

The Evolving Broadband Infrastructure: Expansion, Applications, and Regulation

Patricia Moloney Figliola

Specialist in Internet and Telecommunications Policy

Angele A. Gilroy

Specialist in Telecommunications Policy

Lennard G. Kruger

Specialist in Science and Technology Policy

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Summary

Over the past decade, the telecommunications sector has undergone a vast transformation fueled by rapid technological growth and subsequent evolution of the marketplace. Much of the U.S. policy debate over the evolving telecommunications infrastructure is framed within the context of a "national broadband policy." The way a national broadband policy is defined, and the particular elements that might constitute that policy, determine how and whether various stakeholders might support or oppose a national broadband initiative. The issue for policymakers is how to craft a comprehensive broadband strategy that not only addresses broadband availability and adoption problems, but also addresses the long term implications of next-generation networks on consumer use of the Internet and the implications for a regulatory framework that must keep pace with evolving telecommunications technology.

Consumers have been integrating communications technologies into their lives at unprecedented rates. Trends include increased use of smartphones, increased subscribership on social networking sites such as Facebook and MySpace, increased expectations of cross-platform accessibility, and development of "cloud computing" applications. Each of these trends taken alone likely would have had a significant impact on consumer behavior, but taken together they create a heretofore unseen demand for real-time access to information and an ability to share that information from wherever the consumer happens to be. Policy choices related to consumer use of the Internet, such as user authentication, privacy, digital rights management, filtering of unwanted information, wireless Internet standards, instant messaging, the deployment of IPv6 ("Internet protocol version 6"), and how to link the telephone network to the Internet will all have a profound impact on how broadband and next generation networks evolve.

The challenge facing today's policymakers is to develop a regulatory environment that not only addresses these more recent trends, but that also contains the flexibility to accommodate future and possibly unanticipated changes in technology, applications, and consumer demands. The growth of broadband networks and the proliferation of applications and devices has placed increasing pressure on policy makers to formulate a framework to address a broadband-based world. Many of these developments were not anticipated when the 1996 Telecommunications Act (P.L. 104-104) was passed and have led to the need to update the regulatory assumptions and subsequent regulatory framework upon which the act was based.

Technological changes such as the advancement of Internet technology and the melding of data, voice, and video have resulted in additional trends which must be considered. These trends include the transition from a circuit switched to a packet switched network, thereby enabling the integration of voice, video, and data; the transition from fixed to mobile service; and the transition from one-way to interactive service. Additionally, as broadband becomes an integral component of society, regulators have been called upon to consider how these trends may affect social goals that may or may not have been associated with traditional telephony. Social objectives such as the advancement of universal service goals, timely and accurate emergency services, disability access, and consumer protection that are part of traditional telephony regulatory policies are migrating to the broadband policy environment.

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Introduction

Over the past decade, the telecommunications sector has undergone a vast transformation fueled by rapid technological growth and subsequent evolution of the marketplace. A wide range of new services have become available, offered by a growing list of traditional as well as nontraditional providers. One of the results of this transformation is that the nation's expectations for communications services have also grown.

For nearly a century, access to the public switched network through a single wireline connection, enabling voice service, was the standard of communications. Today the desire for simple voice connectivity has been replaced by the demand, on the part of consumers, business, and government, for access to a vast array of multifaceted fixed and mobile services. Consumers are also demanding greater flexibility and may choose to gain access to identical content over a variety of technologies, whether it be a computer, a television, or a mobile telephone. The trend towards sharing information, such as music, movies, or photographs, is also growing, making it necessary to ensure that network upload speeds match download capabilities. These advances require that networks transition into converged next-generation wireline and wireless broadband networks capable of meeting these demands.

Much of the policy debate over the evolving telecommunications infrastructure is framed within the context of a "national broadband policy." The issue for policymakers is how to craft a comprehensive broadband strategy that not only addresses broadband availability and adoption problems, but also addresses the long term impacts of next-generation networks on consumer use of the Internet and a regulatory framework that must keep pace with evolving telecommunications technology.

Evolution of Broadband in the United States

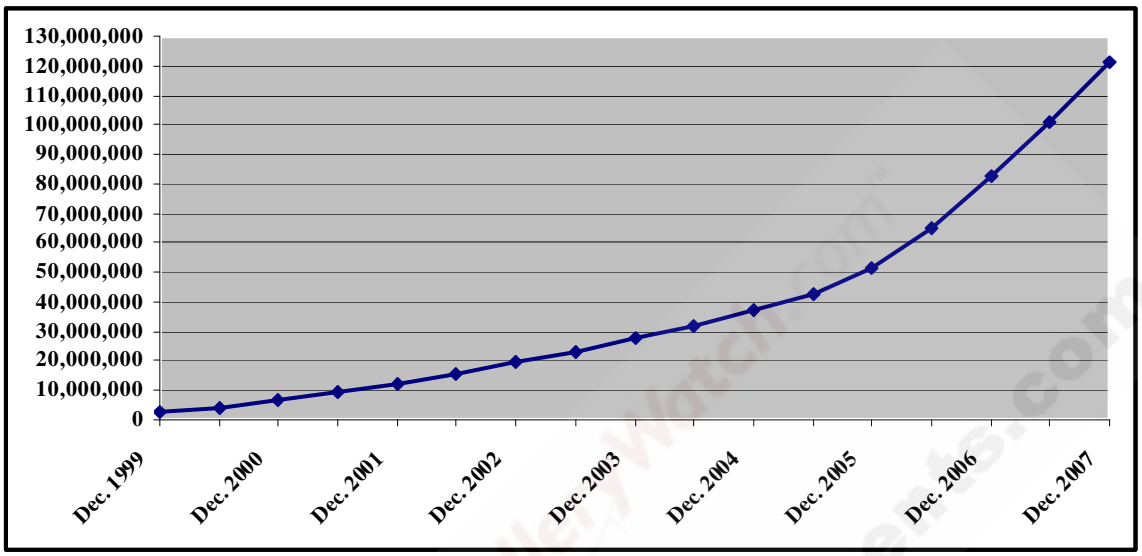
Prior to the late 1990s, American homes accessed the Internet at maximum speeds of 56 kilobits per second by dialing up an Internet Service Provider (such as AOL) over the same copper telephone line used for traditional voice service. A relatively small number of businesses and institutions used broadband or high speed connections through the installation of special "dedicated lines" typically provided by their local telephone company. Starting in the late 1990s, cable television companies began offering cable modem broadband service to homes and businesses. This was accompanied by telephone companies beginning to offer DSL (digital subscriber line) service (broadband over existing copper telephone wireline). **Figure 1** shows the Federal Communication Commission's (FCC's) tracking of high-speed lines[1] in the United States between December 1999 (the initial broadband deployment data point reported) and December 2007 (the most recent data available). Growth has been steep, rising from 2.8 million high speed lines reported as of December 1999 to 121.2 million lines as of December 31, 2007. Of the 121.2 million high speed lines reported by the FCC, 74.0 million serve residential users.[2] Since the

[1] Defined as a line providing a customer over 200 kbps in at least one direction.

[2] FCC, *High-Speed Services for Internet Access: Status as of December 31, 2007,* January 2009. Available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-287962A1.pdf.

initial deployment of residential broadband in the United States, the primary residential broadband technologies deployed continue to be cable modem and DSL.

Figure 1. Total High-Speed Lines in the United States



Source: FCC.

December 2008 survey data from the Pew Internet and American Life Project found that 57% of Americans have broadband at home.[3] It is estimated that less than 10% of U.S. households have no access to any broadband provider whatsoever (not including satellite).[4] While the broadband *adoption* or *penetration* rate stands at close to 60% of U.S. households, broadband *availability* is much higher, at more than 90% of households. Thus, approximately 30% of households have access to some type of terrestrial (non-satellite) broadband service, but do not choose to subscribe. According to the FCC, possible reasons for the gap between broadband availability and subscribership include the lack of computers in some homes, price of broadband service, lack of content, and the availability of broadband at work.[5] According to Pew, non-broadband users tend to be older, have lower incomes, have trouble using technology, and may not see the relevance of using the Internet to their lives. Between 2007 and 2008, low income Americans (under $20,000 annual income) and African Americans showed no significant growth in home broadband adoption after strong growth in previous years.[6] Pew also found that about one-third of adults without broadband cite price and availability as the reasons why they don't have broadband in their homes, while two-thirds cite reasons such as usability and relevance.[7]

[3] Horrigan, John, Pew Internet & American Life Project, "Barriers to Broadband Adoption – The User Perspective," December 19, 2008, available at http://otrans.3cdn.net/fe2b6b302960dbe0d7_bqm6ib242.pdf.

