CURRENT STATE OF THE BROADBAND ECOSYSTEM

CHAPTER 3

TO SEE HOW BROADBAND IS TRANSFORMING American life, walk down a busy street or pay a visit to any school, business or airport. Parents on business trips use their smartphones to check e-mail or watch short videos of their children playing soccer, hundreds, if not thousands, of miles away. Americans work together in real time on complex documents from different desks in the same office, and workers in different offices around the world collaborate via videoconferencing technology. Sales and field maintenance personnel use mobile devices to access inventory information in their businesses, place orders and update records, increasing efficiency and productivity. Students draw on the richness of the Internet to research historical events or watch simulations of challenging math problems. People are using broadband in ways they could not imagine even a few years ago.

To understand how this transformation will evolve, it is important to understand the forces shaping the broadband ecosystem in America today (see Exhibit 3-A).

The broadband ecosystem includes applications and content: e-mail, search, news, maps, sales and marketing applications used by businesses, user-generated video and hundreds of thousands of more specialized uses. Ultimately, the value of broadband is realized when it delivers useful applications and content to end-users.

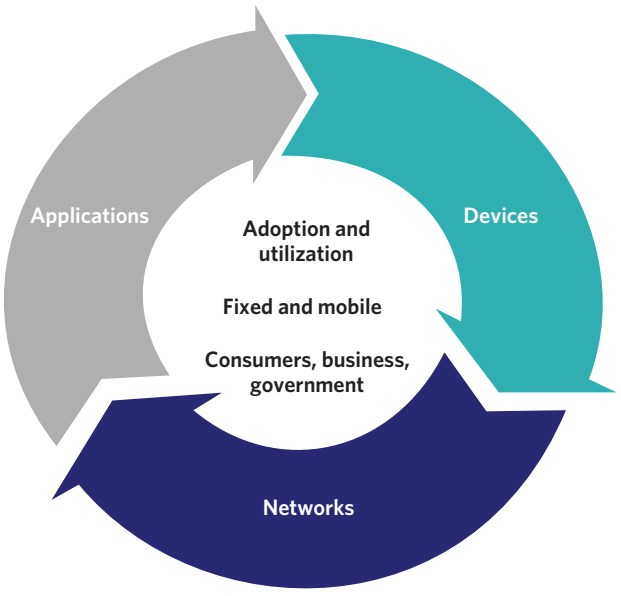
Applications run on devices that attach to the network and allow users to communicate: computers, smartphones, set-top boxes, e-book readers, sensors, private branch exchanges (PBX), local area network routers, modems and an ever-growing list of other devices. New devices mean new opportunities for applications and content.

Finally, broadband networks can take multiple forms: wired or wireless, fixed or mobile, terrestrial or satellite. Different types of networks have different capabilities, benefits and costs.

The value of being connected to the network increases as more people and businesses choose to adopt broadband and use applications and devices that the network supports. Several factors contribute to their decisions. These include whether they can afford a connection, whether they are comfortable with digital technology and whether they believe broadband is useful.

Networks, devices and applications drive each other in a virtuous cycle. If networks are fast, reliable and widely available, companies produce more powerful, more capable devices to connect to those networks. These devices, in turn, encourage innovators and entrepreneurs to develop exciting applications and content. These new applications draw interest among end-users, bring new users online and increase use among those who already subscribe to broadband services. This growth in

Exhibit 3-A:
Forces Shaping the Broadband Ecosystem in the United States



the broadband ecosystem reinforces the cycle, encouraging service providers to boost the speed, functionality and reach of their networks.

While the explosive growth in the use of broadband suggests that many aspects of the American broadband ecosystem are healthy, there are many ways America can do better.

3.1 APPLICATIONS

Users benefit directly from the applications and content they access through broadband networks. Applications help people purchase products, search for jobs, interact with government agencies and find information related to their health.[1] Users also spend considerable time using broadband for banking, shopping, entertainment, social networking and communication (see Exhibit 3-B).[2]

Home broadband use has increased from roughly 1 hour per month in 1995, to more than 15 hours per month in 2000, to almost 29 hours per month today, as consumers find more valuable applications and content online.[4] Increased hours of use are correlated with increased actual speeds of broadband connections to the home.[5] As connection speeds have grown and more applications have been developed, the amount of data consumers download has increased. Today, the average Internet user with a fixed connection consumes 9 gigabytes of data per month over that connection. But that consumption varies significantly across user types, with some heavy users consuming upwards of 1,000 GB or more each month. Total data use per fixed residential connection is growing quickly, by roughly 30% annually.[6]

Almost two-thirds of the time users spend online is focused on communication, information searching, entertainment or social networking.[7] However, use patterns vary significantly. Except for high-definition video, most applications in use today can be supported by actual download speeds of about 1 Mbps (see Exhibit 3-C).

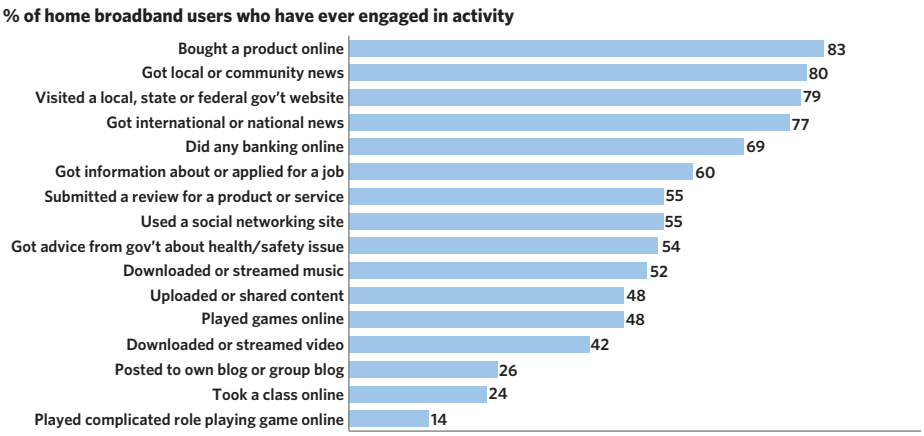
Broadband applications are helping businesses improve internal productivity and reach customers. Many businesses use at least basic applications: 97% of small businesses use e-mail; 74% have a company website.[8] There is evidence that broadband applications may improve individual companies' productivity.[9] Though gains vary drastically depending on the size and type of firm, as well as breadth of implementation, broadband-based applications may allow faster product development cycles, access to new geographic markets, and more efficient business processes and allocation of resources.

These productivity gains benefit the entire economy. Investment in information and communications technologies accounted for almost two-thirds of all economic growth attributed to capital investment in the United States between 1995 and 2005.[10]

Businesses also find it valuable to collect and aggregate information derived from use of broadband applications. More sophisticated digital profiles of Internet users allow businesses to better understand user buying patterns. This information is also useful for advertising or other purposes. Businesses are creating services tailored to individual consumers that improve their health, help them reduce their carbon footprint, track students' educational progress and target appeals for charitable, social and political causes.

