

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)
)
Implementation of Section 6002(b) of the Omnibus)
Budget Reconciliation Act of 1993) WT Docket No. 15-125
)
Annual Report and Analysis of Competitive Market)
Conditions With Respect to Mobile Wireless,)
Including Commercial Mobile Services)

EIGHTEENTH REPORT

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By the Chief, Wireless Telecommunications Bureau:

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I. INTRODUCTION

1. Mobile wireless services are an essential part of Americans' daily lives. Mobile handsets are no longer used only for voice communication, email, social networking, and web browsing, but are increasingly used as hubs for entertainment, mobile commerce, home automation, and to connect other personal devices such as smart watches, fitness trackers, and health monitors. Further, mobile wireless serves a critical role in public

safety, enabling users to summon lifesaving help, receive timely alerts, and access pertinent information. These developments have made mobile wireless one of the most important sectors in the national economy. Preserving and promoting competition in mobile wireless services is central to the Commission's mission and is critical for driving innovation and investment to the ultimate benefit of the American consumer.

2. In this Eighteenth Mobile Wireless Competition Report ("*Report*"), the Federal Communications Commission ("Commission" or "FCC") fulfills its obligation, pursuant to section 332(c)(1)(C) of the Communications Act ("Act"), to report annually to Congress on the state of competition in mobile services. Following on from the *Seventeenth Report*, released in December 2014, which provided an analysis of market conditions and developments during 2013 and the first half of 2014,¹ this *Report* presents data and analysis covering the remainder of 2014 and the first half of 2015, to the extent data are available.² The analysis focuses on "competitive market conditions with respect to commercial mobile services," as required by the Act.³

3. In its presentation of a multitude of industry data on various aspects of mobile wireless competition,⁴ this *Report* follows the model adopted by the *Seventeenth Report*, which is data-centric, combining a concise analysis with a substantial use of Tables and Charts in accessible data formats.⁵ As with previous *Reports*, including the *Seventeenth Report*, the analysis in this *Report* is based on a consumer-oriented view of mobile services. This *Report* therefore follows our practice of undertaking an analysis of all mobile wireless services, including voice, messaging, and broadband.⁶ Consumers view various mobile voice, messaging, and data services as interchangeable with one another, and as a result, it is important to consider potential substitutes when analyzing the competitive landscape for these services, and to evaluate the mobile wireless industry as a whole, rather than just focusing on the provision of services classified as commercial mobile radio services ("CMRS").⁷ Thus, this *Report* analyzes competition across the entire mobile wireless marketplace, including key market segments such as spectrum and infrastructure.

¹ See Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993; Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services, WT Docket No. 13-135, *Seventeenth Report*, 29 FCC Rcd 15311 (WTB 2014) ("*Seventeenth Report*").

² For instance, some of the data are only published as year-end numbers and are publicly available only in the middle of the following year. Quarterly and annual SEC filings for the public wireless service providers are available soon after the release of their financial releases; however, aggregate industry data for public and non-public service providers tend only to be available after they have been compiled by analysts and trade associations based on their set releases. For example, all CTIA – The Wireless Association ("CTIA") data are now released based on year-end data available in its annual report published a few months after the close of its industry survey. For these data, we are able to present only annualized numbers with no mid-year updates.

³ 47 U.S.C. § 332(c)(1)(C).

⁴ 47 U.S.C. § 332(c)(1)(C). As with previous *Reports*, this *Report* does not address the merits of any license transfer applications that are currently pending before the Commission or that may be filed in the future, which will be decided based on the record collected in each proceeding.

⁵ Following that practice, we are providing the charts and tables in the *Report* and its Appendices, as well as much of the underlying data, on a dedicated website that we intend to update before the release of the next *Report* as new data becomes available. See FCC Mobile Wireless Competition Reports, available at https://www.fcc.gov/reports-research/reports?og_group_ref_target_id=1638&field_report_series_tid=1733&shs_term_node_tid_depth=All&=Apply.

⁶ See, e.g., *Seventeenth Report*, 29 FCC Rcd at 15348 ¶ 71.

⁷ See, e.g., *Seventeenth Report*, 29 FCC Rcd at 15314 ¶ 3; Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993; Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services, WT Docket No. 11-186, *Sixteenth Report*, 28 FCC Rcd 3700, 3734 ¶ 20 (2014) ("*Sixteenth Report*"). We note that previous *Reports* have therefore included in their analysis a consideration of mobile broadband service before the reclassification of that service in the 2015 *Open Internet Order*. See Protecting and Promoting the Open Internet, GN Docket No. 14-28, *Report and Order on Remand, Declaratory Ruling, and Order*, 30 FCC

4. Congress enacted the requirement in 1993 that the Commission report annually on “competitive market conditions with respect to commercial mobile services.”⁸ At the same time, it created the statutory classification of “commercial mobile services” to promote the consistent regulation of mobile radio services that are similar in nature,⁹ and established the promotion of competition as a fundamental goal for CMRS policy formation and regulation.¹⁰ In particular, the statute requiring the annual report on CMRS competition states:

The Commission shall review competitive market conditions with respect to commercial mobile services and shall include in its annual report an analysis of those conditions. Such analysis shall include an identification of the number of competitors in various commercial mobile services, an analysis of whether or not there is effective competition, an analysis of whether any of such competitors have a dominant share of the market for such services, and a statement of whether additional providers or classes of providers in those services would be likely to enhance competition.¹¹

5. This *Report* complies with the statutory requirements for analyzing competitive market conditions with respect to commercial mobile services. This *Report* analyzes competition in the mobile wireless services marketplace, as well as examining competition across the entire mobile wireless ecosystem. We analyze the competitive rivalry between service providers in the mobile wireless marketplace and how that competitive rivalry, innovation, and investment benefit American consumers. Consistent with the Commission’s first seven *Reports*, and the *Fourteenth Report* and subsequent *Reports*, this *Eighteenth Report* does not reach an overall conclusion or formal finding regarding whether or not the CMRS marketplace was effectively competitive, but rather it provides an analysis and description of the CMRS industry’s competitive metrics and trends.¹² Given the complexity of the various inter-related segments and services within the mobile wireless ecosystem, any single conclusion regarding the effectiveness of competition would be incomplete and possibly misleading in light of the complexities we observe.¹³ This *Report* instead focuses on presenting the best data available on various aspects of competition throughout the mobile wireless ecosystem and highlights several key trends.

6. First, this *Report* provides an analysis of the overall competitive dynamics of the industry, describing the various operating entities and their relative positions using indices such as market share, subscribership (totals, additions, and churn), as well as various financial indicators.¹⁴ The *Report* then presents a broad overview of industry trends and developments in the mobile marketplace that have taken place since the

Rcd 5601, 5715 ¶ 388 (2015) (“2015 *Open Internet Order*”).

⁸ 47 U.S.C. § 332(c)(1)(C). As noted in previous *Reports*, any individual proceeding in which the Commission defines relevant product and geographic markets, such as an application for approval of a license transfer, may lead to narrower or broader market(s) than any used, suggested, or implied in this *Report*. See, e.g., *Seventeenth Report*, 29 FCC Rcd at 15360 ¶ 100.

⁹ Omnibus Budget Reconciliation Act of 1993, Pub. L. No. 103-66, Title VI, § 6002(b), amending the Communications Act of 1934 and codified at 47 U.S.C. § 332(c).

¹⁰ 47 U.S.C. § 332 (a)(3).

¹¹ 47 U.S.C. § 332 (c)(1)(C).

¹² This is in contrast to the *Eighth Report* through the *Thirteenth Report*, which included a specific finding that there was effective competition in the provision of CMRS service without defining the term “effective competition.” See, e.g., 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, 6310 ¶ 274 (WTB 2009) (“*Thirteenth Report*”).

¹³ We note that there is no definition of “effective competition” widely accepted by economists or competition policy authorities such as the U.S. Department of Justice (“DOJ”). See *Seventeenth Report*, 29 FCC Rcd at 15315 ¶ 6.

¹⁴ Unless stated otherwise, dollar figures stated in this *Report* have not been adjusted for inflation (*i.e.*, they are nominal dollars).

Seventeenth Report, such as increased network coverage, subscribership growth, and the adoption and deployment of technologies. The *Report* then turns to an analysis of key inputs necessary for provision of mobile service, such as spectrum and network infrastructure. Spectrum, in particular, is a critical input that wireless service providers need for the provision of mobile wireless services, and this *Report* examines the distribution of spectrum in the various bands. Next, the *Report* analyzes recent developments in the ways service providers compete for and attract subscribers through pricing innovations, such as the decreased reliance on traditional handset subsidies and term contracts. The *Report* then analyzes competitive rivalry in non-price factors, such as the coverage, service quality, and speed of providers' service offerings. Finally, the *Report* considers developments in the downstream mobile wireless ecosystem as well as issues such as consumer access to information and intermodal developments.

7. In addition to providing an analysis of market conditions, the *Report* highlights the Commission's policies and actions designed to enhance competition. For example, the Commission is making more spectrum available to existing mobile service providers and potential new entrants through competitive bidding, such as in the upcoming Incentive Auction and promoting innovative new approaches, which includes spectrum sharing in the 3.5 GHz Band.¹⁵ The Commission's policies have been guided by the goal of promoting and preserving competition, which in turn has facilitated the ability of consumers to make choices among numerous service providers and leads to lower prices, improved quality, and increased innovation.¹⁶

II. COMPETITIVE DYNAMICS WITHIN THE MOBILE WIRELESS INDUSTRY

8. We begin our analysis by providing a discussion of the various competitive dynamics within the industry.¹⁷ We note that providers of mobile wireless services typically offer an array of mobile voice and data services, including interconnected mobile voice services, text and multimedia messaging, and mobile broadband Internet access services.¹⁸ Facilities-based mobile wireless service providers offer such services primarily using their own network facilities, although coverage areas often are supplemented through roaming agreements, and may operate nationwide, multi-regional, regional, or local networks.¹⁹ In this section, we present information and

¹⁵ See Broadcast Incentive Auction Scheduled to Begin on March 29, 2016, Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying To Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward), AU Docket No. 14-252, GN Docket No. 12-268, WT Docket No. 12-269, MB Docket No. 15-146, *Public Notice*, 30 FCC Rcd 8975 (2015) ("*Auction 1000 Bidding Procedures Public Notice*"); Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, *Report and Order and Second Further Notice of Proposed Rulemaking*, 30 FCC Rcd 3959 (2015) ("*3.5 GHz Order and 2nd FNPRM*").

¹⁶ See Policies Regarding Mobile Spectrum Holdings; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, WT Docket No. 12-269, GN Docket No. 12-268, *Report and Order*, 29 FCC Rcd 6133, 6144 ¶ 17, 6193 ¶ 143 (2014) ("*Mobile Spectrum Holdings Report and Order*"), *recon. denied, Order on Reconsideration*, 30 FCC Rcd 8635 (2015) ("*Mobile Spectrum Holdings Reconsideration Order*"). Our public interest evaluation necessarily encompasses the "broad aims of the Communications Act," which include, among other things, a deeply rooted preference for preserving and enhancing competition in relevant markets, accelerating private sector deployment of advanced services, and generally managing the spectrum in the public interest. See, e.g., Applications of AT&T Mobility Spectrum LLC, New Cingular Wireless PCS, LLC, Comcast Corporation, Horizon Wi-Com, LLC, NextWave Wireless, Inc., and San Diego Gas & Electric Company for Consent To Assign and Transfer Licenses, WT Docket No. 12-240, *Memorandum Opinion and Order*, 27 FCC Rcd 16459, 16472 ¶ 34 (2012) ("*AT&T WCS Order*").

¹⁷ We discuss in sections V. and VI. below additional aspects in the competitive dynamics of the industry when we discuss elements of price and non-price rivalry.

¹⁸ We note that mobile wireless services also include machine-to-machine connections for fleet management systems, smart grid devices, vehicle tracking, home security systems, and other telematics services. Fixed wireless services currently are not included in our analysis of mobile wireless services.

¹⁹ Some data and messaging services offered by facilities-based providers rely only on Internet Protocol ("IP")-based, packet-switched networks, but most mobile voice services continue to connect to the Public Switched Telephone Network ("PSTN") and rely on North American Numbering Plan ("NANP") telephone numbers.

data on all mobile wireless services as well as on individual services and segments where appropriate, and where the data are available.

A. Service Providers

1. Facilities-Based Service Providers

9. *Nationwide Service Providers.* As of year-end 2014, there were four facilities-based mobile wireless service providers in the United States that industry observers typically describe as “nationwide”: AT&T,²⁰ Sprint,²¹ T-Mobile,²² and Verizon Wireless.²³ Although none of these four service providers has a network that covers the entire land area or population of the United States, each has a network that covers a significant portion of both and therefore these four service providers will be referred to as “nationwide service providers” throughout this *Report*.²⁴

10. *Multi-Regional, Regional, and Local Service Providers.* US Cellular is a multi-regional service provider that has developed wireless networks and customer service operations in portions of 23 states and as of December 31, 2014, provided services to approximately 4.8 million customers.²⁵ US Cellular relies on roaming agreements with nationwide service providers, as well as other smaller service providers, to supply service to its

²⁰ AT&T Mobility began operations in October 2000 as a joint venture between AT&T and BellSouth and, in 2004, acquired AT&T Wireless Services, Inc. Upon AT&T’s acquisition of BellSouth in 2006, AT&T Mobility became a wholly-owned subsidiary. See AT&T Inc., Form 10-K, for the fiscal year ended December 31, 2014, at 2, available at https://www.sec.gov/Archives/edgar/data/732717/000073271715000016/ye14_10k.htm.

²¹ Sprint Nextel was created by the merger in 2005 of Sprint Corp. and Nextel Communications, Inc. See 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. 05-71, *Tenth Report*, 20 FCC Rcd 15908, 15931 ¶ 60 (2005). On July 5, 2013, the Commission released an order approving the acquisition of Sprint by SoftBank Corp., and Sprint’s acquisition of 100% of Clearwire’s stock. See Applications of Sprint Nextel Corp. and SoftBank Corp. and Starburst II, Inc. for Consent To Transfer Control of Licenses and Authorizations, IB Docket No. 12-343, *Memorandum Opinion and Order, Declaratory Ruling, and Order on Reconsideration*, 28 FCC Rcd 9642, 9643-44 ¶¶ 1-4 (2013) (“*Softbank-Sprint-Clearwire Order*”).

²² T-Mobile traces its roots to May 2001, when Deutsche Telekom AG acquired VoiceStream Wireless and Powertel. In September 2002, they were re-branded with the T-Mobile brand name. See T-Mobile USA Inc., Form 10-K, for the fiscal year that ended December 31, 2002, at 2, available at <http://www.sec.gov/Archives/edgar/data/1097609/000089102003000720/v88048ore10vk.htm>. Most recently, on March 12, 2013, the application of Deutsche Telekom, T-Mobile, and MetroPCS was approved, which resulted in the creation of T-Mobile USA as a wholly-owned subsidiary of Deutsche Telekom. See Applications of Deutsche Telekom AG, T-Mobile USA, Inc., and MetroPCS Communications, Inc. for Consent To Transfer of Control of Licenses and Authorizations, WT Docket No. 12-301, *Memorandum Opinion and Order and Declaratory Ruling*, 28 FCC Rcd 2322, 2323-24 ¶¶ 1-2 (WTB, IB 2013) (“*T-Mobile-MetroPCS Order*”).

²³ As of December 31, 2013, Verizon owned a controlling 55% interest in Verizon Wireless and Vodafone owned the remaining 45%. On September 2, 2013, Verizon entered into a stock purchase agreement with Vodafone and Vodafone 4 Limited, pursuant to which Verizon agreed to acquire Vodafone’s indirect 45% interest in Cellco Partnership d/b/a Verizon Wireless for approximately \$130 billion. Verizon completed the transaction on February 21, 2014 and acquired 100% ownership of Verizon Wireless. See Verizon Communications, Inc., SEC Form 10-K, for the fiscal year that ended December 31, 2013, at 2, available at <https://www.sec.gov/Archives/edgar/data/732712/000119312514073266/d622994d10k.htm>.

²⁴ All four nationwide service providers hold spectrum in the continental United States, as well as in Hawaii and Alaska.

²⁵ See United States Cellular Corp., SEC Form 10-K, at 1 (filed Feb. 25, 2015), available at http://www.sec.gov/Archives/edgar/data/821130/000082113015000010/form_10k.htm. USCC is a majority-owned (84%) subsidiary of Telephone and Data Systems, Inc. See *id.*

customers when they travel to areas not covered by its networks. C Spire and nTelos²⁶ are two other regional service providers with substantial market presence in certain parts of the country. There are also dozens of regional and local facilities-based service providers²⁷ throughout the continental United States, Alaska, and Hawaii that typically provide service in a single geographical area, many of them rural areas.²⁸ As the Commission noted in the *Mobile Spectrum Holdings Report and Order*, non-nationwide service providers are important sources of competition in rural areas, enhancing competitive choices for consumers in the mobile wireless marketplace, and helping to promote deployment in rural areas.²⁹

2. Resellers/Mobile Virtual Network Operators and Other Service Providers

11. *Resellers/MVNOs.* Resellers and mobile virtual network operators (“MVNOs”) do not own any network facilities, but instead they purchase mobile wireless services wholesale from facilities-based providers and resell these services to consumers.³⁰ An agreement between an MVNO and a facilities-based service provider may be more likely to occur when the MVNO has better access to some market segments than the host facilities-based service provider, and can potentially target specific market segments such as low-income consumers or consumers with low-usage needs.³¹ Unlike facilities-based service providers, MVNOs do not engage in non-price rivalry by creating capacity through network investments, network upgrades, or network coverage. In 2014, the largest MVNO, with approximately 26 million subscribers at year-end, was TracFone Wireless (“TracFone”).³²

²⁶ nTelos recently entered into agreements with Shenandoah Personal Communications, LLC (“Shenandoah”) and Sprint pursuant to which nTelos would become a wholly-owned subsidiary of Shenandoah, and all of nTelos’s spectrum licenses would be assigned to Sprint. See Application To Assign Licenses from NTELOS Inc. to SprintCom, Inc., ULS File No. 0006917154 (lead application) (filed Aug. 25, 2015).

²⁷ Some regional facilities-based service providers include, but are not limited to, Alaska Communications Systems, Bluegrass Cellular, Carolina West Wireless, Cellcom, Choice Wireless, Nex-Tech Wireless, Pioneer, and Sagebrush Cellular.