[4] S. Derek Turner, Free Press, *Down Payment on Our Digital Future*, December 2008, p. 8.

[5] Federal Communications Commission, *Fourth Report to Congress*, "Availability of Advanced Telecommunications Capability in the United States," GN Docket No. 04-54, FCC 04-208, September 9, 2004, p. 38. Available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-208A1.pdf.

[6] "Barriers to Broadband Adoption – The User Perspective," p. 1.

[7] Horrigan, John, Pew Internet & American Life Project, "Obama's Online Opportunities II: If You Build It Will They Log On?" January 21, 2009, available at http://www.pewinternet.org/pdfs/PIP_Broadband%20Barriers.pdf.

Broadband speeds (and prices) are important factors that can determine which technologies are deployed, which applications will be enabled, and how widespread deployment will be. The FCC's fifth and latest "706 report," which is prepared pursuant to section 706 of the Telecommunications Act of 1996 to periodically determine whether broadband is being deployed in a reasonable and timely fashion, found that, "In the future, we anticipate ever-greater demand for services and applications requiring greater bandwidth over an ever-expanding area."[8] **Table 1** shows a compilation by the California Broadband Task Force showing different broadband speed ranges and the applications they make possible. **Table 2** shows advertised speed ranges offered by different broadband technologies that are currently commercially available.

As part of any discussion over national broadband policy, a distinction is often made by industry and policymakers between "current generation" and "next generation" broadband (commonly referred to as next generation networks or NGN). "Current generation" typically refers to currently deployed cable, DSL, and many wireless systems, while "next generation" refers to dramatically faster download and upload speeds offered by fiber technologies and also potentially by future generations of cable, DSL, and wireless technologies.

Table 1. Broadband Speeds and Applications

Upstream and Downstream Speeds	Applications
500 kbps - 1 Mbps	voice over IP, SMS, basic email, web browsing (simple sites), streaming music (caching), low quality video (highly compressed)
1 Mbps - 5 Mbps	web browsing (complex sites), email (larger size attachments), remote surveillance, IPTV-SD (1-3 channels), file sharing (small/medium), telecommuting (ordinary), digital broadcast video (1 channel), streaming music
5 Mbps - 10 Mbps	telecommuting (converged services), file sharing (large), IPTV-SD (multiple channels), switched digital video, video on demand SD, broadcast SD video, video streaming (2-3 channels), HD video downloading, low definition telepresence, gaming, medical file sharing (basic), remote diagnosis, (basic), remote education, building control & management
10 Mbps - 100 Mbps	telemedicine, educational services, broadcast video SD and some HD, IPTV-HD, gaming (complex), telecommuting (high quality video), high quality telepresence, HD surveillance, smart/intelligent building control
100 Mbps - 1 Gbps	HD telemedicine, multiple educational services, broadcast video full HD, full IPTV channel support, video on demand HD, gaming (immersion), remote server services for telecommuting
1 Gbps - 10 Gbps	research applications, telepresence using uncompressed HD video streams, live event digital cinema streaming, telemedicine remote control of scientific/medical instruments, interactive remote visualization and virtual reality, movement of terabyte datasets, remote supercomputing

Source: California Broadband Task Force, January 2008. Available at http://www.calink.ca.gov/pdf/CBTF_FINAL_Report.pdf.

[8] FCC, Fifth Report, p. 36.

Table 2. Advertised Broadband Speeds by Technology

Technology	Advertised Broadband Product Speed Ranges (downstream rate)
Mobile Wireless	200 kbps - 1.4 Mbps
DSL	384 kbps - 6 Mbps
Satellite	512 kbps - 2 Mbps
Fixed Wireless	768 kbps - 3 Mbps
Cable	768 kbps - 15 Mbps
Fiber-to-the-home	1 Mbps - 50 Mbps

Source: California Broadband Task Force, January 2008.

In general, more sophisticated (and potentially valuable) applications are available with faster download and upload connection speeds. The most recent FCC broadband status report to Congress characterized future advances in broadband networks as follows:

> At the same time that broadband demand increases, network technology continues to evolve and improve. Previously distinct networks are now converging and overlapping to form competing broadband networks that perform all of the network applications once only possible by purchasing services from multiple service providers. Competition between broadband platform providers attempting to keep up with their competitors will drive higher speed technologies and service offerings to the marketplace. Coverage too will continue to become more ubiquitous as a diversity of technologies mature.[9]

Subsequently, as increasingly sophisticated and innovative applications become enabled, the impacts on consumers, the economy, and society become potentially more profound and far-reaching.

The Consumer-Oriented Internet

Businesses and government have always had a stake in ensuring they have reliable communications available for their employees and the Internet has helped extend the reach of those networks. However, having been given a glimpse at the services available to them at work, consumers began to demand similar services for personal use. Just how are consumers using the Internet today? How did the Internet evolve from a government experiment to share computer resources to a consumer "destination"?[10]

Access to e-mail, text messages, and social networks have become at least as imperative for a significant number of users as the original intent of the cell phone – voice calls. In the days leading up to and following the 2008 presidential election, the press made much of then-Senator Barack Obama's reliance on his Blackberry. Commentators wondered aloud whether he would become the first "connected President." President Obama initially said that he would reluctantly relinquish his Blackberry upon assuming office due to security concerns, but eventually reached a

[9] FCC, Fifth Report, p. 36.

[10] The Internet Society provides "A Brief History of the Internet," online at http://www.isoc.org/internet/history/brief.shtml.

compromise and will have a new secure Blackberry for his correspondence. President Obama's decision illustrates the extent to which Americans have come to rely on "24-7" access to their information.

A Day in the Life ... [11]

When her Blackberry[12] alarm goes off, "Tina" – a typical "innovative adopter"[13] of technology products – grabs her Blackberry off the nightstand and, before she's even out of bed, glances at the screen to see what types of messages may have come in during the night: e-mail, "text,"[14] or Facebook. After scrolling through her e-mails to see if any urgent work messages have come in (her work voicemail system also sends her an e-mail with the content of any messages), she checks her calendar for the day, which was e-mailed to her overnight, and her friends' most recent Facebook "status updates." Just to make sure she's ready for the day, she checks the weather forecast before heading to the kitchen to get her coffee.

Once at work, Tina logs onto her computer and brings up her work e-mail and her Web browser, opening up three windows automatically – her workplace homepage, the *Washington Post*, and her Gmail. On some days, she may also bring up a Web-based unified "chat" program, such as IMO,[15] and her Facebook page.

Flexible work arrangements at her office – which became possible because of greater technology adoption by employees – allow Tina to do some of her work from home. This day, Tina needs to be home for a technician to install a new speaker system throughout her house. Before leaving the office for the day, therefore, Tina needs to decide which project or projects she will "take home" with her. Previously, Tina may have taken home her files on a floppy disk or a flash drive, or perhaps e-mailed her files to herself. Today, however, Tina can work across platforms and locations using "cloud computing" applications, such as Google Docs. After she uploads her documents, she heads home and works for about another two hours on her desktop computer in her home office. When her work is done, she simply saves her work to her Google Docs account and can be assured she will be able to access it again in the morning from the office.

[11] Examples are illustrative and are not intended as an endorsement of any particular technology, service, or device.

[12] A Blackberry or other "smartphone," such as an iPhone.

[13] Everett Rogers, "Innovativeness and Adopter Categories," in *Diffusion of Innovations*, 3rd ed. (New York: The Free Press, 1962), pp. 247-251.

[14] Text messages are technically called "Short Message Service," or SMS, messages.

[15] See http://imo.im.

Once the work day is over, Tina settles onto her couch for a full evening of mostly online activities: "socializing" with her friends via her ultra-compact "Netbook."[16] Most of Tina's online social communication takes place via her Facebook account, which allows her to chat online with her friends, play Scrabble and other games, and comment on her friends' activities and postings—in fact, communicating with her friends has become a new and richer form of entertainment.

The Internet Everywhere: Who

62% of all Americans are part of a wireless, mobile network

58% of Americans adults have used a cell phone or smart phone to do at least one of ten mobile non-voice activities, such as texting, e-mailing, taking a picture, or looking for a map or directions.

41% of American adults have logged onto the Internet "on the go," that is, away from home or work either with a wireless laptop connection or handheld device.

15% of American teens own a smartphone with Internet access.

Source: Pew Internet & American Life, "Mobile Access to Data and Information," March 2008 (Data collected December 2007).