Businesses often use broadband in ways that are fundamentally different from how consumers use it. For example, high-capacity broadband service is often used to connect PBX's for business voice and local area networks. These mission critical uses require broadband service with business-grade performance and customer support levels.

Exhibit 3-B: Percentage of Home Broadband Users Who Have Ever Engaged in Selected Online Activities[3]



Both consumers and businesses are turning to applications and content that use video. Video is quickly becoming an important element of many applications, including desktop videoconference calls between family members and online training applications for businesses. Cisco forecasts that video consumption on fixed and mobile networks will grow at over 40% and 120% per year, respectively, through 2013.[11]

User-generated video and entertainment—from sites such as YouTube and Hulu—are a large portion of the total video traffic over broadband connections. Increasingly, video is embedded in traditional websites, such as news sites, and in applications such as teleconferencing. Skype reports that video calls account for over one-third of its total calls, and that number is growing rapidly.[12]

Video, television (TV) and broadband are converging in the home and on mobile handsets. The presence of broadband connections and TVs in the home could facilitate the development of a new medium for accessing the Web and watching video content. Traditional, or "linear," television still accounts for more than 90% of all time spent watching video.[13] Video consumed over the Internet still represents a small portion of overall video consumption at less than 2% of all time spent viewing.

Broadband-enabled video could grow as more innovative and user-friendly devices reach the home, allowing access to both traditional linear and Internet content via the TV.

Cloud computing—accessing applications from the Internet instead of on one's own computer—is also growing as more companies migrate to hosted solutions. Software based in the cloud may allow more small businesses and consumers to access applications that were once only available to large corporations with sophisticated information technology departments in the applications and content markets.

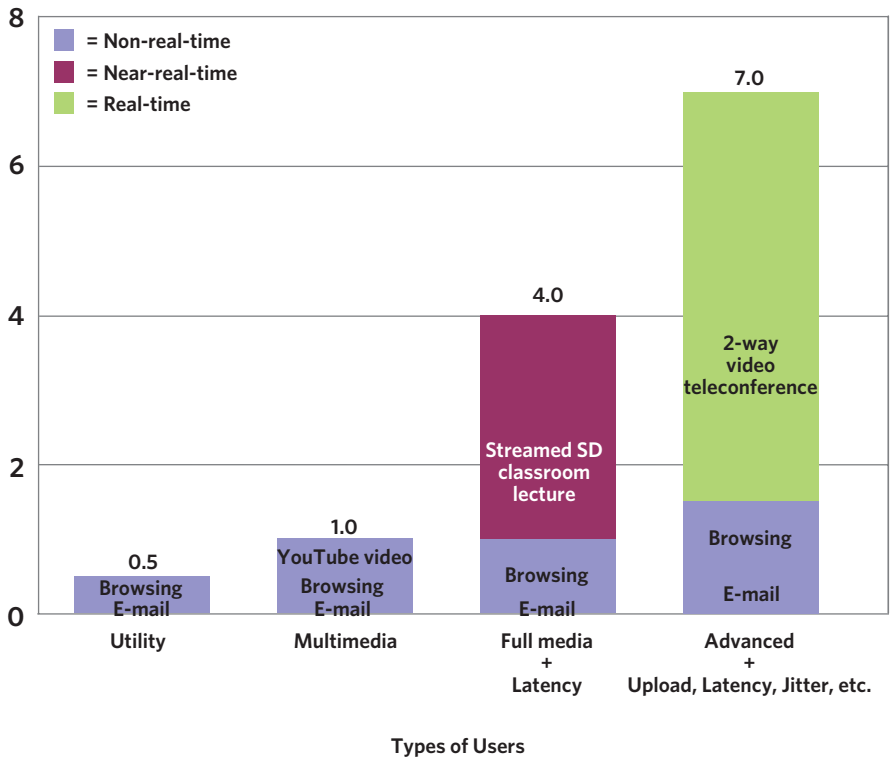
There are several issues that are important for the development of applications and content.

Illegal distribution of copyright-protected content over the Internet continues to be an issue. Although there have been promising results from technologies such as content fingerprinting and from industry-led initiatives to develop guidelines for dealing with illegal content, piracy is still present in the broadband ecosystem.[14]

Increased use of personal data raises material privacy and security concerns. Almost half of all consumers have concerns about online privacy and security, which may limit their adoption or use of broadband.[15] Better security and more control over private information may trigger a more robust applications market.

By making more of its information freely available, government can make it easier for companies to develop applications and content. The Global Positioning System (GPS) industry was born after the U.S. Department of Defense opened its fleet

Exhibit 3-C:
Actual Download Speeds Necessary to Run Concurrent Applications (Mbps)



of GPS navigational satellites to the public and the National Oceanic and Atmospheric Administration made public its satellite data.[16] More recently, Sunlight Labs sponsored Apps for America, a competition to build useful applications with federal government data available on Data.gov. One application was FlyOnTime.us, which gives average flight delay information by airline and between U.S. cities.[17] Moving forward, government information can unleash additional new applications that help drive the growth of the broadband ecosystem.

3.2 DEVICES

Devices continue to grow in number and variety as more computers, phones and other machines connect to the Internet. New devices have repeatedly revolutionized the personal computer (PC) market in the past three decades. Today, about 80% of U.S. households have some sort of personal computer.[18] Although desktops initially dominated the market, 74% of all new personal computers sold today are laptops.[19] Many predict that, over the next 5 years, growth in the netbook and tablet markets will far outpace growth in the traditional PC market.[20]

The mobile phone market has also seen robust innovation. There were more than 850 different certified mobile products in the United States in 2009.[21] In that same year, approximately 172 million mobile phones were sold in the United States. Of these, 27% were Internet-capable smartphones manufactured by a wide variety of firms, including Apple, HTC, LG, Motorola, Nokia, Palm, RIM, Samsung and Sony-Ericsson. Analysts expect smartphone sales to overtake standard mobile phone sales soon.[22]

Countless other Internet-capable devices come to the market each year. Companies are building smart appliances that notify owners of maintenance issues over broadband networks and communicate with the electric grid to run at off-peak hours when prices are lowest. E-book readers deliver books almost instantly to consumers anytime and anywhere, often at lower prices than traditional editions. Devices monitor patients at home and wirelessly transmit data to doctors' offices, so problems can be identified before they become too serious.