²⁸ Verizon Wireless’s LTE in Rural America (“LRA”) program allows Verizon Wireless to offer its customers 4G LTE coverage in the rural areas of its rural partners, and the program allows customers of participating companies to roam on Verizon Wireless’s 4G LTE network throughout the U.S., including Alaska. See “Verizon’s LTE in Rural America (LRA) Program Celebrates Five Years of Delivering Advanced Wireless Services to Rural Customers,” available at <http://www.verizonwireless.com/news/article/2015/05/verizons-lte-in-rural-america-lra-program-celebrates-five-years-of-delivering-advanced-wireless-services-to-rural-customers.html>; “Verizon: All 21 LTE in Rural America Carrier Partners Have Launched Service,” available at <http://www.fiercewireless.com/story/verizon-all-21-lte-rural-america-carrier-partners-have-launched-service/2015-10-15>.

Sprint has partnered with the Competitive Carriers Association (“CCA”) and Net America to launch the Net America alliance, which should allow Sprint customers to obtain 4G LTE service via roaming in rural areas and allow customers of participating companies to roam on Sprint’s 4G LTE network throughout the U.S. See Net America Alliance website, “SMART Delivers the Future to Rural America,” available at <http://www.netamericaalliance.com/smart>.

²⁹ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6207 ¶¶ 179-80.

³⁰ According to Verizon Wireless, “MVNOs execute a contract with [the facilities-based provider] to buy wireless service from [the facilities-based provider] to resell under their own brand to customers and perform all marketing, billing, collections and customer service for the customers they activate. MVNOs establish and maintain the relationship with its customers. MVNOs own the relationship with their customers and establish their own calling plans and pricing.” See Verizon Wireless, “Authorized Retailers and MVNOs,” available at <http://www.verizonwireless.com/b2c/aboutUs/reseller/authorizedAgentIndex.jsp>.

³¹ See P. Kalmus and L. Wiethaus, “On the Competitive Effects of Mobile Virtual Network Operators,” *Telecommunications Policy*, Vol. 34, 2010, at 263, 266, 268; A. Banerjee and C. Dippon, “Voluntary Relationships Among Mobile Network Operators and Mobile Virtual Network Operators: An Economic Explanation,” *Information Economics and Policy*, Vol. 21, 2009, at 72. See also The Yankee Group, Jason Armitage, “Yankee Group’s 2011 Predictions: 4G Fuels the Decade of Disruption,” at 7 (stating, “[I]t’s critical the MVNO does not compete to any meaningful degree with the host.”).

³² See TracFone website, available at <http://www.tracfone.com/>; <http://www.prepaidphoneweb.com/2015/02/fouth-quarter-2014-prepaid-mobile.html>. Examples of other MVNO companies include, but are not limited to, Straight Talk, H2O

12. *Mobile Satellite Service Providers.* Mobile Satellite Services (“MSS”) providers offer satellite-based communications to mobile devices. Traditionally, MSS has involved voice and narrowband data services. MSS services are generally targeted at users who require service in remote areas, in disaster response situations, or other places where terrestrial mobile wireless network access may be limited. Examples of MSS customers include the oil industry, maritime users, public safety agencies, and other government/military operations.

13. *Narrowband Data Service Providers.* Narrowband data and paging services comprise a specialized market segment of the mobile wireless industry. These services include two-way messaging, as well as machine-to-machine and other telemetry communications, and are consumed primarily by businesses, government users, and other institutions.³³

B. Connections, Net Additions, and Churn

1. Subscribers, Total Connections, and Net Additions

14. This *Report* uses several data sources to estimate the number of mobile wireless subscribers and connections. One source, the Numbering Resource Utilization Forecast (“NRUF”), tracks the quantity of phone numbers that have been assigned to mobile wireless devices.³⁴ As shown in Chart II.B.1 below, in the period since the *Seventeenth Report*, the total number of connections continued to grow strongly. Based on NRUF, the number of mobile wireless connections in December 2013 were approximately 340 million, and connections grew by approximately five percent during 2014 to reach approximately 357 million by year-end 2014. CTIA also estimated the total number of mobile wireless connections,³⁵ and found that the number of connections grew by approximately six percent during that same period, from approximately 336 million at year-end 2013 to approximately 355 million at year-end 2014.³⁶ Chart II.B.2 presents data on total connections by service segment and shows that in 2014, the postpaid segment accounted for more than 60 percent of the total connections, while the prepaid connections accounted for approximately 20 percent of the total connections. Wholesale connections and connected devices are a small but growing part of total mobile wireless connections.³⁷ Similar patterns were observed through the first half of 2015.

Wireless, Ultra Mobile, Net10, LycaMobile, Telcel America, Simple Mobile, Red Pocket, Pure Talk, Ting, iWireless, and Voyager. See Amgoo, “Mobile Industry Insider,” MVNO list, available at <http://www.amgoo.com/blog/the-big-mvno-list-83-mvno-providers-in-usa>.

³³ There is approximately 7 megahertz of spectrum allocated to narrowband and paging services and there are hundreds of licensees for these services, including private individuals, firms, and local and state governments.

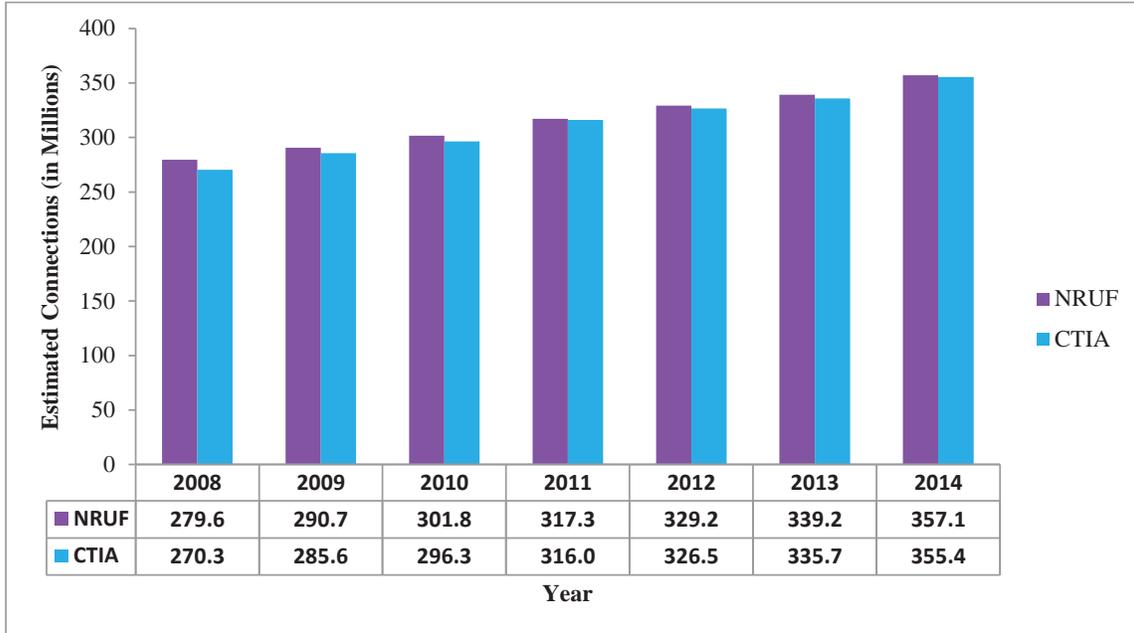
³⁴ When all mobile wireless devices were assigned telephone numbers and subscribers generally carried one mobile device for making voice calls, NRUF was a reasonably accurate measure of subscribership. Currently, however, consumers are more likely to use more than one mobile device that have been assigned telephone numbers – particularly non-voice devices, such as Internet access devices (*e.g.*, wireless modem cards and mobile Wi-Fi hotspots), e-readers, tablets, and telematics systems. In addition, certain mobile broadband service providers do not assign telephone numbers to at least some of the devices on their networks. Therefore, NRUF is becoming less useful in measuring the number of individual subscribers. Instead, it provides a measure of the number of mobile wireless connections or connected devices, although we note that it will become a less accurate measure of connected devices to the extent that more are sold that do not use telephone numbers.

³⁵ CTIA states that “the terms subscriber, subscriptions, and connections are being used interchangeably” in their report and survey. See CTIA Year-End 2014 Wireless Indices Report, at p. 12.

³⁶ See Appendix Table II.B.i for detailed data on total mobile wireless connections.

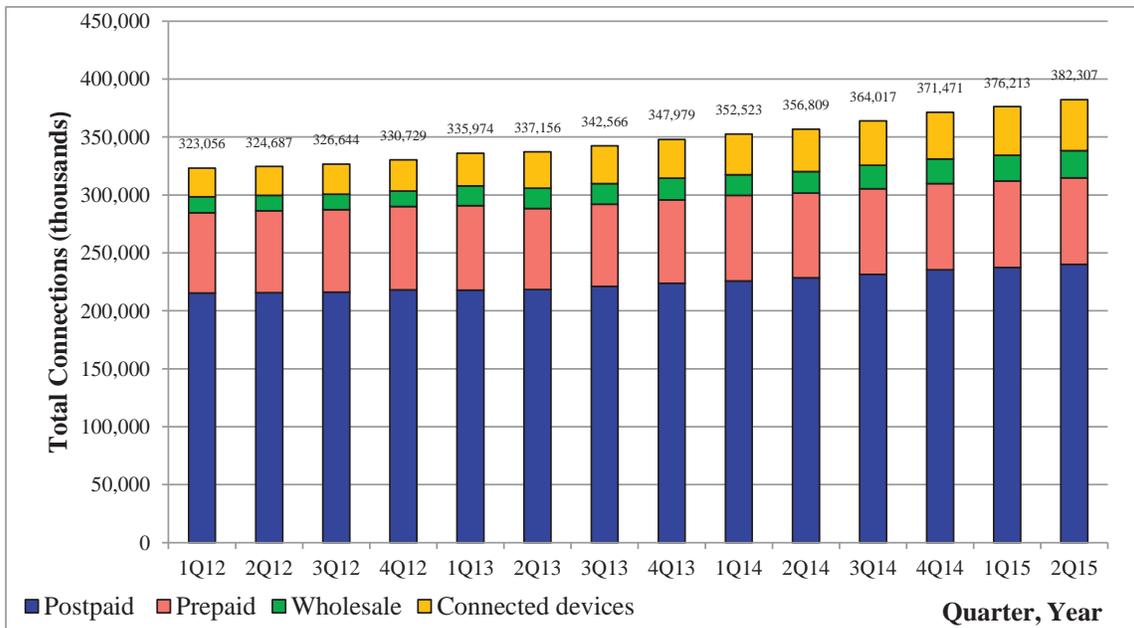
³⁷ See Appendix Table II.B.ii for detailed data on total mobile wireless connections by service segment.

Chart II.B.1
Total Mobile Wireless Connections: 2008 – 2014



Source: NRUF and CTIA (CTIA Year-End 2014 Wireless Indices Report, Table 6).

Chart II.B.2
Quarterly Total Mobile Wireless Connections by Service Segment: 2012 – 1st Half 2015



Source: UBS Investment Research. US Wireless 411 Version 51, Figure 17; US Wireless 411 Version 57, Figure 31.

15. Table II.B.1 presents data on total mobile wireless connections of the larger service providers operating in the United States. This Table shows that as of year-end 2014, and in mid-2015, Verizon Wireless and AT&T together accounted for approximately two-thirds of the estimated connections, while T-Mobile and Sprint together accounted for slightly less than one-third. As of year-end 2014, T-Mobile had approximately 55 million connections, compared to approximately 56 million for Sprint. By mid-2015, T-Mobile had seen an increase in its number of connections to approximately 59 million, and Sprint had also seen an increase in its connections to approximately 58 million. By mid-2015, regional service providers accounted for well under two percent of total connections.³⁸

Table II.B.1
Estimated Total Connections for Publicly Traded Facilities-Based Mobile
Wireless Service Providers (in thousands): 2012 – 1st Half 2015

Nationwide Service Providers	EOY 2012	EOY 2013	EOY 2014	June 30, 2015
Verizon Wireless	116,570	125,535	134,612	136,641
AT&T	106,965	110,276	120,620	123,932
T-Mobile	30,299	46,684	55,018	58,908
Sprint	55,626	54,622	55,929	57,668
Nationwide Service Provider Total	309,460	337,117	366,179	377,149
Regional Service Providers	EOY 2012	EOY 2013	EOY 2014	June 30, 2015
US Cellular	5,798	4,774	4,760	4,779
Metro PCS	8,887	*	*	*
Leap Wireless	5,297	4,551	*	*
NTELOS	440	465	449	379
Cincinnati Bell	398	340	82	*
Regional Service Provider Total	20,820	10,130	5,291	5,158
Total Estimated Connections	330,279	347,247	371,470	382,307

Source: UBS US Wireless 411 Report. Version 51 2014 Q1, Table 21. UBS US Wireless 411 Version 57, Figure 41. Total estimated connections figure includes data only for the service providers reported in this table.

16. All four nationwide service providers provide service directly to consumers and businesses and also provide machine-to-machine (“M2M”) services.³⁹ Later in this *Report*, detailed data and analysis are provided on retail voice and broadband services; however, there are limited statistics on M2M communications. For 2014, Berg Insight, for example, reports that AT&T led the U.S. market with approximately 16 million M2M

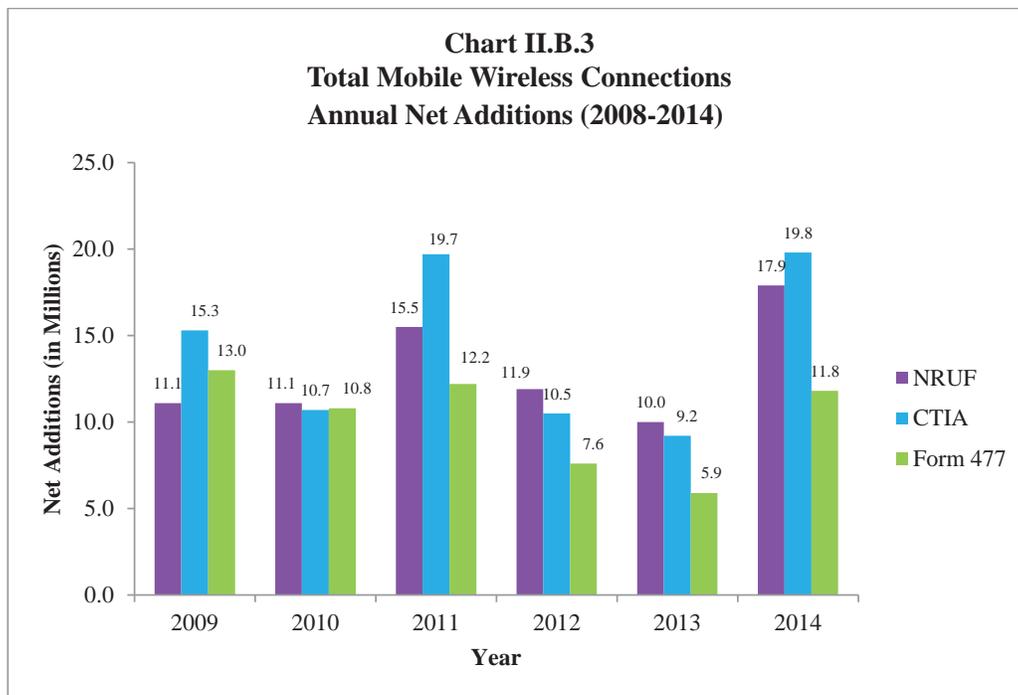
³⁸ We note that C Spire, the largest privately held service provider in the U.S., whose total number of connections are not reflected in this Table, states that it has nearly 1 million subscribers, with its primary service area in the Southeastern U.S. See “C Spire, Who We Are,” available at http://www.cspire.com/company_info/about/more_info.jsp.

³⁹ M2M is a subset of the larger Internet of Things (“IoT”), and aside from differing definitions, researchers may be including or excluding connections that are not specifically defined by the industry as M2M. These variations make it difficult to compare data from multiple reported sources. The IoT is seen by some commentators as the next major opportunity for providing advanced connections among devices, and many industries such as healthcare are beginning to transform to use M2M networks to connect their numerous smart devices and machines.

subscribers, ahead of Verizon Wireless at approximately 9 million.⁴⁰ SNL Kagan reports that in the second quarter of 2015, AT&T had a connected device base of 23.4 million, Verizon Wireless had 16.3 million, Sprint had 8 million, and T-Mobile had 4.5 million.⁴¹ Many research firms forecast that the overall trends for M2M will become more significant as new and existing network service providers continue to deliver connectivity between devices, sensors, monitors, etc., and their networks.

2. Subscribers and Net Additions

17. As shown in Chart II.B.3 below, net additions for 2014 totaled approximately 18 million based on NRUF data, and approximately 20 million based on CTIA data. In addition, we include mobile voice and internet subscriber data as reported by service providers on Form 477, which generally show a lower number of subscriber additions than NRUF. For 2014, Form 477 shows that net subscriber additions totaled approximately 12 million.