Tina will likely also watch TV (or other video entertainment) and perform other online activities, such as

- checking her stock portfolio and making online trades;[17]
- checking her bank or credit card account to pay bills;[18]
- shopping for clothes, books, or other items;[19]
- ordering her groceries; and
- searching for health information regarding a medical procedure she has been discussing with her doctor.[20]

This particular night, Tina also accesses two e-government sites, the first to pay a parking ticket and another to find information on a city board vacancy she is interesting in filling. Additionally, she will spend some time doing research for a distance learning class she is taking from a university in another state.

[16] A "netbook" is a very small, light-weight, low-cost, energy-efficient laptop, primarily used for Internet-based services such as web browsing, e-mailing, and instant messaging.

[17] A survey by the Pew Internet and American Life Project found that 11% of online users have bought or sold stocks online, with that figure jumping to 21% who earn over $100,000 a year. Online Shopping, Pew Internet and American Life Project, February 2008, p. 2, online at http://www.pewinternet.org/pdfs/PIP_Online%20Shopping.pdf.

[18] A survey by the Pew Internet and American Life Project found that 53% of online users have done banking online, or 39% of all adult Americans. When the Pew Internet Project first asked about banking online in 2000, 18% of internet users (or 9% of all Americans) had at some point done banking online. By 2002, that number had risen to 30% of online users (or 18% of Americans) and when asked again in February 2005, 41% of Internet users had done some banking online (or 27% of all Americans). Online Shopping, Pew Internet and American Life Project, February 2008, p. 6, online at http://www.pewinternet.org/pdfs/PIP_Online%20Shopping.pdf.

[19] A survey by the Pew Internet and American Life Project reported that 66% of online users said they had bought something online. Online Shopping, Pew Internet and American Life Project, February 2008, p. 2, online at http://www.pewinternet.org/pdfs/PIP_Online%20Shopping.pdf.

[20] A survey by the Pew Internet and American Life Project found that between 75% and 80% of Internet users have looked online for health information. The Engaged E-patient Population, The Pew Internet and American Life Project, p. 4, online at http://www.pewinternet.org/pdfs/PIP_Health_Aug08.pdf.

The Internet Everywhere: How

Computers: Desktop, Laptop/Notebook, Subnotebook/"Netbook"

Smartphones: Blackberry (Various devices), Palm (Various devices), Apple iPhone, Samsung (Various devices)

In deciding what to watch on TV, Tina can choose from her regular cable line-up, her recorded programs on her TiVo, or an instantly downloadable movie from her Netflix account to her television over her Roku box. While Tina watches her program and "chats" online, she receives an incoming video call from her mother, who is coming to visit. She pauses her program and takes the call. Afterwards, she logs onto two different travel sites to search for the best flight deal for her mother's visit and purchases a ticket.[21]

Discussion

As illustrated in the above examples, always-on[22] broadband enables disintermediation between the consumer and the product sought, eliminating the "middle man" that was previously required to obtain a good or service: a stock broker, a bank, a medical professional (for information), a travel agent, a store, or a university, to name a few. Instead, the consumer can search for and obtain information, services, and products (and, when appropriate, compare them) for oneself.

For example, with respect to "E-Health," the Pew Internet Project estimated in the Fall of 2008 that between 75% and 80% of Internet users have looked online for health information. In fact, home broadband users are twice as likely as home dial-up users to do health research on a typical day – 12% vs. 6%.[23] Further, 75% of consumers with a chronic condition say their last health search affected a decision about how to treat an illness or condition, compared with 55% of patients without a chronic condition. Newly diagnosed individuals and those who have experienced a health crisis in the past year are also particularly likely to use information found online: 59% say the information they found online led them to ask a doctor new questions or get a second opinion, compared with 48% of those who had not had a recent diagnosis or health crisis. Some 57% of recently diagnosed e-patients say they felt eager to share their new health or medical knowledge with others, compared with 45% of other patients.[24]

In addition to always-on broadband at home, many consumers also rely on their mobile devices to maintain contact with friends and colleagues and to search for information while away from their homes or offices. For example, if it had been a Friday night instead of a weeknight, Tina may have headed straight out from work to meet friends. In that case, she might have posted her plans on Facebook via her status message so that her friends would know where to find her. As the night wore on and the places she went became too loud for a telephone conversation, she would be able to stay in touch with people via e-mail, text or Facebook messaging, or the unified chat program on her Blackberry. Additionally, the global positioning capabilities of her phone would ensure she was able to find the places she wanted to go.

[21] In Fall 2007, about half of all Americans had purchased airline or other travel tickets online. Online Shopping, Pew Internet and American Life Project, February 2008, p. 6, at http://www.pewinternet.org/pdfs/PIP_Online%20Shopping.pdf.

[22] In other words, a non-dial-up connection that is never turned off.

[23] The Engaged E-patient Population, The Pew Internet and American Life Project, p. 4, at http://www.pewinternet.org/pdfs/PIP_Health_Aug08.pdf.

[24] The Engaged E-patient Population, The Pew Internet and American Life Project, p. 4, at http://www.pewinternet.org/pdfs/PIP_Health_Aug08.pdf.

For early adopters of technology, as well as an increasing number of Internet users overall, these scenarios are not out of the ordinary. The Internet is no longer used only to find information and communicate with coworkers, it is now also a social, educational, and entertainment medium: a means to socialize with friends (some likely "known" only online), research issues, watch television programming and movies, play games, and maybe even get a little work done on off hours that would not have been done before.

The Evolution of the Consumer-Oriented Internet

When early-adopting consumers downloaded Mosaic, the first widely-available web browser in December 1993,[25] it gave them access to "the Internet:" the World Wide Web (Web). Previously, the Internet had been the domain of a small cadre of defense and university researchers. The Web, however, provided a graphical, "what-you-see-is-what-you-get" (WYSIWYG) experience to information previously available only as plain text, as well as the ability to refer a reader to another page via a "hyperlink" that the reader would "click" on with her computer mouse. Browsers also provided a more user-friendly interface to File Transfer Protocol ("FTP"), Gopher, and similar information sources. These early-adopters could not have foreseen how much the Web would transform the way they worked, shopped, searched for information on current events, and conducted other day-to-day activities – in short, how the Web would change their lives.

In the early days of the Web, most Web and e-mail use took place at work, where Internet connections were provided via dedicated high-speed circuits. Most people did not have any Internet access at home; those who did had dial-in access to a corporate network, usually to access e-mail. Accessing the Web was excruciatingly slow via dial-up and there wasn't that much content of interest on the Web. Further, there was not much information on the Web that consumers would be interested in accessing at home: the earliest information available on the Web was not aimed to appeal to a broad audience and tended towards national, local, and technology news. In fact, the Web address "http://www.news.com" is not for a general news website, but for CNET News, a still-popular technology news site.

During its early years, the Web was without exception a "one-way street" as far as information was concerned: A user would access the Web and download the information he was seeking. Later, many Web sites began requiring users to set up accounts to identify themselves and log in when using the site, but no one would classify such a feature as "interactivity" as we now know it.

In 2002, the FCC removed a regulatory barrier that had limited modem speeds to 53.3 kilobits per second, which prompted equipment manufacturers and Internet service providers to begin offering higher speed dial-up access. Soon after, equipment manufacturers began selling to the growing number of home users of the Internet and Web. Also during this time, telephone and cable companies were increasing the number of subscribers to their digital subscriber line (DSL) and cable modem services, respectively.

The Web slowly grew more interactive as more consumers gained access to the Internet at work as well as at home:

[25] Depending on the operating system (OS) used, earlier releases were compatible with OSs not commonly used by consumers.

- personal Web sites grew in popularity;
- news sources added interactive components to their sites, such as chats with news makers and journalists;
- online shopping options increased;
- individuals began writing and keeping their own Web logs – or "blogs"; and
- photo-sharing sites increased their subscribers.

One driver of home adoption of high-speed Internet service was that consumers became accustomed to faster speeds while at work and were less willing to tolerate slower dial-up speeds at home; the number of home broadband subscribers surpassed the number of dial-up subscribers in early 2005.

The Internet Everywhere: What, Why, and Where[26]

What and Why: **News** sites to stay abreast of current news while on the go.
Where: All major news organizations.

What and Why: **Social networking** to connect with friends, family, and colleagues.
Where: MySpace, Facebook, Bebo, LinkedIn.

What and Why: **Chat** applications and online services to communicate with others in real time.
Where: AOL's AIM, MSN's WindowsLive, IMO, Google Chat, and Yahoo's Y!.

What and Why: **Music** services to download music and, in some cases, share it with others.
Where: iTunes, Rhapsody, Pandora.