Devices already are starting to communicate with each other, keeping humans out of the loop. Increasing machine-to-machine (M2M) interaction will occur over the network, particularly for mobile broadband. A pioneering example of machine-to-machine communication for consumer use is General Motors' OnStar, an M2M system for automobiles in which an onboard sensor automatically notifies OnStar's network if there is an accident or system failure.[23] M2M communications are used in many industries, often to collect information from sensors deployed remotely. For example, devices tracking the heart rate or blood-sugar level of patients with chronic conditions can transmit the information to a monitoring station that will trigger an alarm for a nurse or doctor where an abnormal pattern is detected. Networked sensors in a power plant can collect and transmit data on how generators are operating, to allow analysis by sophisticated predictive methods that will diagnose potential faults and schedule preventive maintenance automatically.

The emergence and adoption of new technologies such as radiofrequency identification and networked micro-electromechanical sensors, among others, will give rise to the "Internet of Things." Billions of objects will be able to carry and exchange information with humans and with other objects, becoming more useful and versatile. For example, the Internet of Things will likely create whole new classes of devices that connect to broadband, and has the potential to generate fundamentally different requirements on the fixed and mobile networks: they will require more IP addresses, will create new traffic patterns possibly demanding changes in Internet routing algorithms, and potentially drive demand for more spectrum for wireless communications.

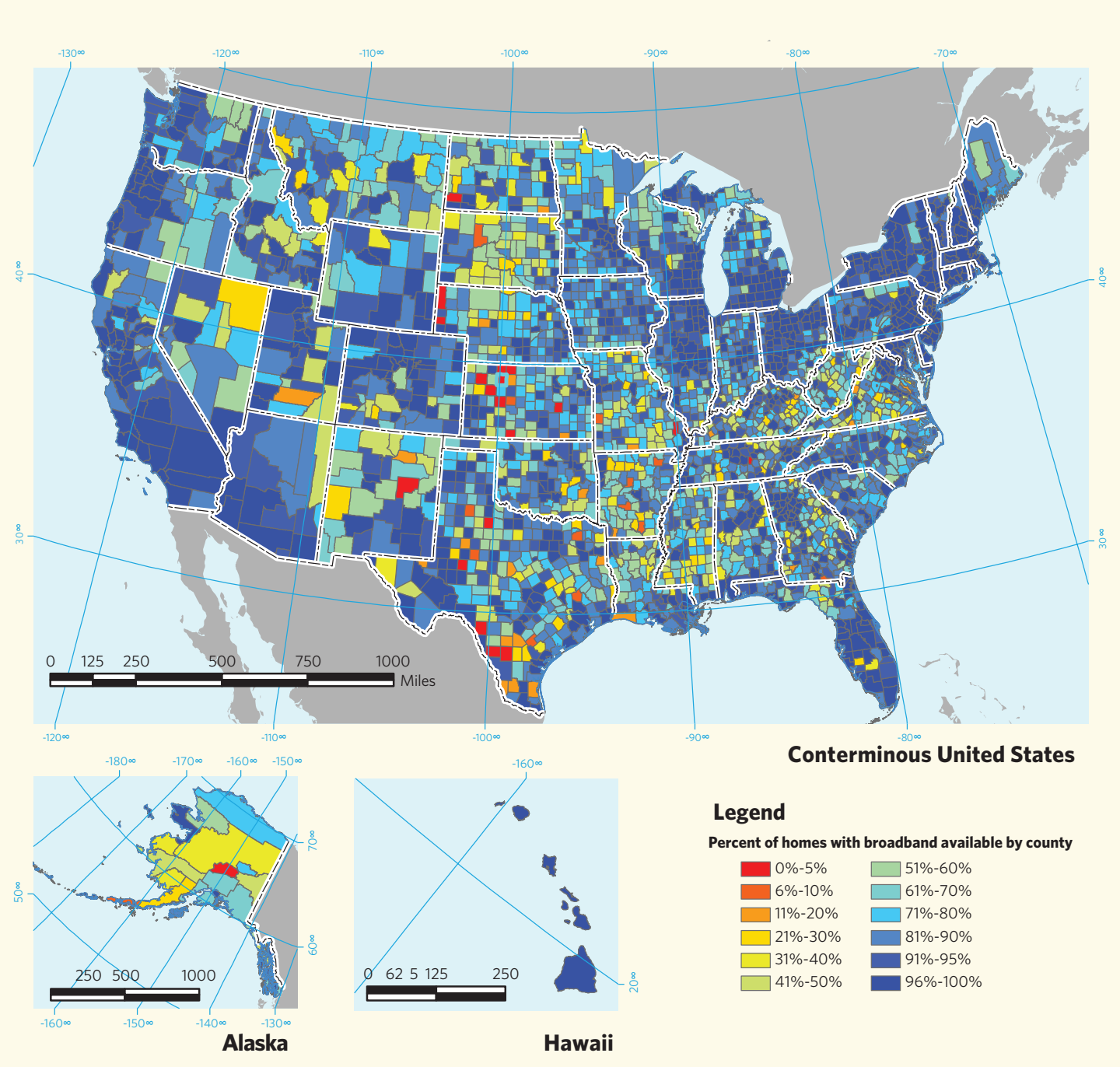
Significant competition and innovation exist for most classes of devices that interact with broadband networks. But one class of devices has not faced substantial competition in recent years: the television set-top box. The Telecommunications Act of 1996 contained provisions designed to stimulate competition and innovation in set-top boxes. Two years later, the FCC, in partnership with industry, developed the CableCARD standard to incent competition in the set-top box market.[24] Yet by 2008, two manufacturers shared 92% of the market, up from 87% in 2006.[25] Only 11 set-top boxes have been certified for retail sale, in contrast to the more than 850 unique handsets that were certified to operate on mobile networks in 2009 alone.[26] In addition, 97% of CableCARD-deployed set-top boxes installed between July 2007 and November 2009 were leased from operators rather than purchased at retail.[27]

Set-top boxes are an important part of the broadband ecosystem. An estimated 39 million set-top boxes were shipped in the United States in 2007 and 2008 combined.[28] The lack of innovation in set-top boxes limits what consumers can do and their choices to consume video, and the emergence of new uses and applications. It may also be inhibiting business models that could serve as a powerful driver of adoption and utilization of broadband, such as, models that integrate traditional television and the Internet.

3.3 NETWORKS

Network service providers are an important part of the American economy. The 10 largest providers have combined annual revenue of more than $350 billion and annual capital investments in excess of $50 billion.[29] These investments have

Exhibit 3-D:
Availability of 4 Mbps-Capable Broadband Networks in the United States by County[36]



led to the deployment of multiple networks that today bring fixed and mobile broadband to end-users via the telephone, cable television, satellite and third-generation (3G) and fourth-generation (4G) mobile networks.