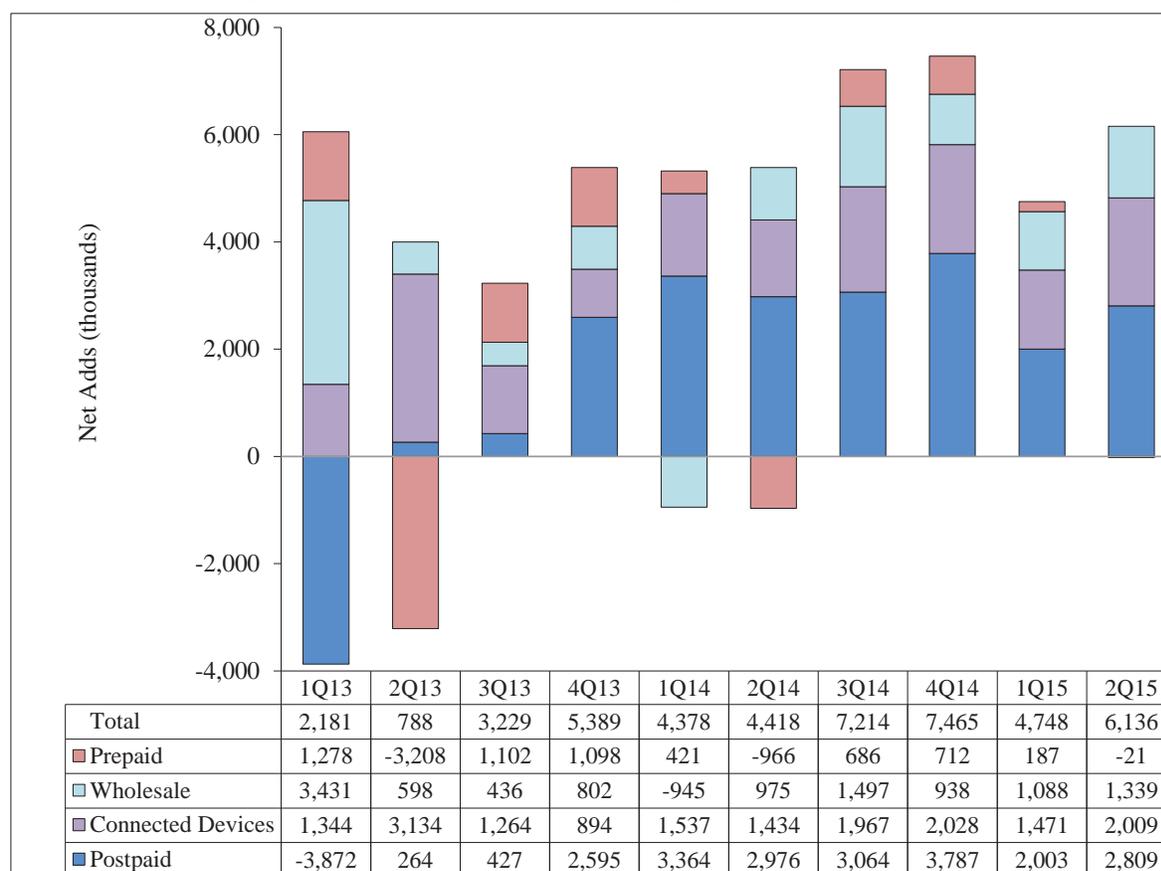
Source: NRUF and CTIA (CTIA Wireless Industry Indices Year-End 2014, Table 6), Form 477.

⁴⁰ See PR Newswire, “The Global Wireless M2M Market – 6th Edition,” available at <http://www.prnewswire.com/news-releases/the-global-wireless-m2m-market--6th-edition-300022274.html>. Further, Chetan Sharma Consulting reports that total M2M subscribers for the U.S. were 22.7 million at year-end 2014, which increased by 1.1 million (or approximately 5%) by 2Q 2015 to 23.8 million. They noted that one of the major growth areas is the connected car segment in which major manufacturers have started including wireless connectivity in their offerings. See <http://www.chetansharma.com/research.htm>.

⁴¹ SNL Kagan defines connected devices to include tablets/eReaders with 3G/4G, cars with 3G/4G, wearables, eHealth, etc. See SNL Kagan: “Smart pipes: Mobile projections through 2025” (Oct. 12, 2015) (complete list of connections included in its examples of connected devices).

18. Chart II.B.4 below shows that the net number of connected device additions was consistently higher than prepaid additions during through the first half of 2014.⁴² Postpaid net additions showed significant growth during 2014, and while there was a slight dip in the first quarter of 2015, postpaid net additions grew in the second quarter of 2015. Chart II.B.4 also shows that prepaid additions have continued to decline as a percentage of total quarterly net additions.

Chart II.B.4
Quarterly Net Additions by Service Segment: 2013 – 1st Half 2015

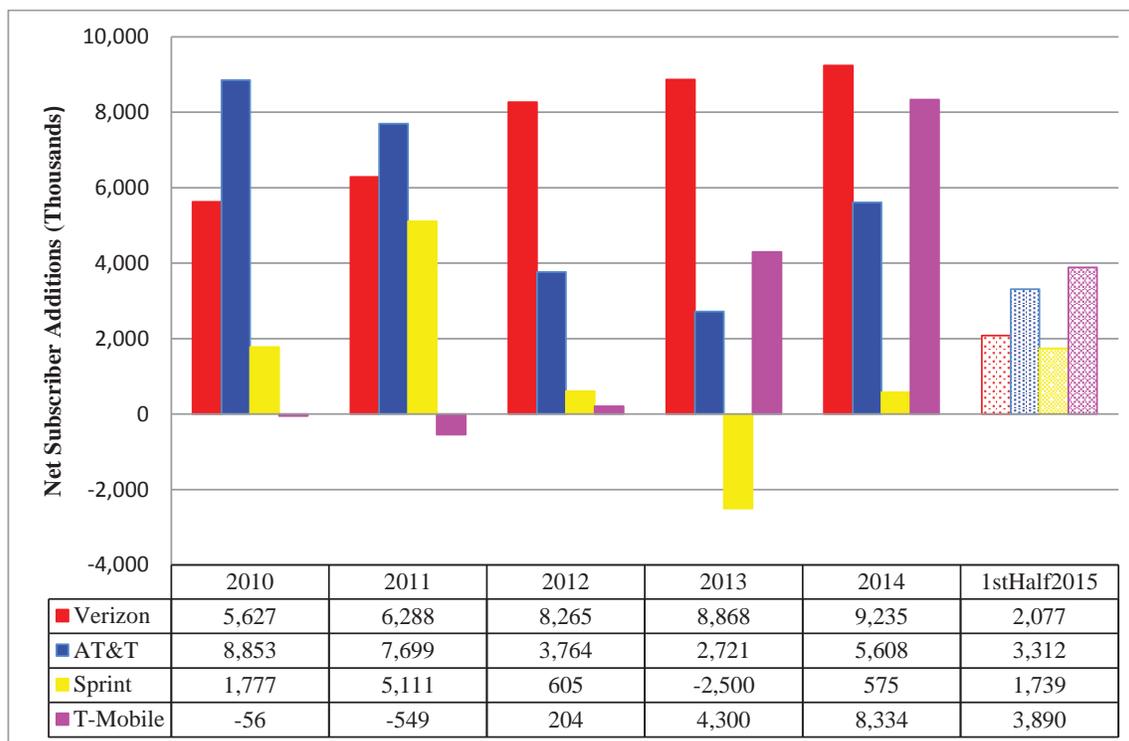


Source: UBS Investment Research. UBS US Wireless 411 Version 57, Figure 31.

19. Chart II.B.5 below shows net subscriber additions by the four nationwide service providers from 2010 through the first half of 2015. While Chart II.B.5 shows that AT&T and Verizon Wireless continue to show strong growth, of particular note is T-Mobile, which nearly doubled its net additions between 2013 and 2014, and this trend in net additions has continued strongly into 2015. In addition, we note that while Sprint's net subscriber additions were negative in 2013, its net additions were positive in 2014. Further, through the first half of 2015, its net subscriber additions jumped sharply.

⁴² See Appendix Table II.B.iii for detailed data on quarterly net additions by service segment.

Chart II.B.5
Annual Net Additions by Service Provider: (2010 – 1st Half 2015)



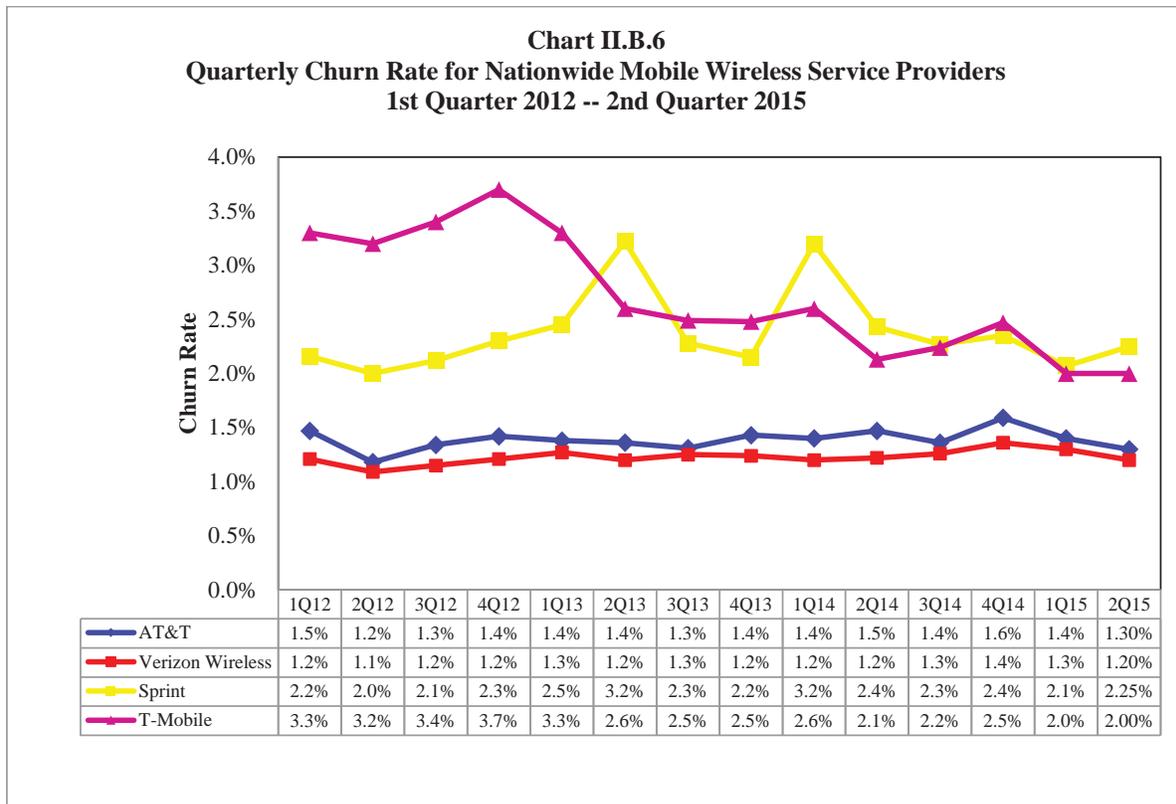
Source: UBS Investment Research. UBS US Wireless 411 Version 51, Figure 14: UBS US Wireless 411 Version 57, Figure 50.

3. Churn

20. Churn measures the number of connections that are disconnected from mobile wireless service during a given period time period, and is usually expressed as a percentage.⁴³ Service providers publish their monthly churn rate information as part of their quarterly filings with the SEC. A service provider's churn rate depends on many factors, including the distribution of its customers between postpaid and prepaid service plans, customer satisfaction with their service provider, service provider switching costs, and competition. The average industry monthly churn rates from the first quarter of 2012 to the second quarter of 2015 have ranged from 1.44 percent to 1.85 percent.⁴⁴ Churn rates of the nationwide facilities-based service providers, as shown in Chart II.B.6 below, ranged from approximately 1 percent for Verizon Wireless and AT&T to approximately 2 percent for T-Mobile and Sprint for the second quarter of 2015.

⁴³ Churn is calculated by dividing the aggregate number of wireless subscriber connections who canceled service during a period by the total number of wireless subscriber connections at the beginning of that period. The churn rate for the period is equal to the weighted average of the churn rate for each month of that period, *e.g.*, the three months in a quarter or the twelve months for an annual churn rate. Thus, a monthly churn rate of 1% averaged over the three-month reporting period would also be reported as 1%. For example, if a service provider has an average monthly churn rate of 2% in each month of a year, the service provider would lose approximately 24% of its subscriber connections over the course of the year.

⁴⁴ See UBS Investment Research. US Wireless 411 Version 57, Figure 48.



Source: UBS Investment Research. US Wireless 411 Version 49, Table 16. US Wireless 411 Version 51, Figure 28. US Wireless 411 Version 57, Figure 22.

C. Market Shares and Concentration

21. Revenues and connections or subscribers, presented in Table II.C.1 below, are key metrics that are used to measure the size of a company. In turn, the size of a company relative to the total size of the industry determines market share, which is generally calculated as the percentage of an industry or market's total revenues earned (or number of customers served) by a particular company over a specified time period. In general, changes in market share may provide a signal of the relative competitiveness of a company's products or services. Nationwide (and regional) service provider market shares by service revenues are shown in Table II.C.2 below. The four nationwide service providers accounted for approximately 98 percent of the nation's mobile wireless service revenue in 2014, up from approximately 91 percent in 2012, and the service revenues of AT&T and Verizon Wireless together accounted for approximately 71 percent of total service revenue in 2014. Of the four nationwide facilities-based service providers, AT&T and Verizon Wireless continued to maintain the largest market shares throughout 2014, as shown in Table II.C.2. Sprint stayed relatively flat, and T-Mobile had the largest quarterly increases in market share to end 2014, as measured by revenue, narrowing the gap against Sprint.⁴⁵ The same pattern continued in the first half of 2015, with AT&T and Verizon Wireless continuing to account for approximately 71 percent of total service revenues. While T-Mobile continues to narrow the gap against Sprint, as of mid-2015, Sprint remained the third largest service provider in the mobile wireless marketplace in terms of service revenues.

⁴⁵ See UBS Investment Research. US Wireless 411 Version 55 4Q14, Figure 45.

Table II.C.1
Service Revenues for Mobile Wireless Service Providers (\$ millions), 2007 – 1st Half 2015

National	2007	2008	2009	2010	2011	2012	2013	2014	1 st Half 2015
Verizon	38,016	49,717	52,046	55,629	59,157	63,733	69,033	72,630	35,603
AT&T	38,678	44,249	48,563	53,510	56,726	59,186	61,552	61,032	29,927
Sprint	32,106	28,435	25,832	25,894	27,390	29,086	29,263	27,959	13,178
T-Mobile	16,891	19,242	18,926	18,689	18,481	17,213	20,535	22,375	11,963
Regional	2007	2008	2009	2010	2011	2012	2013	2014	1 st Half 2015
US Cellular	3,679	3,940	3,926	3,913	4,054	4,099	3,595	3,398	1,652
NTELOS	357	392	400	383	395	424	467	445	199
Cincinnati Bell	267	291	284	269	252	225	185	126	
Leap Wireless	1,396	1,709	2,171	2,413	2,829	2,947	2,631		
Metro PCS	1,919	2,437	3,130	3,690	4,428	4,540			
Centennial	484	524	408						
CentennialPCS	294	320	236						
Rural Cellular	608	327							
Alltel	7,984								
Dobson	1,030								
SunCom	649								

Source: UBS Investment Research. UBS US Wireless 411 Report. Version 51, Table 31. UBS US Wireless 411 Report Version 57, Figure 51.

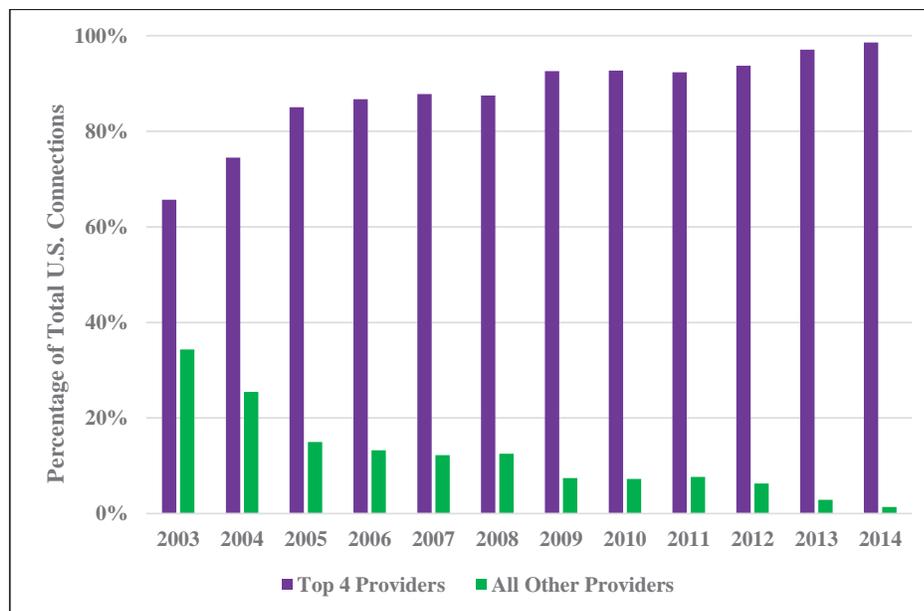
Table II.C.2
Market Shares for Mobile Wireless Service Providers, Based on Service Revenues, 2012 – 1st Half 2015

Nationwide Service Providers	2012	2013	2014	1 st Half 2015
Verizon Wireless	34.4%	36.5%	38.7%	38.1%
AT&T	32.0%	32.5%	32.5%	32.6%
Sprint	15.7%	15.5%	14.9%	14.1%
T-Mobile	9.3%	10.9%	11.9%	13.2%
Total National Service Provider Market Share	91.5%	95.3%	97.9%	98.0%
Regional Service Providers	2012	2013	2014	1 st Half 2015
US Cellular	2.2%	1.9%	1.8%	1.8%
Metro PCS	2.5%	*	*	
Leap Wireless	1.6%	1.4%	*	
NTELOS	0.2%	0.2%	0.2%	0.2%
Cincinnati Bell	0.1%	0.1%	0.1%	*
Other	1.9%	1.0%	*	*
Total Regional Service Provider Market Share	8.5%	4.7%	2.1%	2.0%

Source: UBS US Wireless 411 Report. Version 51 2014 Q1, Table 31, p.19. UBS US Wireless 411 Report. Version 57, Figure 51. See also *Seventeenth Report*, Table II.C.2 for pre-2014 data.

22. Tables II.C.1 and II.C.2 above also show that over time, regional service providers have accounted for increasingly less of overall industry revenues. Based on service revenues, the market share for regional service providers fell from around 8.5 percent in 2012 to around 2 percent by year-end 2014.⁴⁶ In addition, Chart II.C.1 below measures market shares using the number of subscribers/connections as a percentage of overall industry subscribers/connections. It shows that the Top 4 providers have increased their share of overall industry subscribers/connections from around 66 percent in 2003 to around 98.5 percent by year-end 2014,⁴⁷ meaning that the share of regional and local providers has declined from around 34 percent to around 1.5 percent during the same time period.

Chart II.C.1
U.S. Mobile Wireless Connections: 2003 – 2014



Source: 9th Report, Appendix p. A-8, Table 4; 11th Report, p. 93, Appendix Table 4; 12th Report, p. 132, Appendix Table 4; 14th Report, p. 223, Appendix Table C-4; 15th Report, p. 34, Table 3; 16th Report, p. 55, Table 13; 17th Report, p. 10, Table II.B.1; UBS US Wireless 411 Version 57, Figure 41.

