reduce the risk of delay in packets for latency-sensitive applications, but all packets with bits for a particular type of service (for example, video service) would have to be given the exact same priority, whether those packets were carrying bits from the network provider's own video service, bits from the video service of an independent applications provider that had a direct connection to the service router, or bits from the video service of an

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[29] That appears to be the implication of the requirement that a network operator shall not discriminate in favor of itself or any other person, including any affiliate or company with which such operator has a business relationship, in allocating bandwidth.

independent applications provider that had transmitted those bits through the internet backbone. Like S. 2360, under H.R. 5273, neither the links transmitting the packets from the service router to the broadband providers end office/headend nor the last mile connection to the end-user premise could be partitioned in a fashion that would favor the broadband network's applications, for example, by limiting the amount of bandwidth available for independent applications in a way that would not ensure the same quality of service for independent applications and the broadband provider's applications. Depending on interpretation of the bill's language, this might or might not be the case under S. 2917 (S. 215 in the 110th Congress).

The current network configurations and service offerings of Verizon, AT&T, and Comcast would not appear to meet the requirements in S. 2360 and H.R. 5273 because they all reserve significant bandwidth for their own video services and do not appear to make an equal amount of bandwidth available for other applications providers. Also, to the extent that these broadband networks incorporate partitioning and prioritization, and charge accordingly, they do not conform with all the network neutrality requirements.

But partitioning and prioritization need not have discriminatory or anticompetitive consequences. For example, the current Fios offering, which brings 100 mbps of bandwidth to a customer premise on a download laser, and offers up to 30 mbps of that bandwidth for downloading any service, appears to make available enough bandwidth for independent applications providers to be able to compete with Verizon's applications in the provision of even bandwidth-intensive applications.

It is not clear how the network neutrality conditions in any of these bills would have addressed a price squeeze. On one hand, the prohibition on surcharges for prioritization or for network access would appear to constrain the ability of a network provider to use charges imposed on independent applications providers to create a price squeeze. On the other hand, there does not appear to be any constraint on the price that end users could be charged for internet access, and if the price of the network provider's applications did not cover the imputed cost of such access plus the other costs of offering the service, the network provider could create an anticompetitive price squeeze.

S. 2917 (S. 215 in the 110th Congress) appeared to have an additional point of departure that might have resulted in virtually no restrictions on broadband providers. The duties of broadband service providers outlined in sections 12(a)(4) and (5) applied to "service made available via the Internet," without further delineation. But there may be differences of opinion about which services are offered via the internet. Consider, for example, the VPN-like services available as part of Verizon's Fios offering, discussed earlier. Those services would be provided by independent applications providers that would purchase the bandwidth from Verizon in order to have an end-to-end connection with the end user; the independent applications provider who purchases that bandwidth would be compensated by charging the end user for the service provided. This end-to-end connection is shown in **Figure 1** by the link that goes directly from the independent applications provider to the service router in the broadband network provider's proprietary IP cloud and then through the broadband last mile to the end user. Arguably, since the traffic transported over this VPN service never touches the public internet, but rather goes from an independent

applications provider directly to Verizon's proprietary IP network over a private line connection, it is not "a service made available via the Internet." With that interpretation, services offered over this VPN path would not be subject to the nondiscrimination provisions relating to prioritization, partitioning, and charges in sections 12(a)(4) and (5).

Perhaps more significantly, as shown in **Figure 1**, the broadband network providers' video services do not use the public internet; they receive satellite, terrestrial, or broadcast feeds into their video server and then route those signals through the service router in their proprietary IP networks and then through their last mile networks to subscribers. The nondiscriminatory bandwidth and prioritization provisions in section 12(a)(4) and (5) therefore might not have applied to the network providers' video services or any other applications that were not delivered through the public internet.

Antitrust and Unfair Methods of Competition Laws

In the 109th Congress, several bills were introduced to have allegations of anticompetitive broadband network access behavior scrutinized through application of existing or modified antitrust and competition laws rather than regulatory rules.

The Internet Freedom and Nondiscrimination Act of 2006 (H.R. 5417), which was to be reported out of the House Judiciary Committee, would have amended the Clayton Act by inserting a new section 28 making it unlawful for any broadband network provider:

- to fail to provide its broadband network services on reasonable and nondiscriminatory terms and conditions such that any person can offer or provide content, applications, or services to or over the network in a manner that is at least equal to the manner in which the provider or its affiliates offer content, applications, and services, free of any surcharge on the basis of the content, application, or service;
- to refuse to interconnect its facilities with the facilities of another provider of broadband network services on reasonable and nondiscriminatory terms and conditions;
- to block, to impair, to discriminate against, or to interfere with the ability of any person to use a broadband network service to access, to use, to send, to receive, or to offer lawful content, applications, or services over the Internet;
- to impose an additional charge to avoid any conduct that is prohibited by this subsection;
- to prohibit a user from attaching or using a device on the provider's network that does not physically damage or materially degrade other users' utilization of the network; or
- to fail to clearly and conspicuously disclose to users, in plain language, accurate information concerning any terms, conditions, or limitations on the broadband network service.

In addition, under H.R. 5417, if a broadband network provider prioritized or offered enhanced quality of service to data of a particular type, it would have been required

to prioritize or offer enhanced quality of service to all data of that type (regardless of the origin or ownership of such data) without imposing a surcharge or other consideration for such prioritization or enhanced quality of service.