Terrestrial Fixed Broadband Availability

Today, 290 million Americans—95% of the U.S. population—live in housing units[30] with access to terrestrial, fixed broadband infrastructure capable of supporting actual download speeds of at least 4 Mbps.[31] Of those, more than 80% live in markets with more than one provider capable of offering actual download speeds of at least 4 Mbps.[32] Meanwhile, 14 million people in the United States living in 7 million housing units do not have access to terrestrial broadband infrastructure capable of this speed.[33] Although housing units without access to terrestrial broadband capable of 4 Mbps download speeds exist throughout the country, they are more common in rural areas (see Exhibit 3-D).[34]

Businesses and community anchor institutions are often served by broadband. Ninety-six percent of all business locations have access to Digital Subscriber Line (DSL) service, and 92% have access to cable broadband service.[35] In addition, 99% of all health care locations with physicians have access to actual download speed of at least 4 Mbps (see Exhibit 3-D). Finally, 97% of schools are connected to the Internet,[37] many supported by the federal E-rate connectivity programs. But crucial gaps exist: More than 50% of teachers say slow or unreliable Internet access presents obstacles to their use of technology in classrooms,[38] and only 71% of rural health clinics have access to mass-market broadband solutions.[39] Further, many business locations, schools and hospitals often have connectivity requirements that cannot be met by mass-market DSL, cable modems, satellite or wireless offers, and must buy dedicated high-capacity circuits such as T-1 or Gigabit Ethernet service. The availability and price of such circuits vary greatly across different geographies, and many businesses and anchor institutions face challenges acquiring the connectivity to support their needs.

Typical advertised broadband speeds that consumers purchase have grown approximately 20% each year. This growth has been driven by a shift in consumer preferences to faster, more advanced technologies, improved performance of different technologies and large investments by service providers in network upgrades.[40]

Both telephone and cable companies continue to upgrade their networks to offer higher speeds and greater capacities. Many have announced specific upgrades. For example, Verizon plans to pass over 17 million homes by the end of 2010 with its FiOS fiber-to-the-premises (FTTP) service, three million more than today.[41] AT&T has announced it will build fiber-to-the-node (FTTN) infrastructure to serve 30 million homes by 2011, 11 million more than today. In addition, many smaller companies plan to aggressively build FTTP networks. If the targets in these public announcements are met, at least 50 million homes will be able to receive peak download speeds of 18 Mbps or more from their telephone company within the next 2 years.[42]

Cable companies have also announced that over the next 2–3 years they will upgrade their networks to DOCSIS 3.0 technology, which is capable of maximum download speeds of more than 50 Mbps. One analyst predicts that by 2013, leading cable companies will cover 100% of the homes they pass with DOCSIS 3.0. The top five cable companies currently pass 103 million housing units, or about 80% of the country's homes.[43]

As noted in a recent report from the Columbia Institute for Tele-Information (CITI), history suggests that service providers will meet these announced targets. So it is likely that 90% of the country will have access to advertised peak download

Exhibit 3-E: Announced Upgrades to the U.S. Fixed Broadband Network (Millions of households covered)[51]

	Companies	2009	2010	2011
FTTP	• Verizon • Cincinnati Bell • Tier 3 ILECs	• All providers (17.2 million–Sept) • Verizon FiOS (14.5 million–June)	• Verizon FiOS (17 million)	
FTTN	• AT&T • Qwest	• Qwest (3 million)	• Qwest (5 million)	• AT&T U-verse (30 million)
DOCSIS 3.0	• Comcast • Cablevision • Cox • Knology • Time Warner • Charter • Mediacom • RCN	• Comcast (40 million) • Charter (St. Louis) • Mediacom (50% of footprint) • Knology (50% of footprint) • RCN (begin deployment)	• Comcast (50 million) • Cablevision (entire footprint) • Cox (entire footprint) • Time Warner (New York City) • Knology (entire footprint)	

speeds of more than 50 Mbps by 2013.[44] The affordability and actual performance of these networks will depend on many factors such as usage patterns, investment in infrastructure, and service take-up rates.

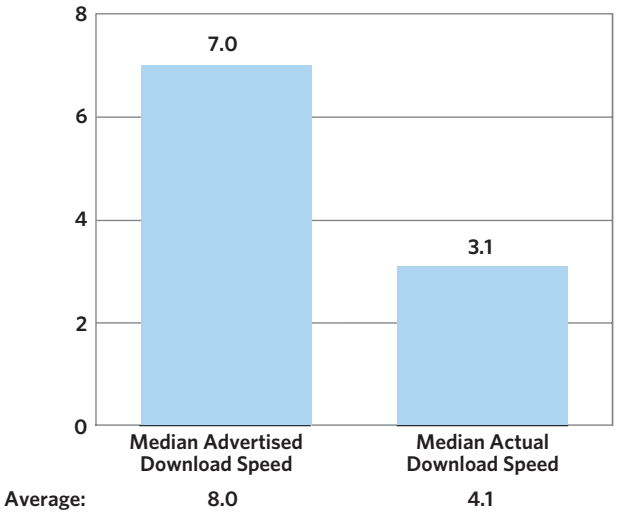
However, these major announced buildouts target areas already served by broadband. It is unlikely there will be a significant change in the number of unserved Americans based on planned upgrades over the next few years, although some small companies may upgrade their networks to support broadband in currently unserved areas.

The performance of fixed broadband connections is often advertised in terms of maximum "up to" download and upload speeds. For example, an end-user with a connection for which download speeds are "up to 8 Mbps" can expect to reach 8 Mbps download speeds, but not necessarily reach and sustain that speed all or even most of the time. Data show that actual speeds experienced by end-users differ considerably from the "up to" speeds advertised by service providers. This distinction is important because it is the actual experience of the consumer (not theoretical technical capabilities) that enables or limits the use of different applications by end-users.

Estimates of the average advertised "up to" download speed that Americans currently purchase range from 6.7 Mbps to 9.6 Mbps,[45] with the most detailed data showing an average of approximately 8 Mbps and a median of approximately 7 Mbps.[46] As noted, the average advertised speed purchased by broadband users has grown approximately 20% each year for the last decade. Upload speeds are significantly lower, as the advertised "up to" upload speed typically is closer to 1.0 Mbps.[47]

However, the actual experienced speeds for both downloads and uploads are materially lower than the advertised speeds. Data indicates the average *actual* download speed in American households for broadband is 4 Mbps (median *actual* is 3.1 Mbps) (see Exhibit 3-G).[48] Therefore, the actual download speed experienced on broadband connections in American households is approximately 40–50% of the advertised "up to" speed to which they subscribe. The same data suggest that for upload speeds, actual performance is approximately 45% of the "up to" advertised speed (closer to 0.5 Mbps).