23. Market concentration can be measured by the number of competitors in the marketplace or by the sum of the share of subscribers and sales/revenues attributable to each competitor. High market concentration levels in a given market may raise some concern that the market is not competitive. However, an analysis of other factors, such as prices, non-price rivalry, and entry conditions, may find that a market with high concentration levels is competitive. The Herfindahl-Hirschman Index (“HHI”), which is employed by the Commission to measure market concentration, is a widely-accepted measure of concentration in competition analysis. The HHI is calculated by summing the squared market shares of all firms in any given market.⁴⁸ In this

⁴⁶ We note that these estimates are based on UBS US Wireless 411 Reports, which do not provide a break out number for privately held regional service provider, C Spire.

⁴⁷ For purposes of Chart II.C.1, a Top 4 service provider is defined as a service provider that is one of the leading four providers in any given year as measured by its subscribers/connections over total industry subscribers/connections.

⁴⁸ Following widespread industry practices, the Commission generally attributes the subscribers of MVNOs to their host facilities-based service providers, including when it calculates market concentration metrics.

Report, we calculate HHIs by Economic Area (“EA”) to maintain continuity with past *Reports* and to ensure that we do not compromise the confidential information found in the NRUF data.⁴⁹

24. As shown in Chart II.C.1, at the end of 2014, the weighted average HHI (weighted by population across the 172 EAs in the United States) for mobile wireless services was 3,138, an increase from 3,027 at year-end 2013.⁵⁰ As in previous years, the most recent increases in the weighted average HHI reflect continued industry consolidation, such as the acquisition by AT&T of Leap Wireless in 2014.⁵¹ At the end of 2014, the HHI in individual EAs ranged from a low of 2,219 in EA 63 (Milwaukee-Racine, WI) to a high of 7,312 in EA 142 (Scottsbluff, NE-WY).⁵²

25. Chart II.C.2 below shows the relationship between the HHI by EA and EA population densities, indicating that HHI values, or market concentration, tend to decline as the population density increases. The most concentrated EAs tend to be more rural, while major metropolitan areas lie in the least concentrated EAs. This likely reflects greater demand and greater cost efficiencies (per-user mobile wireless network deployment costs tend to decrease with increases in the population density) in more densely-populated areas.⁵³

⁴⁹ NRUF subscriber data indicate the number of assigned phone numbers that a wireless service provider has in a particular wireline rate center (there are approximately 18,000 rate centers in the country). Rate centers are geographic areas used by local exchange carriers for a variety of reasons, including the determination of toll rates. See Harry Newton, Newton’s Telecom Dictionary: 19th Expanded & Updated Edition 660 (July 2003). All mobile wireless service providers must report to the Commission the quantity of their phone numbers that have been assigned to end users, thereby permitting the Commission to calculate the total number of mobile wireless subscribers. For purposes of geographical analysis, the rate center data can be associated with a geographic point, and all of those points that fall within a county boundary can be aggregated together and associated with much larger geographic areas based on counties. We note that the aggregation to larger geographic areas reduces the level of inaccuracy inherent in combining non-coterminous areas, such as rate center areas and counties.

As discussed in this *Report*, “markets” are independent of the relevant market determined in the context of secondary market transactions review. In prior transactions, the Commission has found that the relevant geographic markets for certain wireless transactions generally are “local” and have used Cellular Market Areas (“CMAs”) as the local geographic market. In addition, it has also evaluated a transaction’s competitive effects at the national level where a transaction exhibits certain national characteristics that provide cause for concern. See, e.g., Applications of AT&T Inc., Leap Wireless International, Inc., Cricket License Co., LLC and Leap Licenseco, Inc. for Consent To Transfer Control and Assign Licenses and Authorizations, WT Docket No. 13-193, *Memorandum Opinion and Order*, 29 FCC Rcd 2735, 2735 ¶ 27 (WTB, IB 2014) (“*AT&T-Leap Order*”).

⁵⁰ Antitrust authorities in the United States generally classify markets into three types: Unconcentrated (HHI < 1500), Moderately Concentrated (1500 < HHI < 2500), and Highly Concentrated (HHI > 2500). See *Horizontal Merger Guidelines*, U.S. Department of Justice and the Federal Trade Commission (Aug. 19, 2010), available at <http://www.justice.gov/atr/public/guidelines/hmg-2010.pdf>.

The Commission’s initial HHI screen identifies, for further case-by-case market analysis, those markets in which, post-transaction: (1) the HHI would be greater than 2800 and the change in HHI would be 100 or greater; or (2) the change in HHI would be 250 or greater, regardless of the level of the HHI. See, e.g., *AT&T-Leap Order*, 29 FCC Rcd at 2753 ¶ 41 n.140; Applications of AT&T Inc. and Atlantic Tele-Network, Inc. for Consent To Transfer Control of and Assign Licenses and Authorizations, WT Docket No. 13-54, *Memorandum Opinion and Order*, 28 FCC Rcd 13670, 13684-85 ¶ 30 n.77 (WTB, IB 2013) (“*AT&T-ATN Order*”); Applications of GCI Communication Corp., ACS Wireless License Sub, Inc., ACS of Anchorage License Sub, Inc., and Unicom, Inc. for Consent To Assign Licenses to the Alaska Wireless Network, LLC, WT Docket No. 12-187, *Memorandum Opinion and Order and Declaratory Ruling*, 28 FCC Rcd 10433, 10450 ¶ 42 n.135 (2013) (“*Alaska Wireless Order*”).

⁵¹ See generally *AT&T-Leap Order*, 29 FCC Rcd 2735.

⁵² See (web) Appendix II for detailed data on the HHI by EA, available at https://www.fcc.gov/reports-research/reports?og_group_ref_target_id=1638&field_report_series_tid=1733&shs_term_node_tid_depth=All&=Apply.

⁵³ Apart from differences in population, EAs also vary with regard to other likely determinants of market demand and facilities-based service provider costs, such as per-capita income and the age distribution of the population.

Chart II.C.1
Average Population-Weighted HHI Across EAs: 2004 – 2014

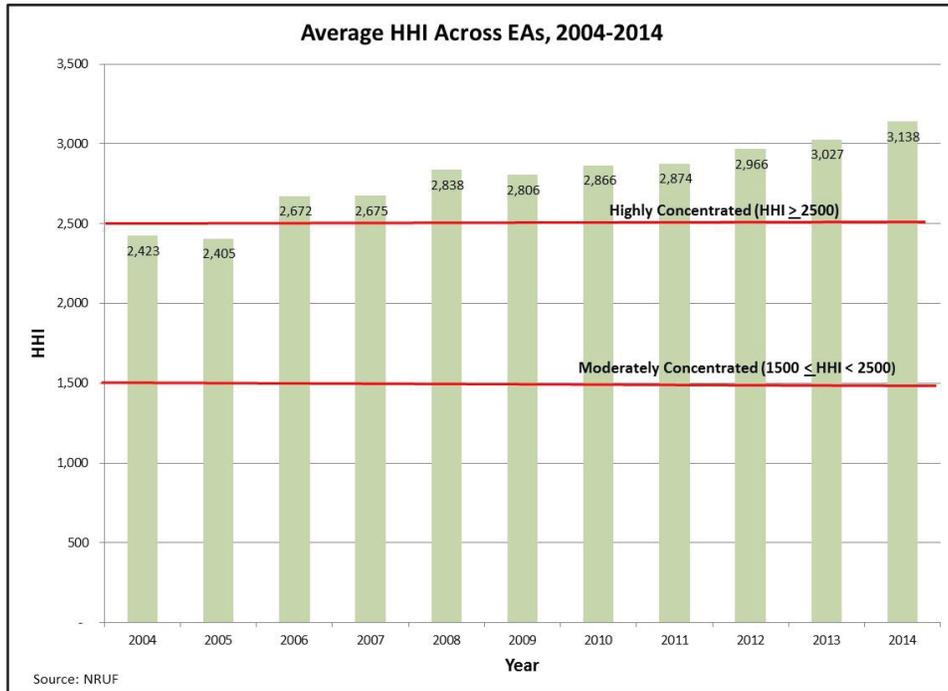
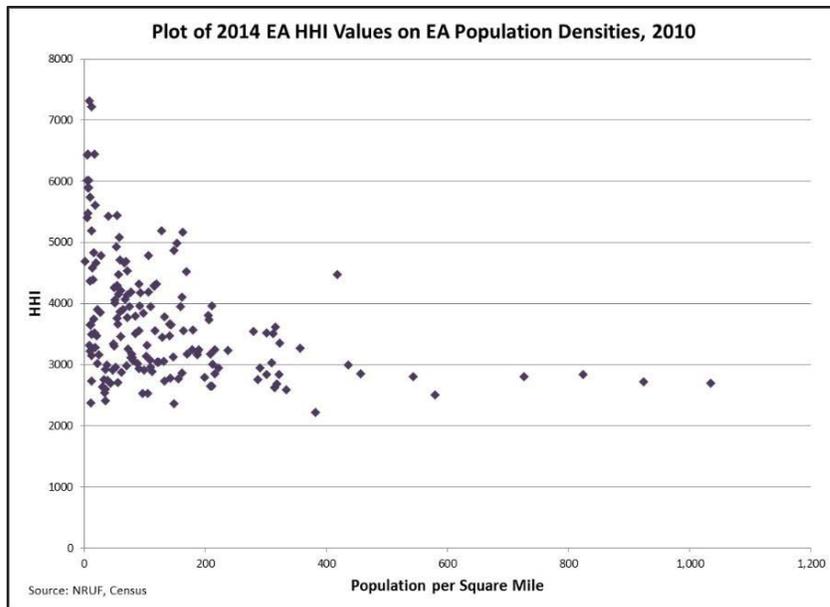


Chart II.C.2
2014 HHIs Plotted Against 2010 EA Population Density



D. Financial Indicators

1. Revenue and Average Revenue Per Unit

26. Average price metrics have been necessary and useful tools to compare broad trends in pricing in this industry, even though average metrics have always had their limitations given the longstanding variation in terms of plan characteristics and pricing for mobile voice and data.⁵⁴ Total wireless service providers' revenues, as reported by CTIA, include monthly service fees, usage-related charges, activation charges, vertical services (voice mail, enhanced calling features, and other services), out-collect roaming revenues, and data service revenues.⁵⁵ In 2014, total wireless service revenue was \$187.8 billion, and in contrast to previous years, was a year-over-year drop of less than one percent.⁵⁶ This decline in service revenues likely indicates the beginning separation of the provider's revenue streams into two separate components – service revenues and equipment revenues.⁵⁷ Total reported prepaid revenues for 2014 equaled \$24.7 billion, up 10.5 percent from \$22.4 billion reported for 2013.⁵⁸

27. CTIA reported an industry average measure of "Average Revenue per Reported (subscriber) Unit," or ARPU, which is based "upon total revenues divided by the average total reported active units per survey period, divided by the number of months in the survey period," *i.e.*, an annualized monthly ARPU.⁵⁹ As shown in

⁵⁴ Different service providers have offered a variety of pricing plans for their voice and data services, with service often offered under multi-part pricing schemes and with differing non-price terms and features, such as early termination fees and the consequences of reaching usage limits. As discussed in previous *Reports*, it is therefore difficult to identify sources of information that track mobile wireless service prices in a comprehensive and consistent manner. Also, data on subscribership is not available at the plan level and any average price comparison implicitly assumes uniform subscribership of all plans.

⁵⁵ See CTIA Year-End 2014 Wireless Indices Report, at p. 80.

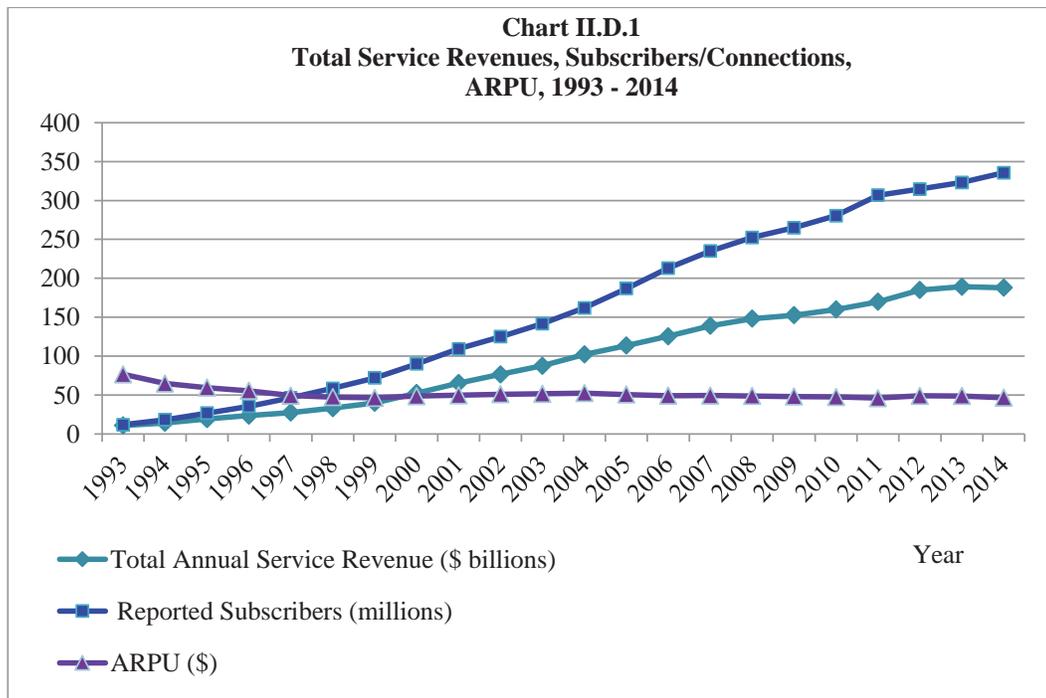
⁵⁶ Revenue increased by 3.0%, 4.8%, 6.2%, 9.0%, and 2.3% in 2009, 2010, 2011, 2012, and 2013, respectively. See Appendix Table II.D.i for details.

⁵⁷ Analysts at MoffettNathanson Research distinguish the difference between traditional accounting for revenues and changes under Equipment Installment Plan ("EIP") accounting, stating that "Equipment installment plans replace the traditional handset subsidy with a more transparent separation between the equipment and service components of a wireless offering. The underlying economics are not terribly different, and the monthly cost to the consumer is about the same either way." MoffettNathan Research: "U.S. Wireless: Removing the Rose-Colored Glasses," June 18th 2014. Under EIP, the revenue associated with the sale of a handset is fully recognized at the time of sale – regardless of whether the handset is paid for upfront or financed – accelerating revenue and therefore EBITDA and earnings. At the same time, future service revenues are reduced, lowering service ARPU and lowering EBITDA back to pre-EIP adoption levels. By contrast, in traditional subsidy plans, the full cost of the handset is recognized at the time of sale (just as in EIP accounting), but the bulk of the handset's revenues (less the upfront price paid for the device) are recognized over a period of years, in the form of higher service revenues. The result is a near-term reduction in revenues, EBITDA ("Earnings before Interest, Taxes, Debt, and Amortization"), and margins, offset by higher service revenue in the future.

⁵⁸ As detailed in Table II.C.1 above, reported company-specific revenues indicate that Verizon Wireless and AT&T had the highest service revenues in 2014, followed by Sprint, and then by T-Mobile. Beginning with its 2012 report, CTIA discontinued separately tracking and reporting wireless data service revenues. See CTIA Year-End 2013 Wireless Indices Report, at pp. 85-90 for a detailed discussion. As a result of these changes, estimates of the unit price of wireless voice and data revenues are increasingly unreliable and difficult to come by, and the Commission is no longer able to report from the CTIA data an average revenue per text message, an average revenue per megabyte, or an average voice revenue per minute. See *Seventeenth Report*, 29 FCC Rcd at 15328 ¶ 35.

⁵⁹ See CTIA Year-End 2014 Wireless Indices Report, at p. 80. This ARPU is not equal to the "average bill" for a household or consumer as it is not equal to the bill for an "account," which may cover several different devices, such as multiple phones (under a family plan) or multiple devices (including phones, tablets, wireless broadband modems, or other adjunct devices covered by a customer's service plan). It assigns overall service revenue across all revenue generating devices. The total service revenues used include roaming revenues, usage fees, access, and other connection fees. See CTIA Year-End 2014 Wireless Indices Report, at pp. 1, 80.

Chart II.D.1 below, according to CTIA, from December 2013 to December 2014, the industry ARPU was \$46.64. Chart II.D.1 also shows total service revenue, subscribers/connections and ARPU for the past 20 years, and indicates (in nominal dollars), that the ARPU is fairly stable, while revenues and connections have increased over time.⁶⁰



Source: Based on CTIA Wireless Industry Indices Year-End 2014, Table 27.

2. Average Revenue Per Unit by Service Provider

28. We now present UBS estimates of ARPU and the unit price of mobile wireless broadband services. As seen in Table II.D.1, there is some variation in ARPU amongst the various national and regional wireless service providers, despite the relative stability at the industry level. Table II.D.1 below shows that between the fourth quarter of 2012 and the second quarter of 2015, all four nationwide service providers experienced a decline in ARPU. AT&T's ARPU declined by approximately 13 percent, Verizon Wireless's ARPU declined by approximately 9 percent, Sprint's ARPU declined by approximately 12 percent, and T-Mobile's ARPU declined by approximately 14 percent, respectively. The overall declines in ARPU are likely attributable to the more widespread use of EIPs, as discussed in section V. below, which enable subscribers to pay for equipment via installment payments.⁶¹ Regional service providers such as US Cellular experienced a slight increase in ARPU during this time.

⁶⁰ As discussed in the *Seventeenth Report*, while the ARPU metric remains the best such measure currently used by industry and financial analysts, its consistent estimation has become more difficult. Industry and financial analysts have had to make additional assumptions and begun to estimate a new, normalized version of ARPU, dividing overall reported service revenues by the average number of connections for the period. See *Seventeenth Report*, 29 FCC Rcd at 15328-29 ¶ 36.

⁶¹ See UBS Investment Research. UBS US Wireless 411 Version 55, pp.7-9.