Since enforcement of the Clayton Act is solely within the jurisdiction of either the Federal Trade Commission (FTC) or the Antitrust Division of the Department of Justice (DOJ), the general thrust of H.R. 5417 was to implement the network neutrality provisions in H.R. 5273, but to move enforcement responsibility from the FCC to the antitrust agencies, which specialize in competition analysis and, in the case of the FTC, consumer protection analysis. The FTC has indicated that it believes it already possesses sufficient authority to adequately address the competition and consumer protection issues of concern to network neutrality proponents,[30] but "any new legislation should clearly preserve the FTC's existing authority over activities currently within its jurisdiction."[31]

H.R. 5417 also would have had the effect of creating a private right of action by aggrieved applications providers. Although H.R. 5417 contained no explicit language to that effect, section 4(a) of the Clayton Act[32] authorizes treble-damage suits in appropriate district courts by "any person who shall be injured in his business or property by reason of anything forbidden in the antitrust laws...."

The Digital Age Communications Act of 2005 (S. 2113), which was based in large part on a proposal developed as part of the Digital Age Communications Act (DACA) project of the Progress and Freedom Foundation,[33] would have replaced the current regulatory framework with a framework based on the Federal Trade Commission Act (15 U.S.C. 41 et seq.). It would have prohibited unfair methods of competition, and would have given the FCC the authority to enforce the law. Specifically:

- it would have unlawful for any provider of electronic communication service to engage or participate, or attempt to engage or participate, in unfair methods of competition, or unfair or

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[30] Behavior that is unfairly discriminatory or anticompetitive is reachable via sections 1 or 2 of the Sherman Act (15 U.S.C. 1and 2, which prohibit, respectively, contracts or conspiracies in restraint of trade and monopolization), or as a violation of section 5 of the FTC Act (15 U.S.C. 45(a), which proscribes "unfair methods of competition" or "unfair or deceptive acts or practices"). The Sherman Act is enforceable by either the FTC or the DOJ; the FTC Act is enforceable only by the FTC.

[31] "FTC Jurisdiction Over Broadband Internet Access Services," Testimony of FTC Commissioner William E. Kovacic before the Senate Judiciary Committee, Hearing on Reconsidering Our Communications Laws: Ensuring Competition and Innovation, June 14, 2006, available at [http://judiciary.senate.gov/print_testimony.cfm?id=1937&wit_id=5415], viewed on December 13, 2006.

[32] 15 U.S.C. 15(a).

[33] Digital Age Communications Act: Proposal of the Regulatory Framework Working Group of the Digital Age Communications Act Project of the Progress and Freedom Foundation, June 5, 2005, available at [http://www.pff.org/issues-pubs/other/050617 regframework.pdf], viewed on December 13, 2006.

deceptive practices in or affecting electronic communications networks and electronic communications services;
- the FCC would have been allowed to define with specificity, by rule, the acts or practices that would constitute unfair methods of competition or unfair or deceptive acts or practices;
- promulgated rules could have included such requirements as the FCC determined necessary to prevent any methods, acts, or practices prohibited by this section;
- the FCC would have had no authority to issue rules that declared unlawful an act or practice on the grounds that such act or practice was an unfair method of competition or unfair or deceptive act or practice, except that the FCC could have declared an act or practice unlawful if the FCC determines, based on a showing of clear and convincing evidence presented in a rulemaking proceeding that (i) marketplace competition was not sufficient to adequately protect consumer welfare, and (ii) such act or practice (I) caused or was likely to cause substantial injury to consumers, and (II) was not avoidable by consumers themselves and not outweighed by countervailing benefits to consumers or to competition;
- the FCC would have had authority to hear complaints from any party injured by a violation of the prohibitions established and to award damages to such injured party if the FCC determined that a violation had occurred.

Although these provisions lacked specificity as to what types of behavior would have represented unfair methods of competition or unfair or deceptive practices, and in particular did not provide any specificity about discriminatory practices, they did potentially provide a procedure for independent applications providers to file complaints about the terms, conditions, and prices under which they had access to a broadband provider's network. The effectiveness of such a complaint procedure, however, would depend on the standard used in determining whether a particular act or practice represented a legal violation.

On May 10, 2006, in response to questions after his keynote speech at an American Enterprise Institute conference on Key Issues in Telecommunications Policy, Alfred Kahn, who was a DACA Project Advisory Committee Member, commented on the DACA proposal incorporated in S. 2113.[34] He stated that he agreed with the overall framework, but that he believed the proposed standard for finding a violation was set too high. He suggested the standard for a finding of unfair methods of competition or unfair competitive practices should be based solely on demonstrated harm to consumers. He voiced concern with the methodology frequently employed in antitrust analysis today that assumes that no intervention is needed if it can be shown that each $1 loss in consumer surplus is matched by a $1 gain in producer surplus. He argued that unfair practices laws are intended to protect consumers, even if there might be some negative impact on producer efficiency. He therefore would want unfair methods of competition to be "close to *per se* illegal."

[34] Alfred Kahn, keynote address and response to questions, American Enterprise Institute conference on Key Issues in Telecommunications Policy, Washington, DC, May 10, 2006.