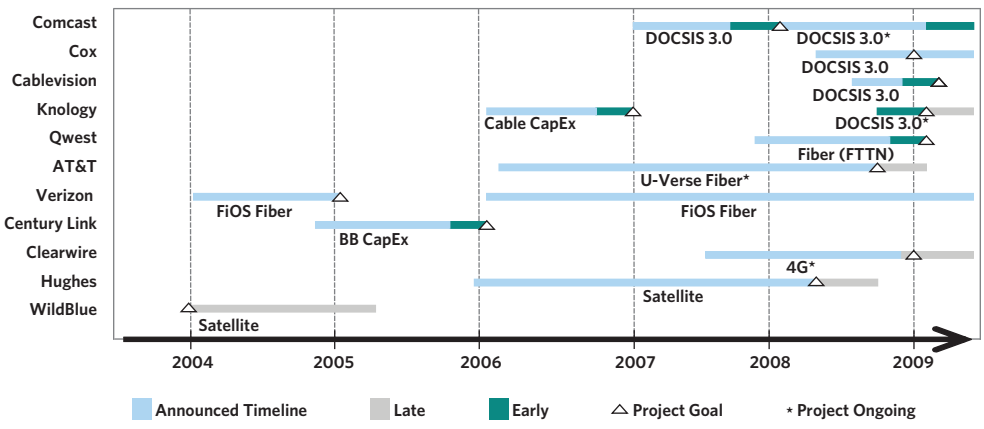
Exhibit 3-G:
Advertised Versus Actual U.S. Fixed Broadband Residential Download Speeds (Mbps)



Actual download speeds vary by technology as well.[50] While median actual download speeds for fiber and cable are 5–6 Mbps, median actual download speeds for DSL are 1.5–2 Mbps, and under 1 Mbps for satellite (see Exhibit 3-F). Despite this variation in performance across technologies, on a percentage basis, the gap between advertised and actual speeds experienced by consumers is consistent and prevalent across all types of connection technologies.[52]

This performance gap between advertised "up to" speeds and actual performance is consistent with reports published in a number of other countries. A study in the United Kingdom

Exhibit 3-F:
Timeline of Fixed Broadband Industry Network Upgrades[49]



found that average actual speeds were typically about 57% of average advertised speeds.[53] Studies in New Zealand, Australia, Italy and Ireland have shown similar results.[54]

Mobile Broadband Availability

As of November 2009, according to data from American Roamer, 3G service covers roughly 60% of U.S. land mass.[55] In addition, approximately 77% of the U.S. population lived in an area served by three or more 3G service providers, 12% lived in an area served by two, and 9% lived in an area served by one. About 2% lived in an area with no provider.[56]

These measures likely overstate the coverage actually experienced by consumers, since American Roamer reports *advertised* coverage as reported by many carriers who all use different definitions of coverage. In addition, these measures do not take into account other factors such as signal strength, bitrate or in-building coverage, and may convey a false sense of consistency across geographic areas and service providers.[57] As with fixed broadband, most areas without mobile broadband coverage are in rural or remote areas. In fact, 3G build out is significantly lower in several states—in West Virginia, only 71% of the population has 3G coverage and in Alaska only 77% have coverage.[58]

Additionally, American Roamer also suggests that 98% of businesses have 3G coverage today, although the data have similar limitations regarding signal strength, bitrate and in-building coverage.[59] While most businesses have wireless broadband coverage,[60] nearly 9% of rural business sites still do not have access, compared to less than 1% of business sites in urban or suburban areas.[61] Finally, while a business location may have coverage, the value in mobile broadband comes when employees can access applications everywhere, which limits the importance of this particular coverage metric.

Several operators have announced upgrades to 4G broadband networks. CITI notes that by 2013, Verizon Wireless plans to roll out Long Term Evolution (LTE)—a 4G mobile broadband technology—to its entire footprint, which currently covers more than 285 million people.[62] AT&T has announced it will test LTE in 2010 and begin rollout in 2011. Through its partnership with Clearwire, Sprint plans to use WiMAX as its 4G technology. WiMAX has been rolled out in a few markets already, and Clearwire plans to cover 120 million people with WiMAX by the end of 2010.[63]

Mobile broadband network availability will change rapidly because of these deployments. Improved spectral efficiencies and significantly lower network latencies are some of the features of 4G networks that could lead to a better mobile broadband experience. For example, the spectral efficiency of mobile broadband networks could improve by over 50% with a transition from early 3G networks to 4G, while improvements relative to state-of-the-art 3G networks are likely to be a more modest 10–30%.[64] The extent to which the effect of these advances are reflected in users' experiences will depend on a variety of factors, including the total amount of spectrum dedicated to mobile broadband and the availability of high-speed backhaul connections from cellular sites.[65]

Evaluating network availability and performance is much harder for mobile than for fixed broadband. For instance, the quality of the signal depends on how far the user is from the cell tower, and how many users are using the network at the same time. Therefore, the fact that users are in the coverage area of a 3G network does not mean they will get broadband-quality performance. Still, as with fixed broadband, it is clear that the speeds experienced on mobile broadband networks are generally less than advertised. Actual average download speeds have been reported to be as low as 245 kbps, while speeds in excess of 600 kbps are advertised. Actual average upload speeds as low as 106 kbps have been reported, versus advertised rates of 220 kbps or higher.[66]

Both mobile network performance and the availability of mobile broadband rely on the availability of spectrum. Carriers and other broadband-related companies agree that more spectrum will be needed to maintain robust, high-performing wireless broadband networks in the near future.[67]

Exhibit 3-H: Announced Upgrades to the U.S. Mobile Broadband Network (Persons covered)[68]

Technology	Companies	2009	2010	2011	By 2013
LTE	• Verizon • AT&T • MetroPCS • Cox		• Verizon (100 million) • AT&T (trials)	• AT&T (start deployment) • Cox (start deployment) • MetroPCS (start deployment)	• Verizon (entire network)
WiMAX	• Clearwire • Open Range • Small wireless Internet service providers (WISPs)	• Clearwire (30 million) • WISPs (2 million)	• Clearwire (120 million)		• Open Range (6 million)