Table II.D.1
ARPU Estimates of Publicly Traded Facilities-Based Mobile Wireless Service Providers
4th Quarter 2012 – 2nd Quarter 2015

Nationwide Providers	4Q12	4Q13	4Q14	2Q15
AT&T	\$ 46.94	\$ 47.58	\$ 42.04	\$41.07
Verizon Wireless	\$ 47.57	\$ 47.50	\$ 45.52	\$43.38
Sprint	\$ 43.37	\$ 44.83	\$ 40.44	\$38.03
T-Mobile	\$ 40.24	\$ 36.91	\$ 35.56	\$34.77
Regional/Rural Providers	4Q12	4Q13	4Q14	2Q15
US Cellular	\$ 50.89	\$ 50.21	\$ 53.58	\$51.27
MetroPCS	\$ 40.86	*	*	*
Leap Wireless	\$ 40.69	\$ 45.55	*	*
NTELOS	\$ 52.78	\$ 54.11	\$ 52.35	\$48.91
Cincinnati Bell	\$ 43.28	\$ 41.35	\$ 39.87	*

Source: UBS Investment Research. UBS US Wireless 411 Version 51, Figure 36. UBS US Wireless 411 Version 57, Figure 53.

3. Wireless Telephone Services Consumer Price Index

29. The Consumer Price Index (“CPI”) is a measure of the average change over time in the prices paid by consumers for a fixed market basket of consumer goods and services.⁶² As documented in previous *Reports*, two different pricing indicators – the Wireless Telephone Services CPI and the per-minute price of voice service – show that mobile wireless prices have declined significantly since the launch of Personal Communications Service (“PCS”) service in the mid-1990s.⁶³ However, given the shift in mobile voice service plans away from a defined number of monthly minutes, as discussed above, there is no simple way to calculate a per-minute price for such services, and thus, this discussion focuses on the CPI.

30. The wireless telephone services’ component of the CPI (Wireless Telephone Services CPI) is published by the U.S. Department of Labor’s Bureau of Labor Statistics (“BLS”) on a national basis.⁶⁴ According to CPI data, the price (in constant dollars) of wireless service has continued to decline. From December 2013 to December 2014, the annual Wireless Telephone Services CPI decreased by 2.1 percent while the overall CPI increased by 1.6 percent and the Telephone Services CPI fell by 0.4 percent.⁶⁵ The Wireless Telephone Services CPI has steadily declined since 2010 following an unchanged Wireless Telephone Services CPI in 2009 and a series of much smaller declines in the period from 2002 to 2008. Since December 1997, the Wireless Telephone Services CPI has declined nearly 45 percent, while the overall CPI has increased by approximately 36 percent.

⁶² The basket of goods includes over 200 categories, such as food and beverages, housing, apparel, transportation, medical care, recreation, education, and communications. The CPI allows consumers to compare the price of the basket of goods and services this month with the price of the same basket a month or a year ago.

⁶³ See, e.g., *Sixteenth Report*, 28 FCC Rcd at 3876-77 ¶ 267.

⁶⁴ Starting in December 1997, the basket included a category for cellular/wireless telephone services. All CPI figures discussed above were taken from BLS databases. See BLS website, available at <http://www.bls.gov>. The index used in this analysis, the CPI for All Urban Consumers (“CPI-U”), represents about 87% of the total U.S. population. See Bureau of Labor Statistics, “Consumer Price Index: Frequently Asked Questions,” available at <http://www.bls.gov/cpi/cpifaq.htm>. The Cellular CPI includes charges from all telephone companies that supply “cellular telephone services,” which are defined as “domestic personal consumer phone services where the telephone instrument is portable and it sends/receives signals for calls by wireless transmission.” This measure does not include business calls, telephone equipment rentals, portable radios, and pagers. While the CPI-U is urban-oriented, it does include expenditure patterns of some of the rural population. Information submitted by companies for the CPI is provided on a voluntary basis.

⁶⁵ See Appendix Table II.D.ii for details.

4. Profitability Metrics

31. One measure of competition in the mobile wireless marketplace is the relative profitability of competitors. In the absence of the data necessary to estimate economic profits, accounting profits can instead be estimated using various metrics available to wireless industry observers. One such accounting profits metric, based on company data reported to the Securities and Exchange Commission (“SEC”), is EBITDA (“Earnings before Interest, Taxes, Debt, and Amortization”), which equals accounting profits before deducting interest expenses, corporate income taxes, depreciation, and amortization. In 2014, as shown in Table II.D.2 below, out of the nationwide facilities-based service providers, EBITDA per subscriber ranged from a low of \$9.20 (T-Mobile) to a high of \$22.67 (Verizon Wireless).

Table II.D.2
Annual EBITDA per Subscriber (\$/month), 2012 – 1st Half 2015

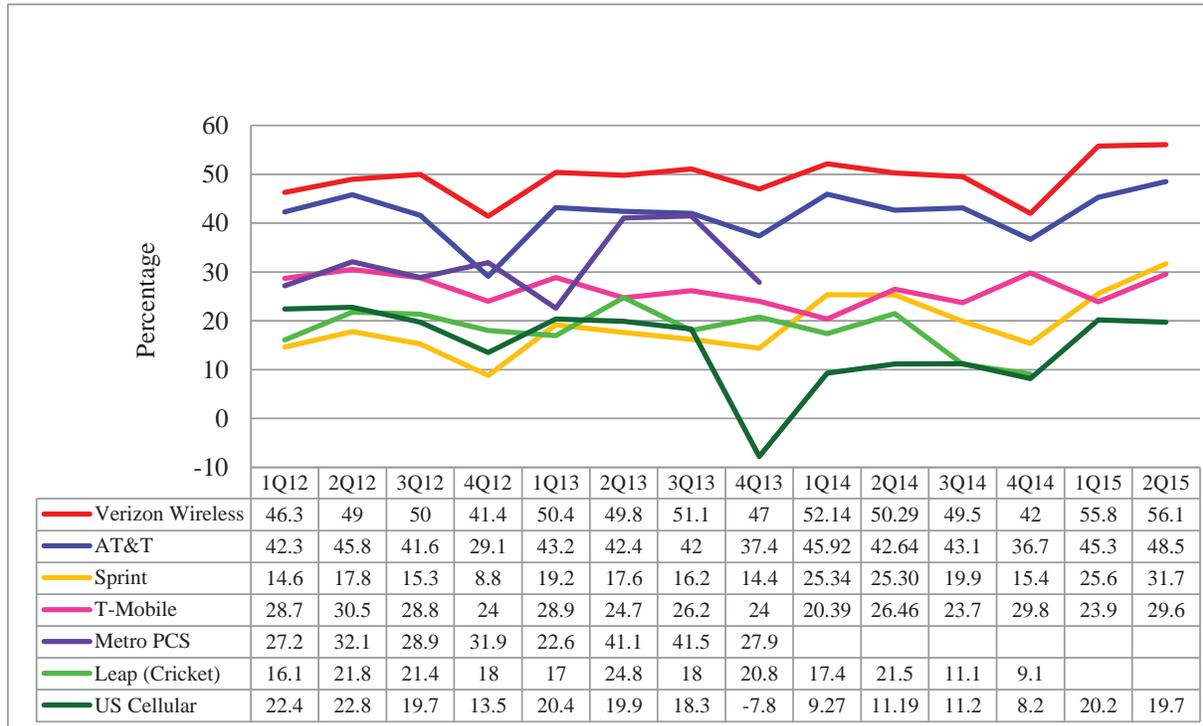
Top 5 Mobile Wireless Service Providers	2012	2013	2014	1 st Half 2015
Verizon Wireless	22.21	23.56	22.67	24.52
AT&T	18.64	19.55	18.39	19.18
Sprint	6.11	7.53	9.14	11.03
T-Mobile	12.09	10.08	9.20	9.37
US Cellular	11.51	7.34	6.01	11.53

Source: UBS Investment Research. UBS US Wireless 411 Version 51, Figure 47. UBS US Wireless 411 Version 55, Figure 59. Annual figures are calculated by taking the average of each quarter for each year.

32. A second indicator of mobile wireless segment profitability is the EBITDA margin, which expresses EBITDA as a percentage of service revenue.⁶⁶ Standardizing EBITDA by service revenues facilitates cross-provider comparisons. The EBITDA margin of a number of the publicly reported mobile service providers for the past three years is shown in Chart II.D.2. At year-end 2014, the EBITDA margin of the top four nationwide service providers ranged from approximately 15 percent for Sprint to approximately 42 percent for Verizon Wireless. As of the second quarter of 2015, the EBITDA margin of the top four nationwide service providers ranged from around 30 percent for Sprint and T-Mobile to around 49 percent for AT&T, and 56 percent for Verizon Wireless.

⁶⁶ The EBITDA margin is equal to EBITDA divided by total revenue. Because EBITDA excludes depreciation and amortization, the EBITDA margin may provide a cleaner view of a company's core profitability.

Chart II.D.2
Reported EBITDA Margins (%) for Selected Publicly Traded
Facilities-Based Wireless Service Providers, 2012 – 2nd quarter 2015



Source: UBS Investment Research. UBS US Wireless 411 Version 51, Fig. 46. UBS US Wireless 411 Version 57, Fig. 58.

III. OVERALL MOBILE WIRELESS INDUSTRY METRICS

33. In this section, we discuss the current market trends in the mobile wireless marketplace and provide additional analysis highlighting specific changes that have occurred over the last year. Specifically, this section examines such indices as the number of connections and distribution of subscribers by geography and by demographics. Further, it analyzes the extent of mobile wireless and LTE broadband coverage, including by number of available service providers, and provides a comparison of rural versus non-rural markets.

A. Network Coverage

34. The initial analysis in this section is based on a centroid methodology applied to U.S. census blocks⁶⁷ overlaid on service provider coverage maps provided to the Commission through a contract with Mosaik Solutions.⁶⁸ If the center point, or centroid, of a census block is within the coverage boundary of a Mosaik map,

⁶⁷ A census block is the smallest geographic unit for which the Census Bureau tabulates decennial census data. There are 11,166,336 blocks designated in the 2010 Census, and they range in population from zero to several hundred. See U.S. Census Bureau, “2010 Census Summary File 1 – 2010 Census of Population and Housing, Technical Documentation” at p. 21 (March 2010), available at <http://www.census.gov/prod/cen2010/doc/sf1.pdf#page=504>.

⁶⁸ Mosaik Solutions is an independent consulting firm that tracks coverage footprints of mobile voice and mobile data networks and provides data to the Commission under contract on facilities-based service providers in the form of coverage boundary maps based on the coverage boundaries provided to them by mobile wireless network operators. See Mosaik, “About Us,” available at <http://www.mosaik.com/about-us/>.

then we consider that block to be “covered” by that service provider and/or technology.⁶⁹ As we noted in earlier *Reports*, this methodology has the potential to overstate coverage in certain blocks.⁷⁰ We then aggregate the population and land area of the covered census blocks to generate our coverage estimates. We note that these coverage estimates represent deployment of mobile networks and do not indicate the extent to which providers affirmatively offer service to residents in the covered areas. While recognizing therefore that this analysis likely overstates the coverage experienced by consumers because of limitations in Mosaik data, we find that this analysis is useful because it provides a general baseline that can be compared over time across network technologies, and service providers.⁷¹

35. We use the same centroid methodology when presenting below some summary information based on Form 477 data, which contains certain specific information on deployment at a detailed geographic level.⁷² We note, therefore, that coverage estimates based on Form 477 data are subject to similar methodological limitations as just described, and consequently have the potential to overstate coverage. We note that moving forward, and as also indicated in section VI. below, we anticipate that Form 477 data will be our primary source for the analysis of overall mobile wireless coverage as well as coverage by individual service providers in the mobile wireless marketplace. We first present our overall mobile wireless coverage estimates of the percentage of the U.S. population, land area, and road miles covered by a certain number of facilities-based service providers.⁷³ We then present estimated LTE mobile broadband coverage, which is now the baseline industry standard for the

⁶⁹ The centroid method overlays the geographic polygons showing wireless coverage onto a map of census blocks. The centroid method codes a census block as covered if the calculated center point (the “centroid”) of the census block is within the coverage polygon. If a centroid is covered, then all of the population and land area in the corresponding census block is also coded as covered. We note that in some cases the calculated center point may lay outside of the boundaries of a census block. In these cases, the centroid will be identified as the point inside the census block nearest to the calculated center point. See *Seventeenth Report*, 29 FCC Rcd at 15332-33 ¶ 45.

⁷⁰ See, e.g., *Seventeenth Report*, 29 FCC Rcd at 15332-33 ¶ 45. These estimates likely overstate the coverage actually experienced by consumers because Mosaik reports advertised coverage as reported to it by service providers, each of which uses a different definition or determination of coverage. The data do not expressly account for factors such as signal strength, bit rate, or in-building coverage, and may convey a false sense of consistency across geographic areas and service providers. Further, we note that an analysis of coverage at the nationwide level will mask regional disparities in coverage. See *id.*

⁷¹ See *Seventeenth Report*, 29 FCC Rcd at 15332-33 ¶ 45.

⁷² Currently, Form 477 collects data from facilities-based service providers of (1) internet service with information transfer rates exceeding 200 kbps in at least one direction; and (2) mobile service to at least one subscriber. This excludes service providers of terrestrial wireless “hot spot” services, like local-area Wi-Fi or Wi-Fi within public places, but includes service providers whose only customers are served via reseller of mobile services. Facilities-based service providers of mobile wireless service submitted polygons in an ESRI shapefile format representing geographic coverage nationwide (including U.S. territories) for each transmission technology (e.g., EV-DO, WCDMA, HSPA+, LTE, WiMAX) deployed in each frequency band (e.g., 700 MHz, Cellular, AWS, PCS, BRS/EBS). See FCC website, “FCC Encyclopedia, Form 477 Orders and Releases,” available at <https://www.fcc.gov/encyclopedia/form-477-orders-and-releases>.

In addition, service providers submit information on the geographic areas in which users should expect to receive the minimum speed advertised by the provider for the used spectrum and deployed technologies. The deployment data, with the exception of certain spectrum and speed information associated with the coverage areas, will be made public while the provider-specific subscription data will remain confidential. See *Modernizing the FCC Form 477 Data Program*, WC Docket No. 11-10, *Report and Order*, 28 FCC Rcd 9887, 9921-23 ¶¶ 79-83 (2013). See also FCC website, “Changes to the Form 477 Data Collection in 2014,” available at <https://www.fcc.gov/encyclopedia/changes-coming-form-477-data-collection>.

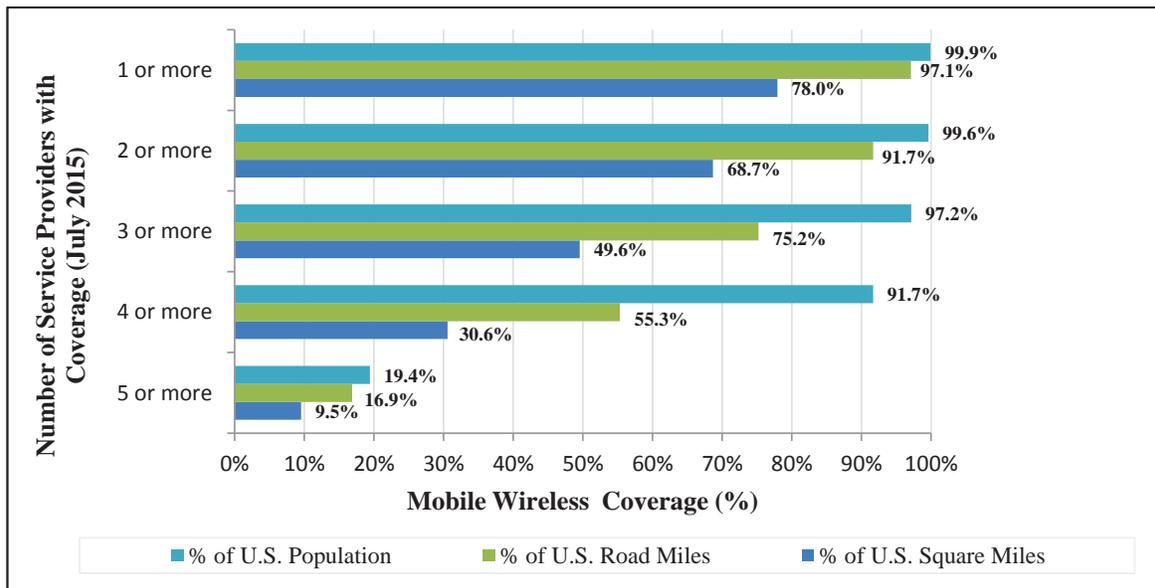
⁷³ We note that service providers often offer coverage outside of their network coverage areas through roaming arrangements which allow their customers to automatically receive service from other providers’ networks when they are in areas that are covered by their roaming partners’ networks but not by their own network. In contrast to the purchase of capacity wholesale to provide resale or MVNO services, a provider uses roaming services to market extended coverage to consumers residing within the provider’s network coverage area, but not to acquire customers where a service provider does not have network coverage. See Appendix Table III.A.i and Table III.A.ii for more details of estimated overall mobile wireless coverage.

marketing of mobile broadband service, using the same categories.⁷⁴ We note that LTE deployment does not necessarily result in specific guaranteed speeds for the consumer.

1. Overall Mobile Wireless Network Coverage

36. Subject to the limitations just described, the available data suggest quite extensive mobile wireless coverage. In looking at comparable past data, we note that the percentage of the population living in a census block with mobile wireless coverage by at least one or two providers has not changed significantly since January 2012.⁷⁵ As of July 2015, while more than 90 percent of the U.S. population lived in census blocks with coverage by at least four providers, these census blocks accounted for only approximately 31 percent of the total land area of the United States, and approximately 55 percent of U.S. road miles. Chart III.A.2 presents the results from the same analysis using Form 477 data. According to both sources, more than 90 percent of the population is covered by at least four service providers, but coverage of road-miles and of land area is much more limited.