What and Why: **Video** websites to share videos and/or legally access copyrighted programming.
Where: YouTube, Hulu.

What and Why: **Photo sharing** sites to share photos and order prints.
Where: Kodakgallery (previously Ofoto), Snapfish, Photobucket.

What and Why: **Blog** sites to share one's thoughts on matters big and small.
Where: Blogger (now owned by Google), Blogspot.

What and Why: **Personal websites** to share personal, professional and educational information with the public.
Where: Geocities, Tripod.

What and Why: **Shopping** sites to compare prices and make purchases without having to visit a "brick and mortar" store.
Where: eBay, Amazon, most major retailers

What and Why: **Cloud computing**, which allows users to store, and in some cases edit, documents and other files regardless of location (e.g., save a document online at work, then open it up and edit it at home).
Where: Google Apps, Drop.io, Symantec's goEverywhere, Amazon's Simple Storage Service and CloudFront.

At the same time that home-based Internet access was becoming faster and more a part of consumers' daily lives, wireless service providers were also beginning to deploy increased speeds for Internet access, which also increased consumer demand for Internet-ready wireless devices. Between December 2004 and June 2008, for example, use of "smartphones" grew from 2.9 million users to 20.3 million users.[27] Also, many non-smartphones also offer some degree of access to the Internet, whether it be e-mail or limited Web access. These devices allow users to access much of the same information they access on their desktop or laptop computers. This

[26] These examples are illustrative and not intended to be all encompassing.

[27] Proprietary data provided by CTIA – The Wireless Association.

cross-platform accessibility has led to growing expectations by consumers that they should be able to seamlessly access information through multiple devices.

The Consumer-Oriented Internet: The Past as Prelude

Between 2005 and 2007, the synergies between advanced services and technologies drove increased demand for and availability of advanced services and technologies. By 2008, consumers had begun integrating communications technologies into their lives at unprecedented rates. Several trends gained momentum nearly simultaneously during 2008:

Fast Facts

Every day people post more than 65,000 videos on YouTube.

In 2006, MySpace surpassed 100 million profiles.

Since 1999, the number of blogs has grown from 50 to 50 million.

More than 50 percent of blogs are authored by children younger than 19.

Source: Daniel J. Solove, "The End of Privacy?," *Scientific American*, September 2008, pp. 101-106.

- increased use of smartphones by consumers (the domain previously used primarily by business users);
- increased membership on social networking sites such as Facebook and MySpace;
- increased expectations of cross-platform accessibility;[28] and
- development of "cloud computing" applications, in which computing and file storage functions are moved off the user's computer and instead provided over the Web as a service.

Separately, each of these trends may have had a significant impact on consumer behavior, but taken together they created a previously unseen expectation for real-time access to information and an ability to share that information from virtually anywhere.

In the past, Web use was primarily one way, with users limited to accessing information (i.e., "downstream" to the user). Today, the consumer has become, in many cases, a producer as well as a consumer of content and can operate as his or her own information hub. This emerging "state" of the Internet is often referred to as "Web 2.0."

The Internet is on the cusp of a new stage, much like it was in 1993 when the Mosaic browser became popular. Now, however, there are many more decisions to be made by industry and policymakers about technology and, to some extent, service development. Choices made today and in the near future regarding user authentication, privacy, digital rights management, filtering of unwanted information, wireless Internet standards, instant messaging, the deployment of IPv6 ("Internet Protocol version 6"), and how to link the telephone network to the Internet will all have a significant impact on the "future Internet" we see in coming years.[29]

[28] Meaning, consumers increasingly expect to be able to access their data from any device they use, whether it be a mobile device, their desktop home or work computer, or perhaps a laptop or netbook.

[29] Michael R. Nelson, Ph.D., "The Grid, the Cloud, and the Next Phase of the Internet," Presentation at Google Cloud (continued...)

To expand on just one of those elements, for example, once it is fully implemented, IPv6 will allow a virtually unlimited number of devices to be connected to the Internet, each with a unique and permanent IP address.[30] Currently, many devices share what amounts to a pool of addresses, making true end-to-end connectivity impossible.[31] Today, consumers can remotely do such tasks as control their TiVo through their Blackberry or their computer at any time; with IPv6, larger concepts of the "smart home" can be realized. For example, consumers will be able to better manage their energy consumption by having remote access to their heating and air conditioning systems, their light fixtures, and other electric appliances.

As with technological leaps that have come before, the evolution into the next stage of connectedness may necessitate that policymakers assess new directions for regulation that will encourage innovation while still protecting consumers. An appropriate regulatory environment will provide the crucial third element in the "deployment-applications-regulation" triad that will ensure American consumers will have access to the technologies and applications they desire.

National Broadband Policy and the Evolving Telecommunications Infrastructure

As broadband technologies and applications evolve, the policy debate in Congress is likely to hinge on how a national broadband policy may be characterized and structured. Particularly, Congress is likely to address the problems of how access to fast and affordable broadband across all sectors of society may be encouraged, how new telecommunications infrastructures should (or shouldn't) be regulated, and how certain societal impacts of new applications that are enabled and increasingly pervasive may have to be regulated or managed.

What is a "National Broadband Policy"?

A variety of stakeholders have called for a "national broadband policy" to help provide ubiquitous broadband coverage throughout the United States. Many argue that a national broadband policy is necessary to ensure the future prosperity of the United States, and in particular, that economically disadvantaged areas of the United States can maintain or recapture economic viability. Although most agree that a national broadband policy or strategy may be necessary and that a goal of "universal broadband" is worthy, stakeholders diverge when the debate focuses on specific policies and measures the federal government should take to reach those goals. Because broadband in the United States is largely deployed by the private sector,[32] any discussion of a

(...continued)

Computing Seminar, Washington, DC, September 12, 2008.

[30] IPv6 supports 2^{128} (about 3.4×10^{38}) addresses. Additional information about IPv6 is available online at http://www.isoc.org/briefings/001.

[31] For a more technical explanation of this process, see "How Stuff Works: Network Address Translation," online at http://computer.howstuffworks.com/nat.htm.

[32] According to the Federal Communications Commission (FCC), telecommunications companies expect to make $50 billion in capital expenditures in 2008 and 2009. See Federal Communications Commission, Fifth Report, "In the Matter of Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996," GN Docket No. 07-45, FCC 08-88, adopted March 19, 2008, released June 12, (continued...)

governmental broadband policy will by definition lead to issues of how government intervention in the marketplace may affect that private sector deployment. Support for a "national broadband policy" depends largely on how the phrase is defined and characterized, and the public policies that are adopted to shape and support a national policy.

A working definition of "national broadband policy" or "national broadband strategy" is inherently imprecise.[33] "Broadband" can encompass a wide variety of industries, technologies, applications, and individual telecommunications policy debates. **Table 3** shows various broadband technologies (both deployed and potential) and general types of applications, as well as the many specific and discrete policy issues that could arguably be categorized under a "national broadband policy." Specific broadband technologies and applications (which in turn can be tied to specific industries and interest groups) can lead to specific policy issues, sometimes unique to that particular technology or application. For example, deployment of wireless broadband technologies can be dependent on how spectrum policies and issues are resolved. Deployment of fiber (for example Verizon's FIOS and AT&T's U-verse) are affected by regulatory issues such as cable franchising and unbundling. Entertainment applications can be affected by how intellectual property issues are managed. E-commerce applications can thrive or be impeded depending on how privacy and security concerns are addressed.

On the other hand, there are issues and policies that are more "technology neutral" and can affect all broadband technologies, industries, and applications. These could include financial assistance policies (such as tax incentives, loans and grants, expansion of universal service), data mapping (determining where broadband is deployed at a granular level), and community broadband – all of which are intended to enhance broadband deployment generally.

Essentially, one can frame a national broadband policy in response to two separate public policy challenges. First, what are the policies necessary to ensure that broadband is deployed to all Americans in a reasonable and timely fashion, as is called for in section 706 of the Telecommunications Act of 1996? A second – and much broader question – is how the future of broadband will transform the economy and society, and whether and to what extent those transformations should be managed by policymakers.

Table 3. Selected Ingredients of a National Broadband Policy

Technologies	
• cable modem	• fixed wireless
• next gen cable (DOCSIS 3.0)	• mobile wireless
• DSL (copper telephone line)	• wifi
• fiber to the home	• satellite
• fiber to the curb	• broadband over powerline (BPL)

(...continued)

2008, p. 37. Available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-88A1.pdf.