3.4 ADOPTION AND UTILIZATION

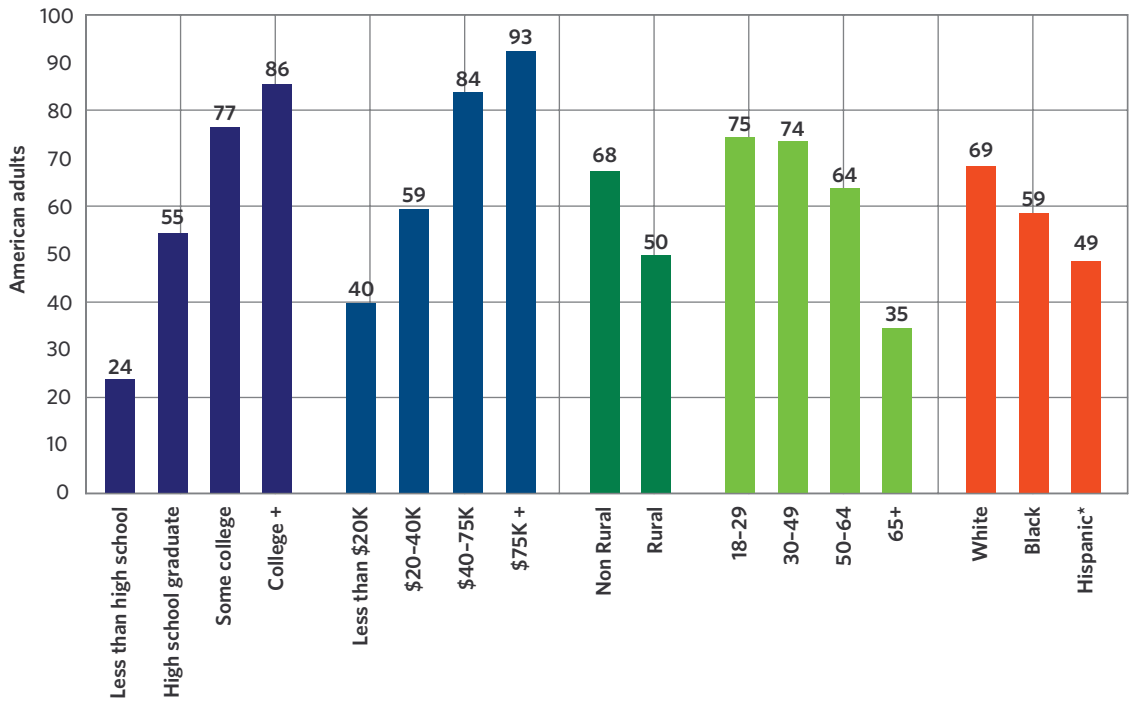
Nearly two-thirds of American adults have adopted broadband at home. While adoption likely will continue to increase, different demographic groups adopt at significantly different rates (see Exhibit 3-I). For example, only 40% of adults making less than $20,000 per year have adopted terrestrial broadband at home, while 93% of adults earning more than $75,000 per year have adopted broadband at home (see Exhibit 3-H). Only 24% of those with less than a high school degree, 35% of those older than 65, 59% of African Americans and 49% of Hispanics have adopted broadband at home.[69] Among people with disabilities, who face distinctive barriers to using broadband, only 42% have adopted.[70] Those living on Tribal lands have very low adoption rates, mainly due to a lack of available infrastructure. What little data exist on broadband deployment in Tribal lands suggest that fewer than 10% of residents on Tribal lands have terrestrial broadband available.[71]

While it is important to respect the choices of those who prefer not to be connected, the different levels of adoption across demographic groups suggest that other factors influence the decision not to adopt. Hardware and service are too expensive for some. Others lack the skills to use broadband.

Broadband adoption among businesses, by contrast, is quite strong: Ninety-five percent of America's small and medium-sized businesses have adopted broadband.[72] Only 10% of small businesses are planning to upgrade to a faster Internet connection in the next 12 months.[73]

Subsequent chapters address adoption as well as the other elements of the broadband ecosystem that can help ensure America captures the full promise of broadband.

Exhibit 3-I: Broadband Adoption by American Adults by Socio-Economic and Demographic Factors



*Hispanics includes both English and Spanish-speaking Hispanics

CHAPTER 3 ENDNOTES

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4 Nielsen Company, Viewership on the Rise as More Video Content Spans All Three Screens, A2/M2 Three Screen Report 2 (2Q 2009) (Nielsen, Viewership on the Rise), *available at* http://blog.nielsen.com/nielsenwire/wp-content/uploads/2009/09/3ScreenQ209_US_rpt_090209.pdf; Lee Rainie & Dan Packel, Pew Internet & Am. Life Project, More Online, Doing More 3 (2001), *available at* http://www.pewinternet.org/~/media/Files/Reports/2001/PIP_Changing_Population.pdf.pdf (last visited Feb. 19, 2009); *see also* Omnibus Broadband Initiative, Broadband Performance, (forthcoming) (OBI, Broadband Performance).

5 comScore database.

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16 RAND Corp., The Global Positioning System, App. B—GPS History, Chronology, and Budgets 247–49 (1995), *available at* http://www.rand.org/pubs/monograph_reports/MR614/MR614.appb.pdf.

17 Sunlight Labs, Apps for America 2: The Data.gov Challenge, http://sunlightlabs.com/contests/appsforamerica2/ (last visited Feb. 19, 2010); FlyOnTime.us, http://flyontime.us (last visited Feb. 19, 2010).

18 *See* Consumer Elec. Ass'n, US Consumer Electronics Sales & Forecasts 2005–2010, at 33 (2010) (CEA, Electronics Sales & Forecasts) (87 percent); Niki Scevak, Forrester Research, Inc., Forrester Research Online Population Access and Demographic Model (2010) (81 percent); Horrigan, *Broadband Adoption and Use in America* at 13 (79 percent).

19 CEA, Electronics Sales & Forecasts 33.

20 CEA, Electronics Sales & Forecasts 33 ("Netbooks will overtake all other notebooks by 2011"); Goldman Sachs, Adobe Systems Inc. (ADBE) PC Refresh Beneficiary 15 (2009) (citing forecast of about 50 million units by 2013).

21 Number calculated using Commission data. *See* Office of Engineering and Technology, FCC, Equipment Authorization Search, https://fjallfoss.fcc.gov/oetcf/eas/reports/GenericSearch.cfm (last visited Feb. 22, 2010). The data represents applications for grants issued for new FCC IDs for equipment class parameters "PCE-PCS Licensed Transmitter held to ear" and "TNE-Licensed Non-Broadcast Transmitter Held to Ear." Data does not include applications for permissive changes and counts multiple entries for the same FCC ID only once.

22 Carolina Milanesi et al., Gartner, Inc., Forecast: Mobile Devices, Worldwide, 2003–2013, at tab 2 (Devices) (2009). We took the information from column L (2012 year), added rows 40 (Basic Phones) and 41 (Enhanced Phones) together (95 million) and compared the number with the number received when rows 43 (Smart Phones—Entry Level) and 44 (Smart Phone—Feature) are added together (109 million). This plan contains several references to Gartner. The Gartner Report(s) described herein, (the "Gartner Report(s)") represent(s) data, research opinion or viewpoints published, as part of a syndicated subscription service, by Gartner, Inc. ("Gartner"), and are not representations of fact. Each Gartner Report speaks as of its original publication date and the opinions expressed in the Gartner Report(s) are subject to change without notice.