Chart III.A.1
Estimated Mobile Wireless Coverage by Census Block: Mosaik, July 2015

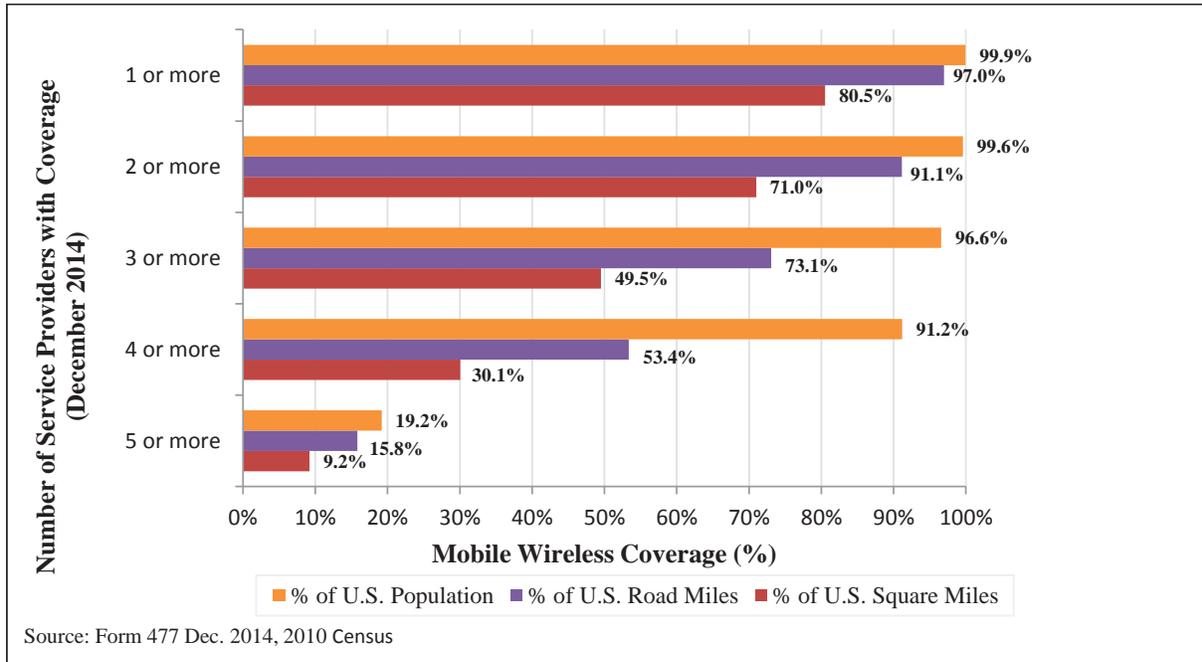


Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage.

⁷⁴ For coverage estimates of mobile service provided using any of the following 3G or 4G technologies: EVDO, EVDO Rev A, WCDMA/HSPA, HSPA+, LTE, and mobile WiMAX, see Appendix III, Chart III.A.i, and Tables III.A.iii and III.A.iv. As of July 2015, mobile wireless coverage of 3G and better technologies is not materially different than coverage that also includes 2G technologies.

⁷⁵ See *Seventeenth Report*, 29 FCC Rcd at 15333-34 ¶ 47. The percentages of population located in census blocks with coverage by a certain number of mobile wireless or mobile LTE broadband providers does not necessarily mean that those service providers offered service to residents in the census block. In addition, we emphasize that a service provider reporting mobile wireless or mobile LTE broadband coverage in a particular census block may not provide coverage everywhere in the census block. For both these reasons, the number of providers in a census block does not necessarily reflect the number of choices available to a particular individual or household, and does not purport to measure competition.

Chart III.A.2
Estimated Mobile Wireless Coverage by Census Block: Form 477, Dec. 2014⁷⁶



Note: The coverage calculation methodology has certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

37. In this *Report*, we have included a service provider if it has a market share above a particular threshold, and we have made estimates based on two alternative thresholds. Specifically, to estimate the number of service providers serving a CMA, we include a service provider if it has a greater than two percent market share (or alternatively, a five percent market share which provides greater assurance of a meaningful choice for consumers) of mobile wireless connections based on NRUF data. Table III.A.1 presents the data for December 2011 and December 2014, and shows that since 2011, based on the five percent market share threshold, the number of CMAs with three service providers has decreased, while the number of CMAs with four service providers has substantially increased.⁷⁷ There has been a decrease in the number of CMAs with at least five service providers based on the five percent market share threshold primarily due to increased industry consolidation, as noted above.

⁷⁶ In order to calculate coverage based on Form 477 data, the same centroid methodology is used as in our calculations of coverage based on Mosaik data. As previously noted, the use of the centroid methodology has certain limitations that likely result in an overstatement of the extent of mobile wireless or mobile LTE broadband coverage. Further, “although most census blocks are small, some can be large, particularly in low-density rural areas, and ... coverage at the centroid might result, incorrectly, in the entirety of those large areas being deemed served.” Connect America Fund, *et al.*, WC Docket No. 10-90, *et al.*, *Report and Order and Further Notice of Proposed Rulemaking*, 26 FCC Rcd 17663, 17787 ¶ 344 (2011).

⁷⁷ Because NRUF includes data on the number of telephone numbers that have been assigned to end-user devices by mobile wireless providers, this analysis does not include providers whose data-only devices are not assigned a mobile telephone number.

Table III.A.1
Estimated Mobile Wireless Service Providers Offering Service by CMA, Excluding Territories

Number of Providers Offering Service Anywhere in a CMA	Two Percent Market Share Threshold				Five Percent Market Share Threshold			
	Number of CMAs		Total CMAs (percent)		Number of CMAs		Total CMAs (percent)	
	2011	2014	2011	2014	2011	2014	2011	2014
<i>Total for U.S., excluding territories</i>	716	716	100.0%	100.0%	716	716	100.0%	100.0%
1 provider	1	0	0.1%	0.0%	2	2	0.3%	0.3%
2 providers	51	75	7.1%	10.5%	120	159	16.8%	22.2%
3 providers	152	121	21.2%	16.9%	213	167	29.7%	23.3%
4 providers	208	377	29.1%	52.7%	246	331	34.4%	46.2%
5 or more providers	304	143	42.5%	20.0%	135	57	18.9%	8.0%

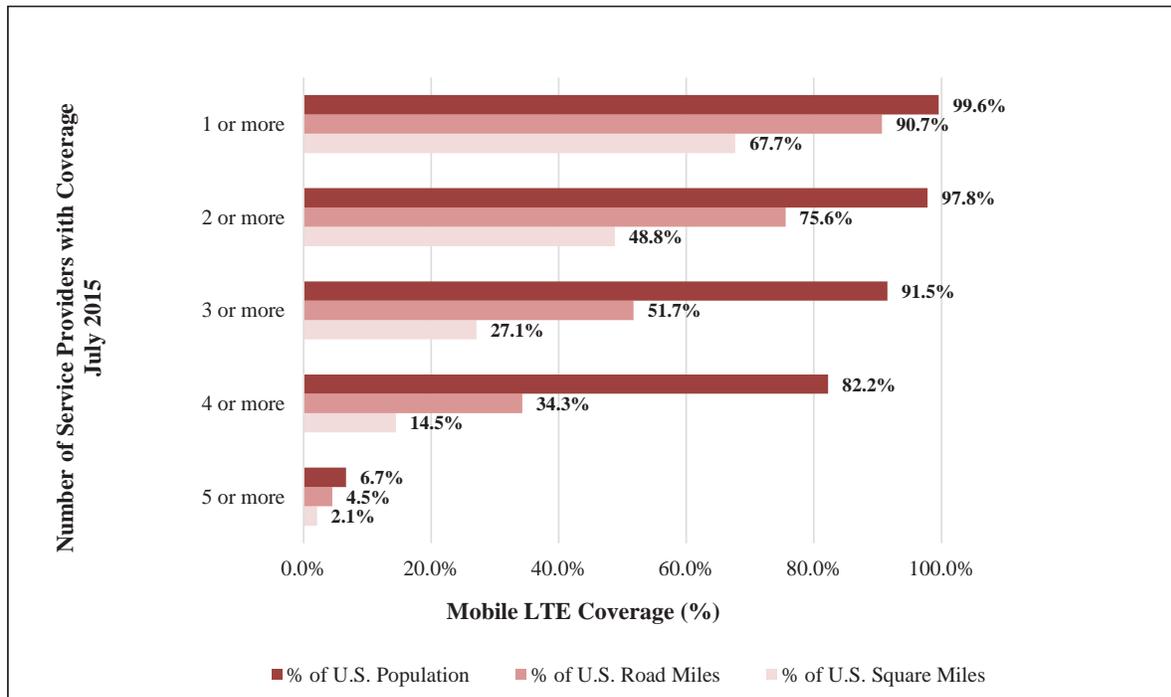
Source: Based on December 2011 and December 2014 NRUF data.

2. LTE Mobile Broadband Coverage

38. Chart III.A.3 presents LTE mobile broadband coverage as of July 2015, based on Mosaik data.⁷⁸ As noted above, LTE deployment does not necessarily result in specific guaranteed speeds for the consumer. In July 2015, approximately 92 percent of the population was covered by three or more service providers, while approximately 82 percent of the population was covered by four or more service providers. Chart III.A.3 also shows that LTE deployment tends to focus on the larger population centers. While over 80 percent of the U.S. population lived in census blocks with LTE coverage by at least four service providers in July 2015, these census blocks only accounted for approximately 34 percent of road miles, and approximately 15 percent of the total land area of the United States. The results are similar based on the Form 477 data: According to both Mosaik and Form 477 data, while over 80 percent of the population is covered by at least four service providers, coverage of road-miles and of land area is much more limited.

⁷⁸ For coverage estimates of mobile service including any of the following 3G or 4G technologies: EVDO, EVDO Rev A, WCDMA/HSPA, HSPA+, LTE, and mobile WiMAX, see Appendix III, Chart III.A.i and Tables III.A.iii and III.A.iv, and III.A.v.

Chart III.A.3
Estimated LTE Coverage in the U.S. by Census Block: Mosaik, July 2015



Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage.

3. Rural/Non-Rural Comparisons

39. While the Communications Act does not include a statutory definition of what constitutes a rural area, since its 2004 *Report and Order* concerning the deployment of wireless services in less populated areas, the Commission has used a “baseline” definition of rural as a county with a population density of less than 100 people per square mile.⁷⁹ By this definition, approximately 56 million people, or approximately 18 percent of the U.S. population, live in rural counties, based on 2010 US Census data. These counties comprise approximately 3

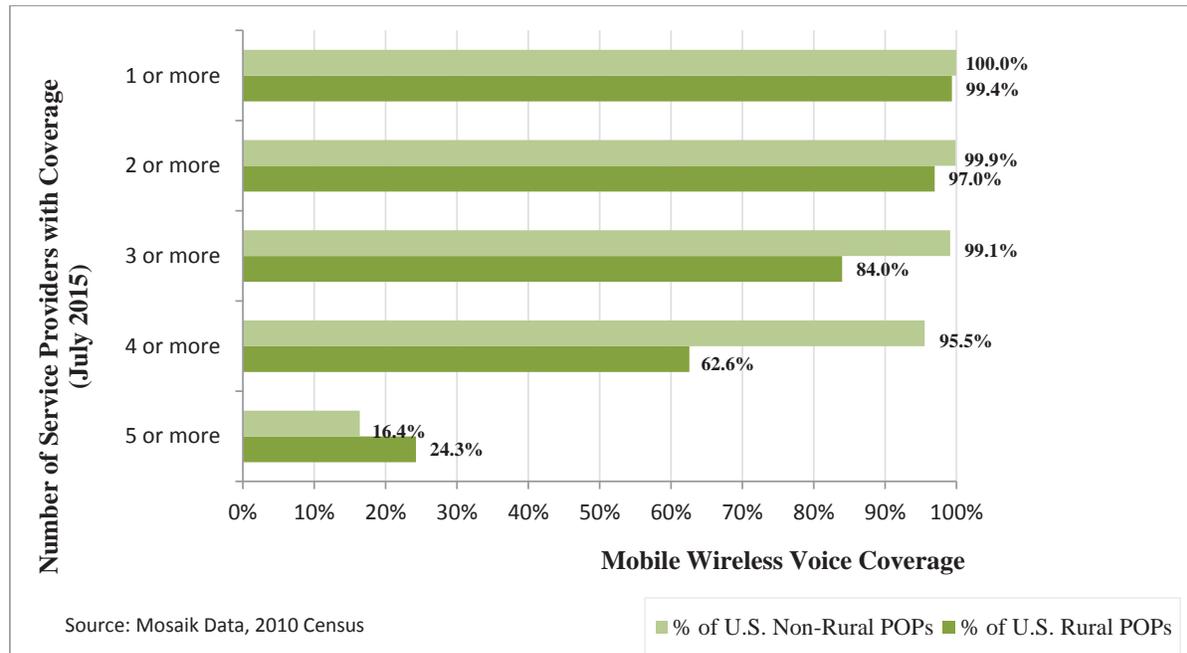
⁷⁹ See *Facilitating the Provision of Spectrum-Based Services to Rural Areas and Promoting Opportunities for Rural Telephone Companies To Provide Spectrum-Based Services*, WT Docket No. 02-381, WT Docket No. 01-14, WT Docket No. 03-202, *Report and Order and Further Notice of Proposed Rule Making*, 19 FCC Rcd 19078, 19086-88 ¶¶ 10-12 (2004) (“2004 *Report and Order*”) (“We recognize, however, that the application of a single, comprehensive definition for ‘rural area’ may not be appropriate for all purposes. . . Rather than establish the 100 persons per square mile or less designation as a uniform definition to be applied in all cases, we instead believe that it is more appropriate to treat this definition as a presumption that will apply for current or future Commission wireless radio service rules, policies and analyses for which the term ‘rural area’ has not been expressly defined. By doing so, we maintain continuity with respect to existing definitions of ‘rural’ that have been tailored to apply to specific policies, while also providing a practical guideline”). *Id.*, 19 FCC Rcd at 19087-88 ¶ 12.

million square miles, or approximately 84 percent of the geographic area of the United States.⁸⁰ We use this same definition of rural to analyze coverage by census block in rural versus non-rural areas in this *Report*.

(i) **Mobile Wireless Network Coverage**

40. Chart III.A.4 shows that the difference between rural and non-rural voice coverage by census block was generally more pronounced as the number of service providers increased.⁸¹ While approximately 96 percent of the population living in non-rural areas was covered by four service providers, only approximately 63 percent of the rural population was covered. The recent acquisitions of urban-focused service providers, MetroPCS and Leap Wireless (“Cricket”) by T-Mobile and AT&T, respectively, are reflected in the numbers for areas covered by five or more network providers. In addition, Appendix Chart III.A.ii presents mobile wireless coverage of rural and non-rural road miles as of July 2015 and shows that non-rural road miles are consistently covered by more service providers than rural road miles.⁸²

Chart III.A.4
Estimated Mobile Wireless Voice Population Coverage by Census Block
in Rural vs. Non-Rural Areas: Mosaik, July 2015



Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage.

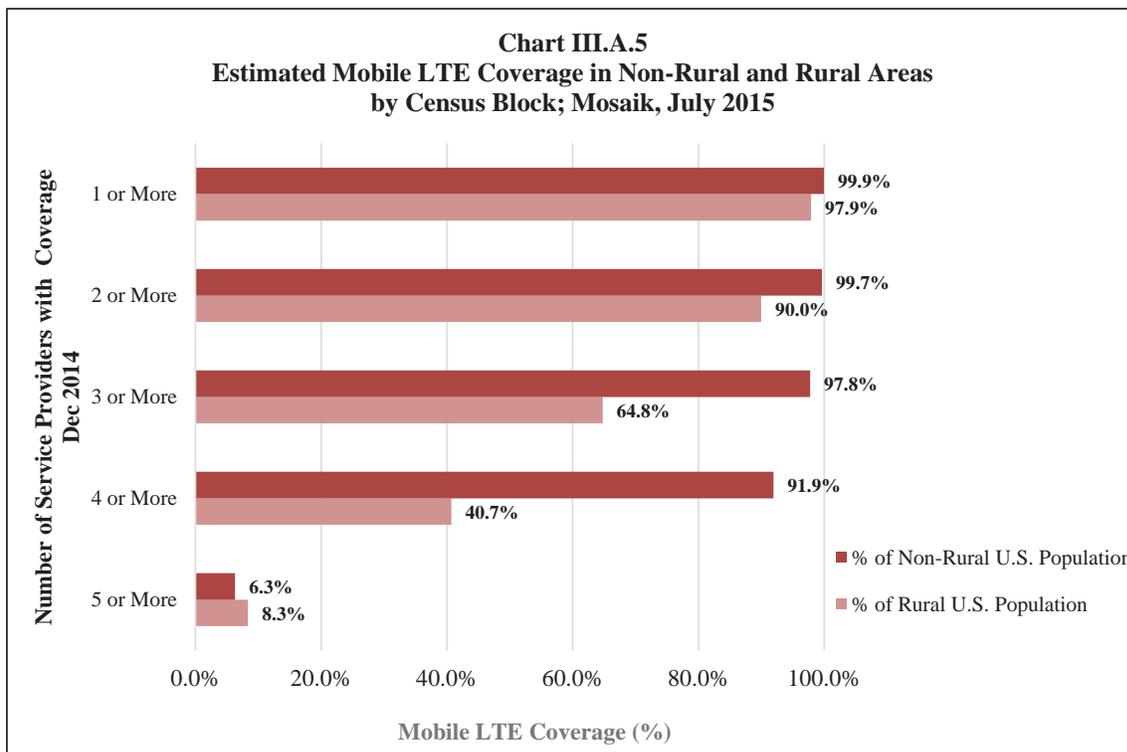
⁸⁰ Based on 2010 Census data (includes the population of Puerto Rico).

⁸¹ See also Appendix Tables III.A.vi and III.A.vii. In addition, the results from Form 477 are similar – the difference between rural and non-rural coverage is generally more pronounced, the higher the number of service providers.

⁸² See also Appendix Tables III.A.vi and III.A.vii.

(ii) Mobile LTE Network Coverage

41. Chart III.A.5 shows that the coverage gap as of July 2015 between rural and non-rural population living in census blocks increased as the number of service providers increased.⁸³ Considering LTE coverage by at least three service providers, Chart III.A.5 shows that while almost 98 percent of the non-rural population was covered by at least three service providers, approximately 65 percent of the rural population had the same network coverage. Considering coverage by at least four service providers, Chart III.A.5 shows that while approximately 92 percent of non-rural America was covered, only approximately 41 percent of rural America was covered. Our analysis of Form 477 yields similar results. While approximately 91 percent of non-rural America was covered by at least four service providers, only approximately 35 percent of rural America was covered.⁸⁴ In addition, Appendix Chart III.A.iii presents mobile wireless LTE coverage by census block of rural and non-rural road miles in July 2015, and shows that non-rural road miles are consistently covered by more service providers than rural road miles.⁸⁵



Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage.