[33] In fact, "broadband" itself has a definition that has evolved as technologies and applications evolved. For example, in earlier days of broadband deployment, "broadband" was seen as synonymous with "high-speed Internet access," which implied access by a computer via a web browser. However today, broadband also includes voice and video directly delivered to telephones and televisions by providers through Internet protocol.

Applications	
• voice over the Internet protocol (volP)	• e-commerce
• telehealth	• social networking
• distance learning	• teleconferencing
• e-government	• telework
• entertainment (video, music, gaming)	• surveillance
• smart electric grids	• public safety communications
Policies/Issues	
deregulation; cable franchising; federal broadband coordination/broadband "czar"; spectrum and wireless policy; Universal Service Fund reform; financial assistance (grants, loans, tax incentives); data mapping and collection; rights of way;	community broadband; intercarrier compensation reform; net neutrality/network management; content issues (privacy, copyright, decency); demand-side issues (training and education, computers for low income families); R&D; Internet2; others

Source: Compiled by CRS.

The Policy Debate in Context

As discussed above, the way a "national broadband policy" is defined, and the particular elements that might constitute that policy, determine how and whether various stakeholders might support or oppose a national broadband initiative. However, in the ongoing broadband debate, there are general areas of agreement that are usually cited, as well as areas of controversy where policymakers and stakeholders diverge.

Areas of General Agreement

There are three basic areas on which most observers seem to agree in any discussion of a national broadband policy. First, broadband is generally viewed as vital public infrastructure, increasingly significant to the nation's (as well as regional, state, and local) economic growth and vitality. The most recent FCC "706 report" acknowledges the link between broadband and economic development:

> local communities report that a key to their future is broadband. In order to attract business and residents, they must be able to provide the necessities, and this increasingly includes broadband. The future of a community's economy, employment opportunities, telecommuting, and opportunities for individuals with disabilities are related directly to the future of broadband in that community.[34]

With broadband initially being deployed in the United States about ten years ago, quantitative data on its impact has just recently begun to be collected and evaluated. A February 2006 study by the Massachusetts Institute of Technology for the Department of Commerce's Economic Development Administration marked the first attempt to measure the impact of broadband on economic growth. The study found that "between 1998 and 2002, communities in which mass-

[34] FCC, Fifth Report, p. 74.

market broadband was available by December 1999 experienced more rapid growth in employment, total number of businesses, and businesses in IT-intensive sectors, relative to comparable communities without broadband at that time."[35] Subsequently, a June 2007 report from the Brookings Institution found that for every one percentage point increase in broadband penetration in a state, employment is projected to increase by 0.2 to 0.3% per year. For the entire U.S. private non-farm economy, the study projected an increase of about 300,000 jobs, assuming the economy is not already at full employment.[36]

A second area of agreement is that there exist some areas and populations of the U.S. which are unserved or markedly underserved by broadband providers. A particularly pronounced disparity in broadband service persists between urban/suburban areas and rural areas. Although there are many examples of rural communities with state of the art telecommunications facilities,[37] recent surveys and studies have indicated that, in general, rural areas tend to lag behind urban and suburban areas in broadband deployment.[38] The comparatively lower population density of rural areas is likely the major reason why broadband is less deployed than in more highly populated suburban and urban areas. Particularly for wireline broadband technologies—such as cable modem and DSL—the greater the geographical distances among customers, the larger the cost to serve those customers. Thus, there is often less incentive for companies to invest in broadband in rural areas than, for example, in an urban area where there is more demand and less cost to wire the market area.[39]

Access to affordable broadband service is viewed as particularly important for the economic development of rural areas because it enables individuals and businesses to participate fully in the economy regardless of geographical location. For example, aside from enabling existing businesses to remain in their rural locations, broadband access could attract and grow new businesses drawn by lower costs and what some may consider a more desirable lifestyle. Essentially, broadband potentially allows businesses and individuals in rural America to live locally while competing globally.

Finally, there is agreement that data regarding broadband deployment in the United States is inadequate, and that policymakers have an incomplete picture of where broadband service is available (and at what speeds and prices). States have begun to address this with a number of

[35] Gillett, Sharon E., Massachusetts Institute of Technology, Measuring Broadband's Economic Impact, report prepared for the Economic Development Administration, U.S. Department of Commerce, February 28, 2006, p. 4. Available at http://www.eda.gov/ImageCache/EDAPublic/documents/pdfdocs2006/mitcmubbimpactreport_2epdf/v1/mitcmubbimpactreport.pdf.

[36] Crandall, Robert, William Lehr, and Robert Litan, The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data, June 2007, 20 pp. Available at http://www3.brookings.edu/views/papers/crandall/200706litan.pdf.

[37] See for example: National Exchange Carrier Association (NECA), Trends 2006: Making Progress With Broadband, 2006, 26 p. Available at http://www.neca.org/media/trends_brochure_website.pdf.

[38] For example, 2008 data from the Pew Internet & American Life Project indicate that while broadband adoption is growing in urban, suburban, and rural areas, broadband users make up larger percentages of urban and suburban users than rural users. Pew found that the percentage of all U.S. adults with broadband at home is 60% for suburban areas, 57% for urban areas, and 38% for rural areas. See Horrigan, John B., Pew Internet & American Life Project, Home Broadband Adoption 2008, July 2008, p. 3, available at http://www.pewinternet.org/pdfs/PIP_Broadband_2008.pdf.

[39] The terrain of rural areas can also be a hindrance to broadband deployment because it is more expensive to deploy broadband technologies in a mountainous or heavily forested area. An additional added cost factor for remote areas can be the expense of "backhaul" (e.g., the "middle mile") which refers to the installation of a dedicated line which transmits a signal to and from an Internet backbone which is typically located in or near an urban area.

mapping and data collection efforts. On the federal level, the FCC, in March 2008, adopted a significantly more detailed data collection protocol.[40] Similarly, the 110th Congress enacted S. 1492, the Broadband Data Improvement Act (P.L. 110-385), which requires the FCC to collect demographic information on unserved areas, data comparing broadband service with 75 communities in at least 25 nations abroad, and data on consumer use of broadband. The act also directs the Census Bureau to collect broadband data, the Government Accountability Office to study broadband data metrics and standards, and the Department of Commerce to provide grants supporting state broadband initiatives. Looking forward, as broadband data improves, it is hoped that a more detailed and granular picture will emerge of where and to what extent broadband deployment shortfalls exist and how they might be addressed.

Areas of Controversy

Although most agree that some form of government intervention may be necessary to help provide broadband in chronically unserved areas, stakeholders disagree over the appropriate level and nature of government intervention in the broadband marketplace. The overarching issue is how to strike a balance between providing federal assistance for unserved and underserved areas where the private sector may not be providing acceptable levels of broadband service, while at the same time minimizing any deleterious effects that government intervention in the marketplace may have on competition and private sector investment. Those who favor increased government intervention argue that measures such as setting a formal national goal (with respect to penetration or speed, for example), expanding universal service, or mandating an "open" Internet (net neutrality) are necessary to ensure a competitive broadband economy. Those who favor a more limited government role argue that markets and the private sector can best deploy broadband with a minimum of government intervention, that deregulatory policies will unleash private sector investment in the broadband infrastructure, and that excessive or inappropriate government intervention in the marketplace is likely to be inconsequential if not deleterious.[41]

The question of current versus next generation broadband also raises important issues for policymakers when formulating broadband policies.[42] For example, as broadband technologies develop, and as speeds increase and applications become more sophisticated, what exactly constitutes "underserved" when assessing areas of the nation that might need some type of government intervention? While most agree that any broadband policy should be "technology neutral" (i.e., not favoring any particular technology or industry), should minimum speed thresholds (and/or upgradeability) be encouraged, and how far-reaching should those thresholds

[40] FCC, News Release, "FCC Expands, Improves Broadband Data Collection," March 19, 2008. Available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-280909A1.pdf.

[41] Some argue that government policies have demonstrated a minimal impact on broadband penetration rates and that variables such as household income, education, and general economic factors are much more determinative. See Ford, George, Phoenix Center, The Broadband Performance Index: What Really Drives Broadband Adoption Across the OECD?, Phoenix Center Policy Paper Number 33, May 2008, 27 pp; available at http://www.phoenix-center.org/pcpp/PCPP33Final.pdf.