23 *See* OnStar Explained, http://www.onstar.com/us_english/jsp/explore/index.jsp (last visited Mar. 1, 2010) (discussing OnStar).

24 Section 629 covers equipment used to receive video programming—including cable set-top boxes, televisions, and DVRs—as well as equipment used to receive other services offered over MVPD systems, including cable modems. *See* 47 U.S.C. § 549 (codifying section 629 of the Telecommunications Act of 1996); *Implementation of Section 304 of the Telecommunications Act of 1996; Commercial Availability of Navigation Devices*, CS Docket No. 97-80, Report and Order, 13 FCC Rcd 14775 (1998).

25 Dell'Oro Group Inc., Set-top Box Report 3Q09, at 89 (2009). Combined market shares for the two manufacturers (Motorola and Cisco) were 87% (2006), 86% (2007), and 92% (2008). *See id.*

26 *Cf.* CableLabs, Certified, Verified and Self-Verified Cable Products, http://www.cablelabs.com/opencable/udcp/downloads/OC_PNP.pdf (Aug. 26, 2009) (reporting 11 certified set-top boxes), *with supra* note 22 (calculating 850 wireless devices).

27 Letter from Neal M. Goldberg, Vice Pres. and Gen. Counsel, National Cable & Telecommunications Association, to Marlene H. Dortch, Secretary, FCC, CS Docket No. 97-80 (Dec. 22, 2009) at 1 (presenting report detailing CableCARD deployment and support).

28 Dell'Oro Group Inc., Set-top Box Report 2Q09 at 89 (2009).

29 These numbers include estimates for 4Q09. *See* Goldman Sachs, Telecom/Pay TV Industry Model 23–25 (2009).

30 Housing units are distinct from households. "A housing unit is a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters." U.S. Census Bureau, Households, Persons Per Household, and Households with Individuals Under 18 Years, 2000 http://quickfacts.census.gov/qfd/meta/long_71061.htm (last visited Feb. 28, 2010). In contrast, "A household includes all the persons who occupy a housing unit. . . . The occupants may be a single family, one person living alone, two or more families living together, or any other group of related or unrelated persons who share living arrangements." *Id.* There are 130.5 million housing units and 111.7 million households in the United States. U.S. Census Bureau, *Census Bureau Reports on Residential Vacancies and Homeownership* (press release), Feb. 2, 2010, at 3 tbl. 3, http://www.census.gov/hhes/www/housing/hvs/qtr409/files/q409press.pdf (Census Bureau, *Residential Vacancies and Homeownership*). Unoccupied housing units (the difference between the count of households and of housing units) include housing units vacant for sale or rent and those for occasional, temporary or seasonal use.

31 *See* OBI, Broadband Performance, The Broadband Availability Gap (forthcoming) (OBI, The Broadband Availability Gap).

32 *See* OBI, The Broadband Availability Gap. Note that this figure represents the capability of existing infrastructure, not current service offerings.

33 *See* OBI, The Broadband Availability Gap. Seven million housing units without access to 4 Mbps terrestrial service are outside the cable footprint and are more than approximately 11,000 feet from the nearest DSLAM location; 6 million housing units with 12 million people do not have access to any always-on service with actual download speeds of 768 Kbps or higher as they are more than approximately 16,000 feet from the nearest DSLAM. Note that the analysis excludes satellite broadband because satellite capacity is limited, as

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discussed in the working paper.

34 *See* OBI, The Broadband Availability Gap. In general, availability of access infrastructure capable of supporting a given download speed does not guarantee that service providers will offer service at those speeds. Note that these numbers do not take into account quality of service.

35 *See* OBI, The Broadband Availability Gap. Coverage reflects access at download speeds consistent with residential discussion; it does not necessarily reflect access to business-class broadband services.

36 *See* OBI, The Broadband Availability Gap; National Atlas of the United States, 2005-06, County Boundaries of the United States, 2001: National Atlas of the United States, Reston, VA (presenting map boundaries).

37 National Center for Educational Statistics, Internet Access in U.S. Public Schools and Classrooms: 1994–2005, at 4 (2006), *available at* http://nces.ed.gov/pubs2007/2007020.pdf.

38 Dep't of Educ., Evaluation of the Enhancing Education Through Technology Program: Final Report 12 (2009), *available at* www.ed.gov/rschstat/eval/tech/netts/finalreport.pdf.

39 *See infra* Chapter 10; *see also* Letter from Theresa Cullen, Rear Admiral, U.S. Public Health Service, Chief Information Officer and Director, Indian Health Service, to Marlene H. Dortch, Secretary, FCC (Feb. 23, 2010) Attach. In this instance, "mass market" refers to non-dedicated line solutions for businesses, which are similar to residential broadband but called "small business" or "business packages" by carriers.

40 Along with aggregate growth in broadband speeds, each technology has shown speed increases. For instance, cable typical advertised speeds have migrated from 1 Mbps in the late 1990s to roughly 10 Mbps today, a 20% annual growth rate. *See* OBI, Broadband Performance.

41 Robert C. Atkinson & Ivy E. Schultz, Columbia Institute for Tele-Information, Broadband In America: Where It Is And Where It Is Going (According To Broadband Service Providers) at 8 (2009) (Atkinson & Schultz, Broadband Report), *available at* http://www4.gsb.columbia.edu/citi/; *see also* Census Bureau, *Residential Vacancies and Homeownership* 3 tbl. 3.

42 Atkinson & Schultz, Broadband Report at 8.

43 Atkinson & Schultz, Broadband Report at 8 (top 5 cable company rankings based on subscribers).

44 Atkinson & Schultz, Broadband Report 8.

45 Atkinson & Schultz, Broadband Report 24.

46 Atkinson & Schultz, Broadband Report 8.

47 *See* Organisation for Economic Co-Operation and Development (OECD), Average advertised download speeds, by country (Sept. 2008) http://www.oecd.org/dataoecd/10/53/39575086.xls (last visited Dec. 22, 2009) (9.6 Mbps); FCC, 2008 Form 477 database (accessed Dec. 2009) (on file with the Commission) (6.7 Mbps). Note that 477 data is collected in speed "tiers" and reflects 2008 data. *See* OBI, The Broadband Availability Gap.

48 comScore database. The median speed is more representative of the speeds seen by the typical American consumer because the average speed is skewed upwards by a limited number of high-speed connections (>15 Mbps advertised). comScore monitored 200,000 computers for data usage and consumption, selected to represent American usage broadly (types of services, service providers, geographies, demographics, etc.). Speed testing was attempted every 36 hours at varying times of day and only done when a given computer was otherwise inactive. Speed tests were conducted using packets sent in ever-increasing size to measure average speeds experienced to end-users. Maximum speeds on each connection were determined based on maximum speeds achieved (+/- 10%) and with confirmation on a sample of bills in tandem with the FCC. Speed testing was conducted from the computer/device to the nearest Akamai server. This approach has been used for speed claims by 5 of the top 10 ISPs in America. *See* OBI, Broadband Performance (discussing the methodology and data further).