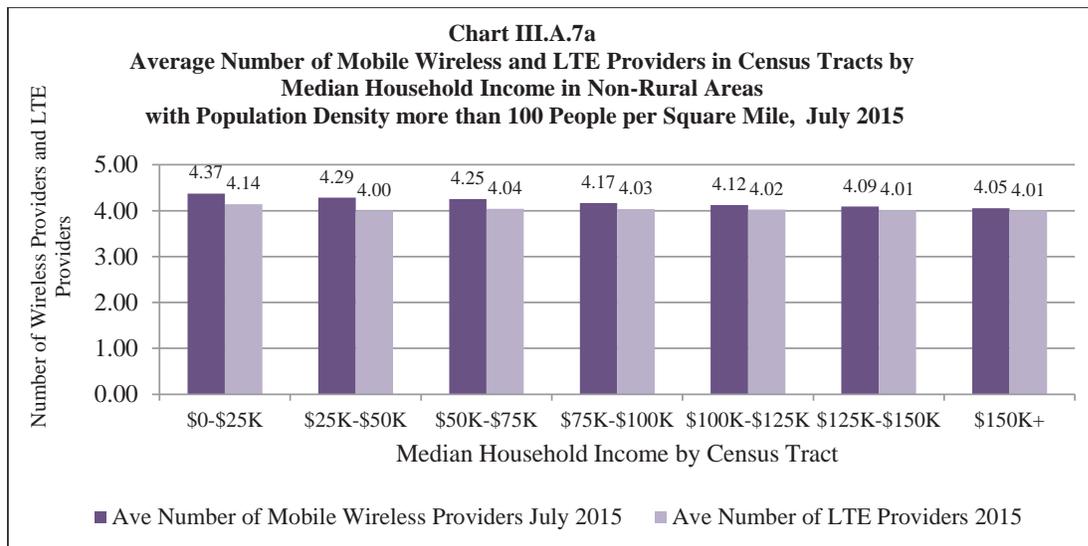
⁸³ See also Appendix Tables III.A.viii and III.A.X.xix.

⁸⁴ Staff estimates based on Form 477 data, Dec. 2014.

⁸⁵ See also Appendix Tables III.A.viii and III.A.xix.

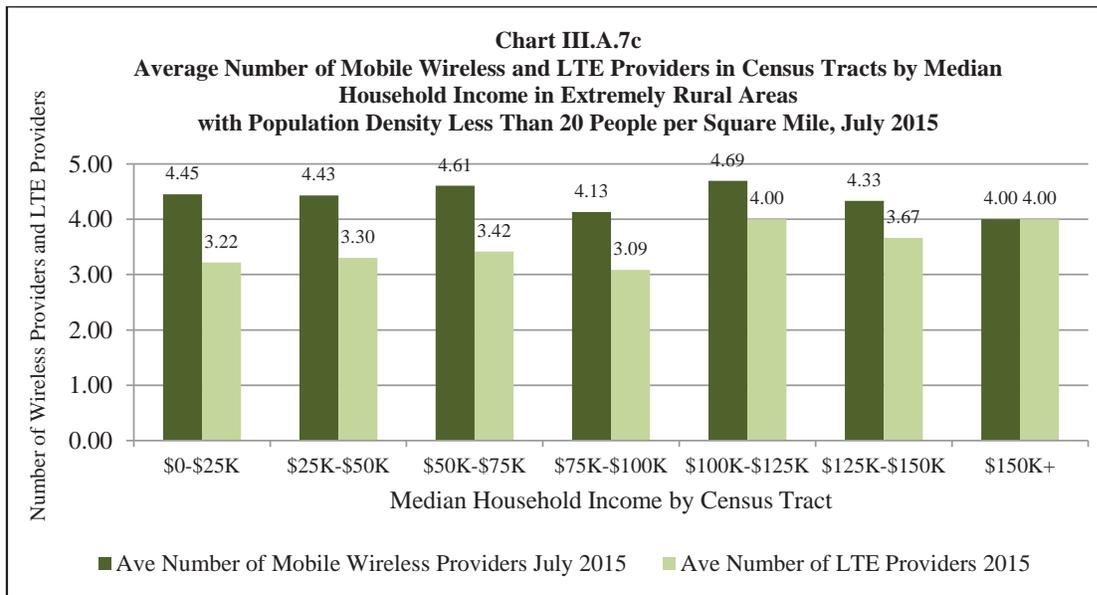
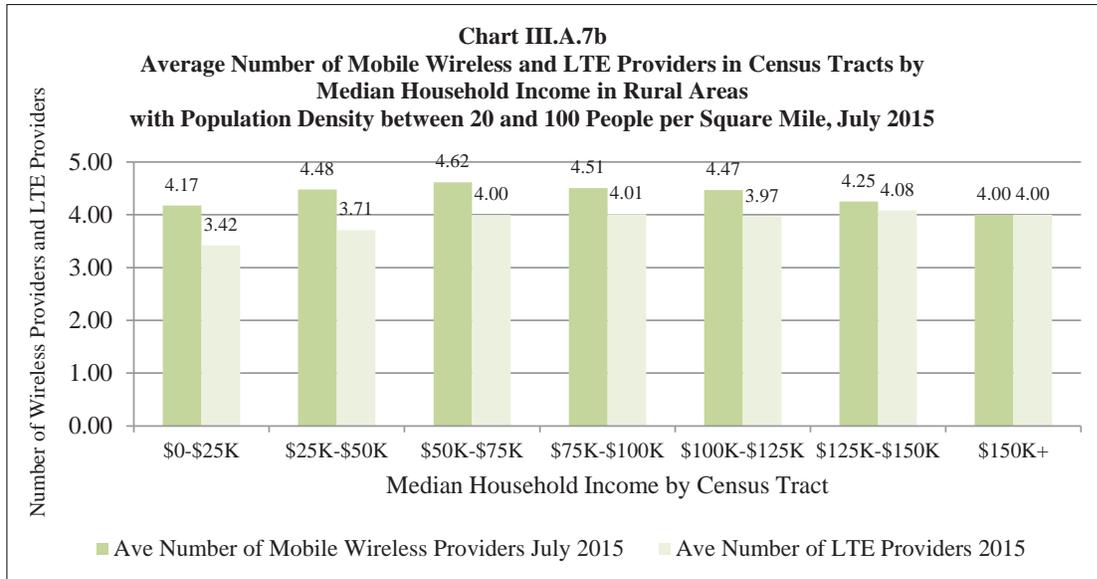
4. Mobile Wireless and LTE Broadband Coverage by Income Levels

42. Charts III.A.7a-c below show how the number of facilities-based mobile wireless service providers that have mobile wireless and LTE coverage in a census tract varies by median household income levels.⁸⁶ As of July 2015, the charts show that the average number of mobile wireless providers with coverage in census tracts was around four, no matter the ruralness of the census tract, nor the median income level. The charts reveal a very different picture for the number of service providers with LTE coverage by census tract. For households with a median income of less than \$25,000, the average number of service providers with LTE coverage in non-rural areas was 4.14, as compared to 3.42 in rural areas, whereas for households with a median income of \$25,000 to \$50,000, the average numbers were 4.00 and 3.71, respectively. In addition, the average number of service providers with LTE coverage further declined to 3.22 in extremely rural areas for households with a median income level of less than \$25,000. We further note that for households with median income of \$75,000 to \$100,000, there is a difference between LTE coverage in rural versus extremely rural areas: while the average number of providers with coverage is approximately four in rural areas, it drops to approximately three in extremely rural areas.



⁸⁶ The percentages of population located in census tracts with a certain number of mobile wireless or mobile LTE broadband providers represent network coverage, which does not necessarily mean that they offered service to residents in the census block. In addition, we emphasize that a service provider reporting mobile wireless or LTE broadband coverage in a particular census tract may not provide coverage everywhere in the census tract. For both these reasons, the number of service providers in a census tract, or by income level does not necessarily reflect the number of choices available to a particular individual or household at a certain income level, and does not purport to measure competition. In addition, calculations based on Mosaik data on coverage, while useful for measuring developments in mobile wireless coverage, have certain limitations that likely result in an overstatement of the extent of mobile wireless and mobile LTE broadband coverage.

Data on median household income are based on the U.S. Census Bureau's American Community Survey ("ACS") 2009-2013. The analysis is done on a census tract, rather than census block, basis because the smallest geographic area for which median household income data is available is census tracts. These data do not allow for an analysis of adoption rates for mobile wireless or mobile LTE broadband services.



Source: Data on median household income by census tract are based on the U.S. Census Bureau’s American Community Survey (“ACS”) 2009-2013. Data on the number of service providers are from Mosaik, July 2015. It is important to note that the number of mobile wireless or mobile LTE broadband service providers in a census tract represents network coverage, which does not necessarily mean that they offered service to any or all the residents in the census tract. In addition, we emphasize that a service provider reporting mobile wireless or LTE broadband coverage in a particular census tract may not provide coverage everywhere in the tract.

B. Connections and Subscribers

1. Connections and Subscribers by Geography

43. To better understand the number of connections across geographic areas, for this *Report*, we have estimated penetration rates (the number of mobile wireless connections per 100 people), using NRUF subscriber data, for the 172 EAs of the United States. As discussed above, we use EAs as the geographic unit for measuring the level of concentration in the mobile wireless services marketplace in order to maintain continuity with past *Reports* and to ensure that we do not compromise the confidential information contained in the NRUF data.⁸⁷ Regional penetration rates for the 172 EAs range from 87 percent in Wausau, Wisconsin to 151 percent in Wichita, Kansas.⁸⁸ The nationwide penetration rate based on NRUF data now exceeds 100 percent, meaning that the number of connected devices exceeds the total population of the United States, and the penetration rate was at least 100 percent in 121 of the 172 EAs at the end of 2014.⁸⁹

2. Connections and Subscribers by Demographics

44. Several socio-economic and demographic factors such as household income and age are correlated with overall mobile wireless subscription rates as well as smartphone subscription rates. Based on September 2015 survey data from ComScore Mobilens,⁹⁰ Chart III.B.1 below shows that mobile wireless subscribers overall, and smartphone subscribers in particular, are in higher income brackets. For example, approximately 25 percent of the population live in households with an annual income of less than \$25,000, but only approximately 18 percent of mobile wireless users and approximately 15 percent of smartphone users are in this bracket. Conversely, approximately 22 percent of the population live in households with an annual income over \$100,000, but approximately 28 percent of mobile wireless subscribers and approximately 31 percent of smartphone subscribers are in this income bracket. Further, we note that more postpaid users are in a higher income bracket, while the converse is true for prepaid subscribers.

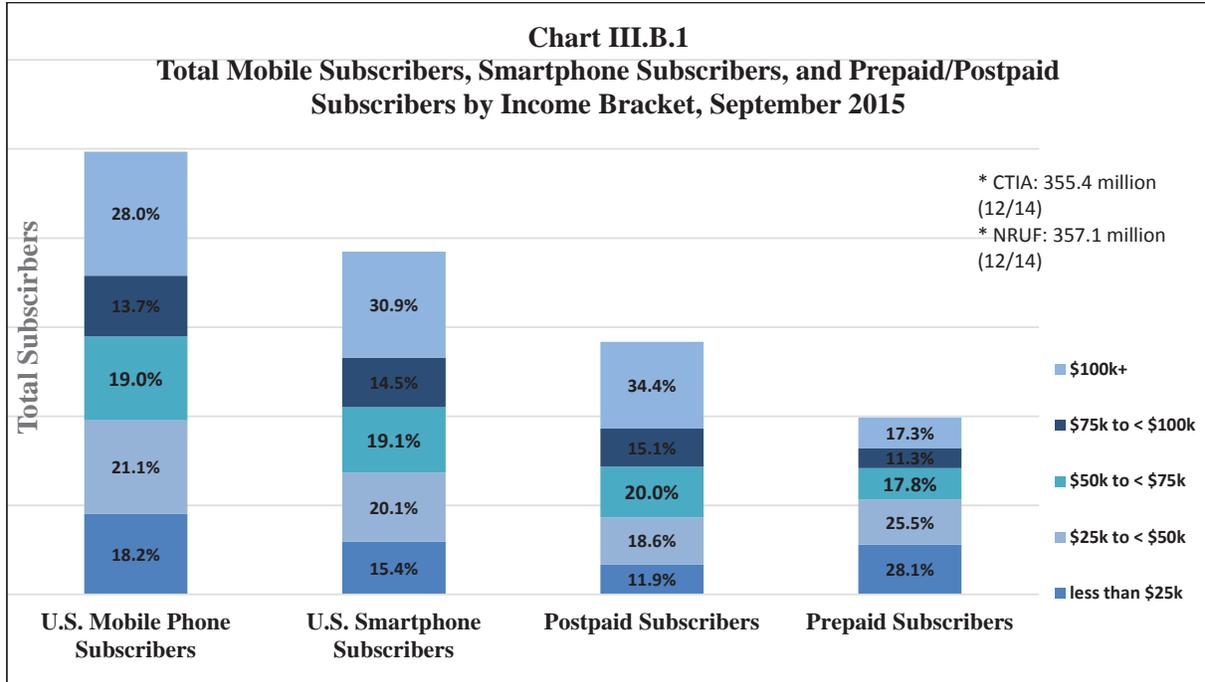
45. As shown in Chart III.B.2 below, the ComScore data also allow the presentation of the composition of mobile users by age. While the general adoption of mobile wireless devices is fairly evenly distributed among various age groups, smartphone adoption is more concentrated in younger age groups. For example, as of September 2015, adults ages 18 to 44 comprise approximately 46 percent of all mobile wireless subscribers, but make up approximately 54 percent of smartphone subscribers, while adults 55 or over represent approximately 29 percent of all mobile wireless subscribers, but only approximately 21 percent of smartphone subscribers.

⁸⁷ See section II.D. *supra*.

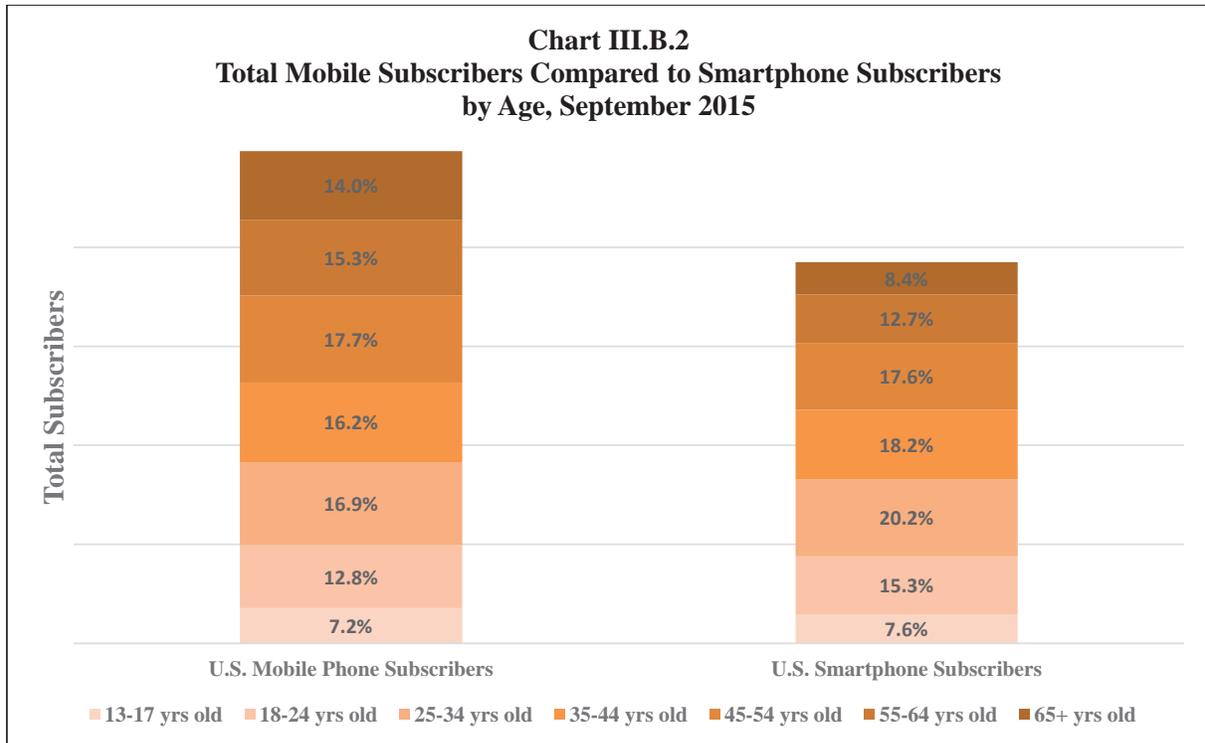
⁸⁸ See (web) Appendix III for detailed data on penetration rates by EA, available at https://www.fcc.gov/reports-research/reports?og_group_ref_target_id=1638&field_report_series_tid=1733&shs_term_node_tid_depth=All&=Apply.

⁸⁹ According to the U.S. Census Bureau, the combined population of the 50 states, the District of Columbia, and Puerto Rico, as of July 1, 2014, was estimated to be 322.4 million. See U.S. Census Bureau website, “American FactFinder,” available at http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP_2014_PEPANNRES&src=pt. We note that if NRUF is used to calculate a mobile wireless penetration rate (of a population), that penetration rate is overstated due to the number of individuals who have more than one mobile wireless device.

⁹⁰ Survey data based on ComScore MobiLens, September 2015. ComScore Mobilens U.S. data are derived from a monthly survey of over 13,000 respondents ages 13 and older who are recruited to represent U.S. Census demographics. The total universe size is estimated from data provided by CTIA and comScore’s monthly subscriber studies. Race data are found at the U.S. Census Bureau State and County Quick Facts 2013 website, available at <http://quickfacts.census.gov/qfd/states/00000.html>. Income data are found in the “Income, Poverty, and Health Insurance Coverage in the United States: 2012 Current Population Reports. United States Census Bureau” (Issued Sept. 2013), Table A-1: “Households by Total Money Income, Race, and Hispanic Origin of Householder,” available at <http://www.census.gov/prod/2013pubs/p60-245.pdf>.