[42] To some extent, the federal government has already had an impact on which speeds are considered "broadband." Starting in 1999, and for many years following, the FCC defined broadband (or more specifically "high-speed lines") as over 200 kilobits per second (kbps) in at least one direction, which was roughly four times the speed of conventional dial-up Internet access. In recent years, the 200 kbps threshold was considered too low, and on March 19, 2008, the FCC adopted a report and order (FCC 08-89) establishing new categories of broadband speed tiers for data collection purposes. Specifically, 200 kbps to 768 kbps will be considered "first generation," 768 kbps to 1.5 Mbps as "basic broadband tier 1," and increasingly higher speed tiers as broadband tiers 2 through 7 (tier seven is greater than or equal to 100 Mbps in any one direction). Tiers can change as technology advances.

be – to meet the needs of consumers today, or what may be anticipated for the future? As always, the countervailing question is: to the degree that government policies encourage or prescribe specific broadband capacities, to what extent does this disrupt the marketplace and impede private sector broadband deployment efforts?

Meanwhile, the debate over government intervention in broadband markets is accompanied by disagreement over how broadband deployment in the United States compares with broadband deployment in other nations. Many supporters of a national broadband policy featuring an increased level of government intervention argue that statistics ("broadband rankings") compiled by the Organisation for Economic Co-operation and Development (OECD)[43] and the International Telecommunications Union (ITU)[44] show that the United States is progressively falling behind other nations in broadband penetration, speeds, and pricing, and that this comparatively low ranking has ominous implications for U.S. economic competitiveness.[45] Those supporting less government intervention assert that the OECD and ITU data is flawed and undercounts U.S. broadband deployment,[46] and that cross-country broadband deployment comparisons involving penetration, speeds, and prices are not necessarily meaningful and inherently problematic.[47]

Looking Ahead: The Future of Broadband

Much of the discussion above concerns a national broadband policy in response to the challenge of providing broadband to unserved and underserved regions and populations of the United States. A national broadband policy can also be viewed from a broader perspective by considering how the future of broadband, accompanied by increasingly sophisticated and pervasive applications, might transform the economy and society and how those transformations might be managed by policymakers. In other words, as broadband technologies, speeds, and applications advance, what are the regulatory issues that may confront policymakers not only with respect to deployment, but also with respect to consumer applications and societal impacts?

Regulatory Framework

As our telecommunications environment continues to evolve, regulators are forced to accommodate the realities of a changing infrastructure as well as the changing expectations of both suppliers and consumers. One of the challenges facing this transition is how to establish a regulatory framework to address this increasingly interrelated and complex environment. Over

[43] Data from the OECD ranks the United States 15th among OECD nations in broadband access per 100 inhabitants as of June 2008. OECD, OECD Broadband Statistics, June 2008. Available at http://www.oecd.org/sti/ict/broadband.

[44] According to the ITU, the United States ranks 24th worldwide in broadband penetration (subscriptions per 100 inhabitants in 2007). International Telecommunications Union, Economies by Broadband Penetration, 2007. Available at http://www.itu.int/ITU-D/ict/statistics/at_glance/top20_broad_2007.html.

[45] See Benton Foundation, Using Technology and Innovation to Address Our Nation's Critical Challenges: A Report for the Next Administration, November 2008, pp. 5-6. Available at http://www.benton.org/sites/benton.org/files/Benton_Foundation_Action_Plan.pdf.

[46] National Telecommunications and Information Administration, Fact Sheet: United States Maintains Information and Communication Technology (ICT) Leadership and Economic Strength. Available at http://www.ntia.doc.gov/ntiahome/press/2007/ICTleader_042407.html.

[47] See Wallsten, Scott, Progress and Freedom Foundation, Towards Effective U.S. Broadband Policies, May 2007, 19 pp. Available at http://www.pff.org/issues-pubs/pops/pop14.7usbroadbandpolicy.pdf.

the past few decades, laws and regulations have been formulated in an attempt to address the growth of competition in what were previously considered to be monopolistic markets. Much attention has been given to attempts to formulate a regulatory environment to incorporate and encourage competition based on the implementation of the 1996 Telecommunications Act (P.L. 104-104).[48] This act and its subsequent implementation has largely focused on the development of a regulatory structure to accommodate the growth of intramodal and intermodal competition in the provision of services.[49]

However, the telecommunications sector is dynamic and technological changes such as the advancement of Internet technology and the melding of data, voice, and video have resulted in additional trends which must be addressed. These trends include:

- the transition from a circuit switched to a packet switched network, thereby enabling the integration of voice, video, and data;
- the transition from fixed to mobile service;
- the transition from narrowband to broadband, thereby enabling greater interactivity.

The challenge facing today's policymakers is to develop a regulatory environment that not only addresses current trends, but contains the flexibility to accommodate future and as yet unanticipated changes in technology, applications, consumer expectations, and policy objectives. The growth of broadband networks and the proliferation of applications and devices has placed increasing pressure on policymakers to formulate a framework to address a broadband-based world. Many of these developments were not anticipated when the 1996 Telecommunications Act was passed and have led to the need to update the regulatory assumptions and subsequent regulatory framework the act was based on. A further challenge results from the Internet's lack of national boundaries. Regulations established in one country may be circumvented, since the World Wide Web is global. Activities that may be declared illegal in one country may be undertaken with relative ease by accessing foreign web sites.[50] However, as broadband access continues to become more vital to both the economic and social well-being of the nation, increased attention will be placed on the degree to which regulators should help to shape this constantly evolving environment.

From Monopoly to Competition

As the sector continues its transition from monopoly to competition, regulatory bodies are confronted with the task of establishing a regulatory environment that does not favor one player over another, nor establish regulatory obstacles to deployment and access. The regulatory treatment of broadband technologies, whether offered by traditional or emerging providers, or

[48] Provisions in the 1996 Telecommunications Act required the Federal Communications Commission (FCC) to initiate more than 80 rulemakings to address the changing telecommunications landscape.

[49] Intramodal competition refers to competition among identical technologies in the provision of the same service (e.g., a cable television company competing with another cable television company in the offering of video services) where intermodal competition refers to provision of the same service by different technologies (i.e., a cable television company competing with a telephone company in the provision of video services).

[50] For example, Internet gambling is generally prohibited in the United States, but such activities are easily accessed through offshore websites. For further information on unlawful Internet gambling see CRS Report RS22749, *Unlawful Internet Gambling Enforcement Act and Regulations Proposed for Its Implementation*, by Charles Doyle.

incumbents or new entrants, has become a major focal point in this transition. Whether present laws and regulatory policies are necessary to ensure the development of competition and its subsequent consumer benefits, or are overly burdensome and only discourage needed investment in and deployment of broadband services, continues to be an issue. The policy debate focuses on issues such as the extent to which legacy regulations should be applied to traditional providers as they enter new markets; the extent to which legacy regulations should be imposed on new entrants as they compete with traditional providers in their markets; and the appropriate treatment of new and converging technologies. Additional concerns over how the role of local, state, and federal regulators should be determined, and under what circumstances federal preemption may be evoked, also arise.

Barriers to Competition

In an attempt to level the playing field and encourage the benefits of marketplace competition, regulators are called upon by policy makers and stakeholders to develop a range of policies that promote competition. Such regulations can take many forms, including subjecting providers of like or competing services to similar regulations; establishing new regulations to protect or nurture new competitors; developing new regulations, if deemed necessary, to address the entrance of new services; or when certain market conditions are met, removing legacy regulations from incumbents.

Technological advances and the growth of competition have had a profound impact on market structure and subsequently their established regulatory framework, requiring regulators to address a wide range of issues. Some of the issues that regulators are grappling with include modifying universal service goals and obligations to address the growth of new and/or competing services; ensuring access to existing infrastructure such as ducts, poles, and rights-of-way; developing portability requirements for subscriber numbers to ease the ability to switch among competitors; implementing technology-neutral regulations; and establishing guidelines to remove, or forbear, regulations in competitive markets.

Integration and Interactivity

Legacy policies and regulatory frameworks have come under increasing strain as technological advances have led to the ability to provide new and integrated services. Historically, a provider was identified by the service it offered and its regulatory destiny was determined by its service classification. For example, a provider of voice telephone service classified as a telecommunications common carrier is regulated under Title II (Common Carriers) of the Communications Act of 1934.[51] Similarly, a provider of video service classified as a cable television system operator is regulated under Title VI (Cable Communications) of the 1934 Act. However, the world of distinct services and applications is disappearing as networks transition from a circuit switched to a packet switched network, enabling the integration of voice, video, and data. As providers move to Internet protocols and advanced broadband options continue to grow, the lines among distinct industry sectors continue to blur. Providers seek to integrate or bundle their services into triple play and in some cases quadruple play offerings.[52] New,

[51] Communications Act of 1934, as amended, 47 U.S.C. 151 et seq.