49 comScore database. *See* OBI, Broadband Performance.

50 Note that speeds experienced by the end-user can be impacted by many factors including the user's own equipment, the service provider network and the applications and sites being accessed online. In the first half of 2009, the median actual speed for those that subscribe to broadband in the United States was 3 Mbps download speed. comScore database. Given past annual growth rates in subscribed speed of approximately 20–25% per year, the median could exceed 4 Mbps by the end of 2010. *Cf.* Akamai, The State of the Internet, 3rd Quarter, 2009, at 10 (Jan 2010) *available at* http://www.akamai.com/dl/whitepapers/Akamai_State_Internet_Q3_2009.pdf?curl=/dl/whitepapers/Akamai_State_Internet_Q3_2009.pdf&solcheck=1& (registration required) (finding average download speeds to be 3.9 Mbps in the third quarter of 2009); *see also* OBI, Broadband Performance (discussing past growth rates).

51 comScore database. Note that fiber in the database refers to both fiber to the premises (FTTP) and short-loop fiber to the node (FTTN). According to the Form 477 database, FTTP advertised download speeds were 3-4 Mbps faster than comScore fiber average. For more data and detail on methodologies *see* OBI, Broadband Performance.

52 comScore database. Commission Form 477 data mirrors comScore advertised speed ranges of different technologies and relative advertised speeds, with important methodology differences for fiber. *See* OBI, Broadband Performance.

53 SamKnows Limited Comments in re NBP PN #24 (*Comment Sought on Broadband Measurement and Consumer Transparency of Fixed Residential and Small Business Services in the United States—NBP Public Notice #24*, GN Docket Nos. 09-47, 09-51, 09-137, Public Notice, DA 24 FCC Rcd 14120 (WCB, rel. Nov. 24, 2009) (*NBP PN #24*)), filed Dec. 16, 2009; Ofcom, UK Broadband Speeds 2009, at 8 (2009), *available at* http://www.ofcom.org.uk/research/telecoms/reports/broadband_speeds/broadband_speeds/broadbandspeeds.pdf.

54 Epitiro Comments in re NBP PN #24, filed Dec. 14, 2009, Apps. 1–4 (multiple appendices attached to comments detailing country results).

55 *See* American Roamer Advanced Services database (accessed Aug. 2009) (aggregating service coverage boundaries provided by mobile network operators) (on file with the Commission) (American Roamer database); *see also* Geolytics Block Estimates and Block Estimates Professional databases (2009) (accessed Nov. 2009) (projecting census populations by year to 2014 by census block) (on file with the Commission) (Geolytics databases). The approximate of 60% is based on total landmass area. In 2008, this figure was 39.6%. *Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993; Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services*, WT Docket No. 08-27, Thirteenth Report, 24 FCC Rcd 6185, 6257, tbl. 9 (WTB 2009).

56 Data from American Roamer shows geographic coverage by technology. The actual service quality of data connections experienced by end-users will differ due to a large number of factors, such as location and mobility. Further, the underlying coverage maps do not include information on the level of service (*i.e.*, signal quality and the speed of broadband service) provided; nor is coverage defined by providers in the same way. Thus, coverage as measured here does not correspond to a specific minimum signal quality or user experience. *See* American Roamer database; *see also infra* Chapter 4, Section 4.1 (Competition in Residential Broadband Networks) (discussing the American Roamer methodology). Population is based on projected census block figures from Geolytics. *See* Geolytics databases.

57 *See infra* Chapter 4, Section 4.1 (Transparency in the retail broadband market) (discussing details on a possible new approach to measurement and disclosure of mobile services).

58 *See* American Roamer database; Geolytics databases.

59 Data from American Roamer applied to business locations will suffer from the same quality of service issues (in-building coverage, varying bit rates) as residential. *See* American Roamer database; *see also* GeoResults National Business and Telecom database (accessed Nov. 2009) (projecting business locations) (on file with the Commission) (GeoResults database).

60 *See* American Roamer database; GeoResults database.

61 *See* American Roamer database; GeoResults database.

62 *See* Atkinson & Schultz, Broadband Report at 8; *see also* Verizon Wireless, Network Facts, http://aboutus.vzw.com/bestnetwork/network_facts.html (last visited Feb. 28, 2010) (providing Verizon's 4G roll-out plan, and coverage of 285 million people by its 3G network).

63 Atkinson & Schultz, Broadband Report at 27.

64 *See* Atkinson & Schultz, Broadband Report at 27. The figures are in millions of people covered.

65 *See* Letter from Dean R. Brenner, Vice Pres. Gov't Affairs, Qualcomm Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket 09-51 (Dec. 9, 2009) Attach.

66 *See* comScore database (discussing data on upload and download speeds); Chetan Sharma & Sarla Sharma, State of the (Mobile) Broadband Nation: A Benchmarking Study (2009), *available at* http://www.chetansharma.com/State%20of%20the%20Broadband%20Nation%20-%20

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67 Letter from Consumer Electronics Association et al., to Chairman Julius Genachowski and Commissioners, FCC, GN Docket No. 09-51 (Dec. 2, 2009) at 1.

68 Horrigan, *Broadband Adoption and Use in America* at 13.

69 Horrigan, *Broadband Adoption and Use in America* at 13.

70 Horrigan, *Broadband Adoption and Use in America* at 13.

71 For the purposes of the Plan, we define "Tribal lands" as any federally recognized Tribe's reservation, pueblo and colony, including former reservations in Oklahoma, Alaska Native regions established pursuant to the Alaska Native Claims Settlement Act (85 Stat. 688), and Indian allotments. The term "Tribe" means any American Indian or Alaska Native Tribe, Band, Nation, Pueblo, Village or Community which is acknowledged by the Federal government to have a government-to-government relationship with the United States and is eligible for the programs and services established by the United States. See Statement of Policy on Establishing a Government-to-Government Relationship with Indian Tribes, 16 FCC Rcd 4078, 4080 (2000). Thus, "Tribal lands" includes American Indian Reservations and Trust Lands, Tribal Jurisdiction Statistical Areas, Tribal Designated Statistical Areas, and Alaska Native Village Statistical Areas, as well as the communities situated on such lands. This would also include the lands of Native entities receiving Federal acknowledgement or recognition in the future. While Native Hawaiians are not currently members of federally-recognized Tribes, they are intended to be covered by the recommendations of this Plan, as appropriate.

72 Horrigan, *Broadband Adoption and Use in America* at 13. The survey offered a Spanish language option, so results for Hispanics include English- and Spanish-speaking Hispanics.

73 FCC, NBP Survey of Businesses.