[52] A typical triple play offering would include video, data, and fixed voice services. A typical quadruple play offering would include video, data, and fixed and mobile voice services.

previously undefined services such as Voice over Internet Protocol (VoIP) further strain traditional regulatory perimeters. The challenge facing regulators is to adapt the regulatory framework to this new environment to ensure that legacy regulations do not inhibit the development of and subsequent benefits derived from next-generation broadband networks but still balance economic and social policy objectives.

The growth in interactive, or two-way applications, has expanded significantly, placing increased demands on the broadband infrastructure. Services and applications are moving from static one-way uses, such as e-mail or web surfing, to interactive two-way applications such as video and voice services that are more dependent on uninterrupted streams of data. Additionally the growth in peer-to-peer activity has placed increasing demands on the existing broadband infrastructure as upload speeds now need to match download speeds and peak usage may cause congestion. As the popularity of such services expand, leading to an increase in the demand for bandwidth, the need to address issues relating to capacity and the subsequent need to manage network traffic have come to the attention of regulators. Policies to balance the needs of subscribers and suppliers, as well as network operators, are among the issues being debated. How to establish a policy framework that ensures effective management of networks facing capacity shortages, protects users of the network, and encourages both innovation and future investment for expansion are among the issues under consideration.

Mobility

Wireless broadband networks offer the ability to access broadband anytime and anywhere and may also offer a solution to providing broadband access to underserved and unserved areas. As access to broadband networks becomes increasingly mobile, regulators may be called upon to address policies to facilitate this connectivity. Wireless providers have expanded and continue to expand their service offerings beyond the traditional voice and ringtones to include text messaging, mobile search, e-mail, games, photo messaging, music, and video. Users, whether they be individual consumers, businesses, or government, expect to receive reliable high-quality service to meet these growing mobile expectations. As wireless broadband applications and expectations increase, the need to develop policies to ensure both sufficient radio frequency spectrum capacity and the ability to offer a seamless mobile experience become paramount. Key to these objectives is the development of policies that ensure effective spectrum management and connectivity among networks.

Spectrum Management

The demand for spectrum is intense and the FCC has responsibility for allocating spectrum among the various users. As wireless broadband networks continue to shift from traditional voice networks to those that incorporate a wide range of advanced broadband services, they will need more spectrum in wider contiguous bandwidths. How this spectrum should be allocated among the myriad users, the size of the blocks allocated, and whether any special considerations should be given to specific entities (e.g., rural or small providers) that bid in spectrum auctions are among the issues confronting policymakers. The need to harmonize spectrum allocations worldwide is also a key policy issue. Harmonization enables network operators and equipment

manufacturers to realize significant economies of scope and scale and facilitates global interoperability for consumers.[53]

Roaming

Directly related to the issue of spectrum management is the need to ensure that users have the ability to connect seamlessly among providers. Mobility depends on the ability of users to roam, or move from location to location outside the provider's service area, without their signal dropping or degrading. In the mobile world, there is a greater tendency to need to share networks, making the ability to interconnect a vital component of the mobile experience. The capability to provide nationwide coverage, absent owning such a network, is dependent on the provider's ability to negotiate roaming commitments with other carriers. Subscribers served by these carriers need access to other networks for voice, data, and broadband traffic when roaming outside of their carrier's home market. The absence of, or potentially exorbitant costs associated with, such commitments can place a carrier in a negative competitive position. Furthermore, subscribers in rural areas, who are often served by small and regional carriers, can be particularly vulnerable in the absence of favorable roaming agreements, subjecting them to more limited and/or more costly service. Although these commitments are largely negotiated without regulatory intervention, some concern has been expressed, particularly on the part of rural, small, and regional carriers, that regulators should intervene to protect their ability to negotiate "reasonable" roaming commitments. Regulators have been called upon to address roaming issues, particularly in the context of the recent trend towards industry consolidations. Concerns that existing roaming commitments may be terminated or degraded during a change in ownership, the lack of roaming obligations among in-market carriers, and the application of roaming commitments to data are among the issues that are under examination.

Open Access

As the number of new providers, products, and services proliferate, the ability to gain access to the marketplace becomes paramount. Considerable debate has focused on what has been termed "open access," a term generally defined to mean the ability of suppliers and users to gain unfettered access to networks, content, applications, devices, and ultimately consumers.

Networks

Much of the recent debate over open access has focused on the ability to gain access to content, applications, and services on the Internet. The ability of subscribers to gain access to and use the Internet, in any legal manner, and the ability of applications and service providers to gain access to those consumers has become a focal point for the open access debate. Today's residential market for broadband delivery is dominated by two platform providers: cable television companies that provide cable modem service and landline telephone companies that provide

[53] For a discussion of spectrum policy and other issues relating to wireless broadband policies see A National Wireless Broadband Strategy, issued by the Wireless Communications Association, available at http://www.wcai.com/images/pdf/2008_wcai_wb_strategy.pdf.

Internet access service (i.e., wireline broadband Internet access, or Digital Subscriber Line Service [DSL]).[54]

The movement to place restrictions on the owners of the networks that comprise and provide access to the Internet, to ensure equal access and non-discriminatory treatment is referred to as "net neutrality." There is no single accepted definition of net neutrality. However, most agree that any such definition should include the general principles that owners of the networks that comprise and provide access to the Internet should not control how consumers lawfully use that network; and should not be able to discriminate against content provider access to that network. Most people acknowledge that networks have always been managed and that a certain degree of management is necessary and may even be desirable. The challenge, however, is to distinguish between what is needed or appropriate management versus discrimination. A balance must be struck between the ability of network operators to manage and maintain their infrastructure responsibly and the ability of suppliers and users to access the network in a nondiscriminatory manner.

In an attempt to strike such a balance the FCC adopted a policy statement outlining four principles to "encourage broadband deployment and preserve and promote the open and interconnected nature of [the] public Internet": (1) consumers are entitled to access the lawful Internet content of their choice; (2) consumers are entitled to run applications and services of their choice (subject to the needs of law enforcement); (3) consumers are entitled to connect their choice of legal devices that do not harm the network; and (4) consumers are entitled to competition among network providers, application and service providers, and content providers. Former FCC Chairman Martin did not called for their codification. However, they have been incorporated into the policymaking and oversight activities of the Commission.[55]

The question of what, if any, action should be taken to ensure "net neutrality" has become a major focal point in the debate over broadband regulation. As the marketplace for broadband continues to evolve, some contend that no new regulations are needed and, if enacted, will slow deployment of and access to the Internet, as well as limit innovation. Others, however, contend that the consolidation and diversification of broadband providers into content providers has the potential to lead to discriminatory behaviors that conflict with net neutrality principles.[56]

Historically, however, regulatory policies regarding access to broadband service have focused on wired networks. However, with the onset and growth of wireless broadband capabilities as a third broadband network option,[57] and the potential of wireless networks to provide broadband access

[54] For FCC market share data for high-speed connections see High-Speed Services for Internet Access: Status as of June 30, 2007, Federal Communications Commission, released March 2008. View report at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-280906A1.pdf. For the most recent data see Local Telephone Competition and Broadband Deployment, High-Speed Services for Internet Access available at http://www.fcc.gov/wcb/iatd/comp.html.

[55] See http://www.fcc.gov/headlines2005.html. August 5, 2005. FCC Adopts Policy Statement on Broadband Internet Access.

[56] For a more detailed discussion of the net neutrality concept and issues see CRS Report RS22444, *Net Neutrality: Background and Issues*, by Angele A. Gilroy.

[57] According to FCC data, mobile wireless is the provider of almost 35 percent of high speed lines (over 200 kbps in at least one direction), as of June 30, 2007. See High-Speed Services for Internet Access: Status as of June 30, 2007, Federal Communications Commission, Table 6, released March 2008. View report at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-280906A1.pdf. For the most recent data, see Local Telephone Competition and Broadband Deployment, High-Speed Services for Internet Access, available at (continued...)

to unserved and underserved areas, pressure to apply some type of open access principles to the wireless network has increased. It appears that under the present regulatory environment wireless carriers, when providing broadband access, are not subject to broadband access policies. Whether the move to an open wireless network will become widespread through voluntary industry efforts, due to the development and adoption of open architecture technologies, or perhaps due to regulatory pressure or mandate, is yet to be determined. As broadband access continues to migrate to the wireless world, increased attention will be focused on what role regulators may have in helping to ensure that wireless networks, like their wired counterparts, are adequately open.

Devices and Applications

In addition to concerns over access to networks, open access principles have also been applied to devices. In the public switched wireline world, the debate over opening the network to devices, or terminal equipment, has a long and complex history. The long-debated issue of whether or not consumers would be permitted to attach their own equipment to the telephone network was largely resolved by the 1968 Carterfone Decision.[58] This decision was issued by the FCC in response to a petition filed by Thomas Carter, an inventor, who developed a device, known as the Carterfone. The Carterfone enabled consumers to connect a two-way mobile radio system to the telephone network. In accordance with its long held policy, AT&T, the parent company of the Bell System, denied the attachment of the Carterfone to its telecommunications network citing concerns about the potential of foreign devices, i.e., non-Bell System devices, to harm the network. Given the Bell System's status as the monopoly provider of telecommunications, the refusal to allow non-Bell System equipment to attach to the network, in effect, resulted in a de facto monopoly over devices as well as the transmission platform. The FCC, however, determined that the Carterfone device and other customer-supplied equipment could be attached to the public telephone network as long as the devices were "privately beneficial, but not publically harmful." These rules on connection were later codified as Part 68 of the FCC's rules.[59] As a result, consumers are free to attach any equipment they desire to the public switched network, as long as it meets Part 68 standards.

Some are pressing the FCC to apply Carterfone-type rules to the wireless network as well. However, the application of such rules may prove to be more difficult. Unlike the public switched telephone network, which is basically supported by a common technology, wireless networks are supported by a variety of different technologies. As the technologies that support wireless networks converge, the application of a Carterfone-type solution may become more feasible.

The FCC has taken some steps to encourage the opening up of the wireless broadband network to devices and applications. When the FCC auctioned spectrum licenses in the 700 MHz band it required the winner of 22 MHz for advanced wireless services, known as the C Block,[60] to adopt an open concept with respect to devices and applications.[61] Consumers are permitted to use the

(...continued)

http://www.fcc.gov/wcb/iatd/comp.html.

[58] See In the Matter of Use of the Carterfone Device in Message Toll Service, 13 FCC 2d 420 (1968).

[59] See Part 68 of Title 47 of the Code of Federal Regulations. Additional information on Part 68 Regulations can be found at http://www.fcc.gov/wcb/iatd/part-68.html.

[60] The C block is a nationwide block of spectrum of which Verizon Wireless was the winner of the majority.

[61] For a copy of former Chairman Martin's March 18, 2008 statement on the 700 MHz auction and its open access provisions see http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-280887A1.pdf.

device of their choice, as long as it is not harmful to the network, as well as any legal software or applications on these networks. The FCC reaffirmed and clarified this two-pronged open access decision in an order adopted November 4, 2008.[62] The FCC stated that its open access requirements, which were codified in Title 47 Section 27.16 of the Code of Federal Regulations, apply to all auctioned licenses in the 700 MHz C Block. Section 27.16 states that a C Block licensee "shall not deny, limit, or restrict the ability of their customers to use the devices and applications of their choice on the licensee's C Block Network," unless reasonably necessary for network management or protection, or to comply with applicable law and also prohibits the above licensees from "disabl[ing] features on handsets" that they provide to their customers.[63]

There are some signs that industry players have begun to voluntarily embrace, to a limited degree, openness principles for wireless devices and applications. For instance, the new Clearwire Corporation,[64] a competitor in the broadband wireless market, has chosen to operate a nationwide network based on WiMax technology. WiMax is an open source technology in the sense that it is designed to permit both applications and devices of the consumer's choice.[65] At the time of filing for FCC approval, the petitioners (Sprint Nextel and Clearwire) proposed a number of voluntary commitments that the new entity, the new Clearwire, would adhere to that were open access based. The FCC, in a November 4, 2008 action, approved the petition, but did not require any open access requirements as a condition of that approval.[66] However, the new Clearwire by choosing to deploy WiMax is committed to pursuing a network which is open access for both devices and applications.

Despite this movement however, the wireless industry continues to be restrictive, to varying degrees, with regard to devices. For example, issues such as handset locking[67] and exclusivity arrangements[68] between commercial wireless carriers and handset manufacturers continue to remain contentious.

[62] See, In the Matter of Union Telephone Company, Cellco Partnership d/b/a/ Verizon Wireless, Applications for 700 MHZ Band Licenses, Auction No. 73 available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-257A1.pdf.

[63] See paragraph 20 of In the Matter of Union Telephone Company, Cellco Partnership d/b/a/ Verizon Wireless, Applications for 700 MHZ Band Licenses, Auction No. 73. For a more detailed discussion of the 700MHz auction and the open access debate see CRS Report RS22218, *Spectrum Use and the Transition to Digital TV*, by Linda K. Moore.

[64] The new Clearwire is composed of merged assets from Sprint Nextel Corporation and Clearwire Corporation with the majority ownership (51 percent) resulting company owned by Sprint Nextel.

[65] WiMax (Worldwide Interoperability for Microwave Access) is an IP-based wireless technology based on an open non-proprietary standard for the delivery of non-line-of-sight wireless broadband services based upon the IEEE802.16 standard. For detailed information on WiMax see WiMax Questions & Answers available at http://www.wimaxforum.org/news/wimax_faq_10-2007.pdf.

[66] See, In the Matter of Sprint Nextel Corporation and Clearwire Corporation, Applications For Consent to Transfer Control of Licenses, Leases, and Authorizations (WT Docket No. 08-94.) Available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-259A1.pdf.

[67] Handset locking refers to the practice of limiting the handset to the applications and features sold by that service provider thereby making them not readily portable to other carriers.

[68] For example, AT&T successfully negotiated a five-year exclusivity deal with Apple Inc. to market, in the United States, the popular iPhone.

Social Versus Economic Regulation

The regulatory issues discussed above are largely classified as those that deal with economic regulation; that is, regulations that address such issues as competition, innovation, and investment. As broadband becomes an integral component of society, however, regulators have been called upon to consider the application of social goals, that may or may not have been identified with traditional telephony, to the broadband world. Social objectives such as the advancement of universal service goals, timely and accurate emergency services, access for those with disabilities, and consumer protection that are part of traditional telephony regulatory policies, are migrating to the broadband policy environment.

Whether universal service objectives, which have been a basic tenet of wireline telephony, should include universal access to broadband service is one of the more significant social issues under debate. The concept of universal service, when applied to telecommunications, refers to the ability to make available a basket of telecommunications goods to the public, across the nation, at a reasonable price. As the importance and growing acceptance of broadband services permeates our lives, a consensus is forming that the definition of what should be included in the package of services should be expanded to include access to advanced (i.e., broadband) services. Others however, have expressed concern over the uncertainty and costs associated with mandating nationwide deployment of such services as a universal service policy goal.[69]

Assurance that 911 emergency access is of comparable quality whether a consumer is using a wireline, wireless, or broadband connection is also under scrutiny. Providing effective 911 service as we migrate from analog to digital technology has proved challenging. For example, considerable effort is being invested on the part of policymakers to ensure that effective enhanced 911 (E-911) capabilities are available to all users so that their location can be determined in an accurate and timely manner regardless of the technology used. There is a growing consensus that a modernized emergency system should incorporate IP networks and standards.[70]

One outcome of the net neutrality debate has been a focus on consumer protection. A growth in information transparency and assurance that consumers are aware of the impact that network management may have on their broadband usage, full disclosure of broadband speeds and usage caps, the ability of consumers to monitor and track their personal usage, as well as the protection of consumer usage information from tracking by other parties, have been significant outgrowths of the debate. Additional social goals being addressed by policymakers include the degree to which broadband devices and services should be fully accessible to those with disabilities (e.g., hearing, speech, or sight deficits); protection from identity theft; and the protection of minors from inappropriate material. Although there is considerable agreement that all of these social goals are worthwhile and must be addressed, the policies needed to achieve them may prove to be controversial and increasingly complex when adapted to a broadband environment.

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[69] For a detailed analysis of the issues surrounding the expansion and reform of the Federal Universal Service Fund see CRS Report RL33979, *Universal Service Fund: Background and Options for Reform*, by Angele A. Gilroy.

[70] For a detailed analysis of the policy issues facing emergency communications see CRS Report RL34755, *Emergency Communications: The Future of 911*, by Linda K. Moore.

Author Contact Information

Patricia Moloney Figliola
Specialist in Internet and Telecommunications Policy
pfigliola@crs.loc.gov, 7-2508

Angele A. Gilroy
Specialist in Telecommunications Policy
agilroy@crs.loc.gov, 7-7778

Lennard G. Kruger
Specialist in Science and Technology Policy
lkruger@crs.loc.gov, 7-7070

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