Source: ComScore, MobiLens Audience Profile September 2015, and U.S. Census Bureau.



Source: ComScore MobiLens, 3-Month Average, September 2015.

IV. INPUT MARKETS

46. Mobile wireless service providers employ a combination of inputs to provide mobile wireless services to their customers. These inputs include electromagnetic spectrum to transmit signals between base stations and end users' devices, as well as non-spectrum inputs such as cellular base stations and towers to carry transmissions. Further, backhaul, which routes voice and data traffic from base stations for onward transmission and may use spectrum or wireline resources, is an additional input required for the provision of mobile service. In this section, we first discuss the critical role of spectrum as an input in the provision of mobile wireless services. Next, we summarize the Commission's policies to facilitate the use of spectrum and then provide information on service providers' current spectrum holdings. Lastly, we provide an analysis of non-spectrum inputs.

A. Spectrum

1. Importance of Spectrum for the Provision of Mobile Wireless Services

47. As the Commission has found, spectrum is a critical input in the provision of mobile wireless services and affects if and when existing service providers and potential entrants will be able to expand capacity or deploy networks.⁹¹ Incumbent service providers may need additional spectrum to increase their coverage or capacity, while new entrants need access to spectrum to enter a geographic area.⁹² In addition, increasing consumer demand for mobile broadband is increasing service providers' need for spectrum at an unprecedented rate and this is projected to grow further.⁹³ Spectrum bands vary in their propagation characteristics, which has implications for how spectrum is deployed.⁹⁴ Spectrum below 1 GHz ("low-band spectrum") has certain propagation advantages for network deployment over long distances, while also reaching deep into buildings and urban canyons, while spectrum above 1 GHz ("high-band spectrum") allows for the better transmission of large amounts of information.⁹⁵ As service providers deploy next-generation mobile networks, the engineering properties and deployment capabilities of the mix of particular spectrum bands have become increasingly important, particularly as multi-band phones allow service providers to take advantage of these different properties.⁹⁶

48. Competition in the mobile wireless marketplace will be better promoted by multiple service providers having the opportunity to access both low-band spectrum that can provide coverage and in-building penetration, as well as high-band spectrum that can provide the increased throughput for mobile broadband applications.⁹⁷ Service providers holding a mix of low- and high-band spectrum licenses have greater flexibility

⁹¹ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6134 ¶ 2. See also *Seventeenth Report*, 29 FCC Rcd at 15355 ¶ 89.

⁹² See *Seventeenth Report*, 29 FCC Rcd at 15355 ¶ 89.

⁹³ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6134 ¶ 2.

⁹⁴ Service providers deploy their spectrum bands differently depending on the nature of the service, geography, density, or other factors in their network build-out. See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6149-54 ¶¶ 31-40; *Seventeenth Report*, 29 FCC Rcd at 15355-57 ¶¶ 90-92.

⁹⁵ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6135 ¶ 3; *Seventeenth Report*, 29 FCC Rcd at 15356 ¶ 90. In this sense, low-band spectrum may be thought of as "coverage" spectrum, and high-band spectrum may be thought of as "capacity" spectrum. We note that there is significantly less low-band spectrum than high-band spectrum that is suitable and available for the provision of mobile telephony/broadband services. See *Seventeenth Report*, 29 FCC Rcd at 15356 ¶ 90.

⁹⁶ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6144 ¶ 18; *Seventeenth Report*, 29 FCC Rcd at 15356-57 ¶¶ 91-92.

⁹⁷ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6157 ¶ 47; *Seventeenth Report*, 29 FCC Rcd at 15356 ¶ 91.

and are better able to optimize network costs for a given quality level.⁹⁸ Service providers without access to low-band spectrum would have to rely on less efficient and cost-effective methods to increase rural and in-building coverage to serve additional customers, such as adding towers, splitting cells, or acquiring roaming rights on other networks.⁹⁹

2. Facilitating Access to Spectrum

49. Recognizing the importance of spectrum in the provision of mobile wireless services, Congress, through the Communications Act, requires the Commission to implement spectrum policies that promote competition, innovation, and the efficient use of spectrum to serve the public interest, convenience, and necessity.¹⁰⁰ Further, policies which promote and preserve competition, in turn, enable consumers to make choices among multiple service providers and lead to lower prices, improved quality, and increased innovation.¹⁰¹ Consistent with this statutory mandate, the Commission has established policies to make spectrum available to existing mobile service providers and potential new entrants through initial licensing, primarily by competitive bidding, and through secondary market transactions.¹⁰² The Commission generally has adopted “flexible use” policies, thereby allowing licensees to decide which services to offer and what technologies to deploy on spectrum used for the provision of mobile wireless services.

a. Auctions

50. Since 1994, the Commission has conducted various auctions of spectrum licenses.¹⁰³ These auctions are open to any eligible entity that submits an application and upfront payment and is found to be a qualified bidder by the Commission.¹⁰⁴ In addition, the Commission generally provides a bidding credit – or discount – to promote participation by small businesses and rural service providers, including businesses owned by members of minority groups and women (collectively “designated entities”).¹⁰⁵ The *Seventeenth Report* discusses auctions for the various frequency bands which are potentially suitable for the provision of mobile telephony/broadband service.¹⁰⁶ Further, the Commission’s auction website provides detailed information regarding completed, ongoing, and planned auctions.¹⁰⁷ To provide service providers with the opportunities to

⁹⁸ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6163-64 ¶ 59; *Seventeenth Report*, 29 FCC Rcd at 15356-57 ¶ 92.

⁹⁹ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6164 ¶ 60. While other cost-related factors exist, ensuring that multiple service providers are able to access a sufficient amount of low-band spectrum is a threshold requirement for extending and improving service in both rural and urban areas. See *id.*, 29 FCC Rcd at 6135 ¶ 3.

¹⁰⁰ 47 U.S.C. § 309(j)(3)(B).

¹⁰¹ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6144 ¶ 17.

¹⁰² See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6143-44 ¶ 17, 6167-68 ¶¶ 67-69, 6190 ¶ 135, 6193 ¶ 144, 6221-22 ¶¶ 225-27, 6223-24 ¶¶ 231-32.

¹⁰³ See FCC website, “Auctions Home,” available at http://wireless.fcc.gov/auctions/default.htm?job=auctions_home.

¹⁰⁴ See FCC website, “About Auctions,” available at http://wireless.fcc.gov/auctions/default.htm?job=about_auctions.

¹⁰⁵ See 47 U.S.C. § 309(j)(3)(B), 309(j)(4)(D); see also 47 C.F.R. § 1.2110. Updating Part 1 Competitive Bidding Rules; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions; Petition of DIRECTV Group, Inc. and EchoStar LLC for Expedited Rulemaking to Amend Section 1.2105(a)(2)(xi) and 1.2106(a) of the Commission’s Rules and/or for Interim Conditional Waiver; Implementation of the Commercial Spectrum Enhancement Act and Modernization of the Commission’s Competitive Bidding Rules and Procedures, WT Docket No. 14-170, GN Docket No. 12-268, RM 11395, WT Docket No. 05-211, *Report and Order*, *Order on Reconsideration of the First Report and Order*, *Third Order on Reconsideration of the Second Report and Order*, and *Third Report and Order*, 30 FCC Rcd 7493 (2015) (“*Part 1 Report and Order*”) (modified by Erratum; rel. Aug. 25, 2015).

¹⁰⁶ See *Seventeenth Report*, 29 FCC Rcd at 15311-19 ¶¶ 95-96.

¹⁰⁷ See FCC website, “Auctions Home,” available at http://wireless.fcc.gov/auctions/default.htm?job=auctions_home.

better meet the rising consumer demand discussed above, the Commission has made, and is continuing to make, substantially more spectrum available for the provision of mobile wireless services. For example, in February 2014, the Commission auctioned the 10 megahertz of H Block in the 1.9 GHz Band with DISH winning each of the 176 licenses.¹⁰⁸ In January 2015, the Commission auctioned 65 megahertz of high-band spectrum in the Advanced Wireless Services-3 (“AWS-3”) auction, generating approximately \$45 billion in (gross) bids.¹⁰⁹ A total of 31 bidding entities won spectrum in the auction, and the spectrum sold for an average of \$2.71 per MHz-POP for paired spectrum and \$0.52 per MHz-POP for unpaired spectrum.¹¹⁰ The 600 MHz Incentive Auction (“incentive auction”), which is scheduled to begin in March 2016, has the potential to make available significant amounts of low-band spectrum currently used for over-the-air television broadcasting.¹¹¹

51. In the *Mobile Spectrum Holdings Report and Order*, the Commission concluded that, in lieu of a post-auction application of the spectrum screen to the initial licensing of spectrum to winning bidders, the Commission would determine whether a band-specific mobile spectrum holding limit is necessary, and if so, would establish an *ex ante* application of that limit to the competitive bidding for that band.¹¹² The Commission declined to adopt band-specific mobile spectrum holding limits for AWS-3, emphasizing the availability of a substantial amount of comparable high-band spectrum to competitors and the significant existing holdings of multiple service providers of comparable spectrum.¹¹³ Regarding the incentive auction, however, the Commission established a market-based spectrum reserve of up to 30 megahertz in each geographic license area (Partial Economic Area) (“PEA”)¹¹⁴ that is designed to ensure against excessive concentration in holdings of low-band spectrum while including safeguards to ensure that all bidders bear a fair share of the cost of the incentive auction.¹¹⁵

52. In the incentive auction, the Commission will allow broadcasters to voluntarily participate in a “reverse auction” of the 600 MHz spectrum, which will then be made available in a “forward auction” to be used

¹⁰⁸ See Auction of H Block Licenses in the 1915-1920 MHz and 1995-2000 MHz Bands Closes; Winning Bidder Announced for Auction 96, *Public Notice*, 29 FCC Rcd 2044 (2014); Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands, WT Docket No. 12-70, Fixed and Mobile Services in the Mobile Satellite Service Bands at 1525-1559 MHz and 1626.5-1660.5 MHz, 1610-1626.5 MHz and 2483.5-2500 MHz, and 2000-2020 MHz and 2180-2200 MHz, ET Docket No. 10-142, Service Rules for Advanced Wireless Services in the 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz and 2175-2180 MHz Bands, WT Docket No. 04-356, *Report and Order and Order of Proposed Modification*, 27 FCC Rcd 16102 (2012) (“AWS-4 Report and Order”).

¹⁰⁹ See Auction Of Advanced Wireless Services (AWS-3) Licenses Closes, Winning Bidders Announced For Auction 97, *Public Notice*, 30 FCC Rcd 630 (2015). See also Amendment of the Commission’s Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands, GN Docket No. 13-185, *Report and Order*, 29 FCC Rcd 4610 (2014) (“AWS-3 Report and Order”).

¹¹⁰ See Phil Goldstein, “AWS-3 Auction Results: AT&T leads with \$18.2B, Verizon at \$10.4B, Dish at \$10B and T-Mobile at \$1.8B” (Jan. 30, 2015), available at <http://www.fiercewireless.com/story/aws-3-auction-results-att-leads-182b-verizon-104b-dish-10b-and-t-mobile-18b/2015-01-30>.

¹¹¹ See Broadcast Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward), AU Docket No. 14-252, GN Docket No. 12-268, WT Docket No. 12-269, MB Docket No. 15-146, *Public Notice*, 30 FCC Rcd 8975 (2015).

¹¹² See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6192 ¶¶ 139.

¹¹³ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6220-21 ¶¶ 222-24.

¹¹⁴ We note that the geographic license areas for spectrum offered vary across the various auctions the Commission has conducted. For example, in Auction 96 (H Block), 176 licenses were offered (one for each of the 176 EAs), while in Auction 97 (AWS-3), 1,614 licenses were offered in total, at both the EA and CMA level. Finally, for the upcoming incentive auction, spectrum licenses will be offered at the PEA geographic level.

¹¹⁵ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6193-6219 ¶¶ 146-217.

for the provision of mobile wireless service, with flexible use service rules.¹¹⁶ The Commission stated that by offering only paired blocks in a single band, and by licensing on a PEA basis, the 600 MHz Band Plan will promote participation by both larger and smaller wireless service providers, including rural service providers, and encourage new entrants, and further will promote interoperability and international harmonization.¹¹⁷ The Commission established procedures necessary to carry out the incentive auction in the *Auction 1000 Bidding Procedures Public Notice*.¹¹⁸ In particular, this Public Notice adopted procedures for: an initial clearing target, allowing market forces to determine the highest and best use of spectrum on a near-nationwide basis; improved transparency for reverse and forward auction bidders; two categories of generic spectrum blocks for bidding in the clock phase of the forward auction; and the market-based spectrum reserve in the forward auction.¹¹⁹ Among the spectrum reserve procedures adopted, the *Auction 1000 Bidding Procedures Public Notice* adopted the Commission's proposed average price and spectrum benchmarks to help ensure that winning bids for the licenses in the forward auction reflect competitive prices and return a portion of the value of the spectrum to taxpayers without reducing the amount of spectrum repurposed for new, flexible-use licenses.¹²⁰ In addition, to promote participation by designated entities, the Commission adopted bidding credits for small businesses and, for the first time, a bidding credit for eligible rural service providers.¹²¹ The Commission capped the overall amount of bidding credit that an entity may receive.¹²²

b. Secondary Markets

53. Subject to the Commission's approval, licensees may assign and exchange licenses, in whole or in part (through partitioning and/or disaggregation), on the secondary market.¹²³ In reviewing proposed acquisitions of spectrum through secondary market transactions, the Commission uses an initial screen to help identify for case-by-case review local markets where changes in spectrum holdings resulting from the transaction may be of particular concern.¹²⁴ As set out in various transactions orders, however, the Commission has not limited its consideration of potential competitive harms solely to markets identified by its initial screen, if it

¹¹⁶ See generally Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, GN Docket No. 12-268, *Report and Order*, 29 FCC Rcd 6567 (2014) ("*Incentive Auctions Report and Order*").

¹¹⁷ See *Incentive Auctions Report and Order*, 29 FCC Rcd at 6585-86 ¶ 44.

¹¹⁸ See generally Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward), AU Docket No. 14-252, GN Docket No. 12-268, WT Docket No. 12-269, MB Docket No. 15-146, *Public Notice*, 30 FCC Rcd 8975 (2015) ("*Auction 1000 Bidding Procedures Public Notice*").

¹¹⁹ See *Auction 1000 Bidding Procedures Public Notice*, 30 FCC Rcd at 8979 ¶ 2.

¹²⁰ See *id.*

¹²¹ See *Part 1 Report and Order*, 30 FCC Rcd 7953.

¹²² See *id.*, 30 FCC Rcd at 7544-48 ¶¶ 122-30.

¹²³ As part of its secondary market policies, the Commission also permits mobile wireless licensees to lease all or a portion of their spectrum usage rights for any length of time within the license term and over any geographic area encompassed by the license. For a more comprehensive overview of the Commission's secondary market policies. See *Seventeenth Report*, 29 FCC Rcd at 15358-60 ¶¶ 97-100.

¹²⁴ See, e.g., *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6221-22 ¶ 225; Applications of AT&T Inc., E.N.M.R Telephone Cooperative, Plateau Telecommunications, Inc., New Mexico RSA 4 East Limited Partnership, and Texas RSA 3 Limited Partnership for Consent To Assign Licenses and Authorizations, WT Docket No. 14-144, *Memorandum Opinion and Order*, 30 FCC Rcd 5107, 5113 ¶¶ 12-13, 5118 ¶ 24 (2015) ("*AT&T-Plateau Wireless Order*"). See also *AT&T-Leap Order*, 29 FCC Rcd at 2752-53 ¶¶ 39, 41. For transactions that result in the acquisition of wireless business units and customers or change the number of firms in any market, the Commission also applies an initial screen based on the size of the post-transaction HHI and the change in the HHI. See, e.g., *AT&T-Plateau Wireless Order*, 30 FCC Rcd at 5118 ¶ 24, n.82.

encounters other factors that may bear on the public interest inquiry.¹²⁵ In addition, the Commission determined in the *Mobile Spectrum Holdings Report and Order* that increased aggregation of below-1-GHz spectrum would be treated as an “enhanced factor” under its case-by-case review of license transfers if post-transaction the acquiring entity would hold approximately one-third or more, or 45 megahertz or more, of the currently suitable and available spectrum below 1 GHz.¹²⁶

54. The Commission includes in its initial screen spectrum that it finds is suitable and available for the provision of mobile telephony/broadband services. Suitability is based upon whether the spectrum band at issue is capable of supporting mobile service given its physical properties and the state of equipment technology, whether the spectrum is licensed with a mobile allocation and corresponding service rules, and whether the spectrum is committed to another use that effectively precludes its uses for the relevant mobile services.¹²⁷ With respect to availability, the Commission considers particular spectrum to be a relevant input if it is fairly certain that it will meet the criteria for suitability in the near term.¹²⁸

55. In the past decade, in the context of its review of secondary market transactions, the Commission periodically determined that additional spectrum was suitable and available, and therefore subject to inclusion in the spectrum screen – including 700 MHz,¹²⁹ Advanced Wireless Service-1 (“AWS-1”),¹³⁰ Broadband Radio Service (“BRS”),¹³¹ and Wireless Communications Service (“WCS”).¹³² The Commission updated the spectrum screen in the *Mobile Spectrum Holdings Report and Order* by adding 151 megahertz of spectrum in total from the AWS-4 (2.0/2.2 GHz), H Block (1.9 GHz), and BRS and Educational Broadcast Service (“EBS”) (2.5 GHz) bands.¹³³ It also designated for future inclusion in the spectrum screen, the amount of 600 MHz Band spectrum that would be made available through the incentive auction, and the 65 megahertz of AWS-3 spectrum as it becomes available on a market by market basis.¹³⁴ The current suitable and available spectrum included in the screen is as follows:

¹²⁵ See, e.g., *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6221-22 ¶ 225; *AT&T-Plateau Wireless Order*, 30 FCC Rcd at 5113 ¶ 12. See also *AT&T-Leap Order*, 29 FCC Rcd at 2752 ¶ 39.

¹²⁶ See, e.g., *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6240 ¶¶ 282-88.

¹²⁷ See, e.g., *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6169 ¶ 71; *AT&T-Plateau Wireless Order*, 30 FCC Rcd at 5116-17 ¶ 21; *AT&T WCS Order*, 27 FCC Rcd 16459, 16469-70 ¶ 29 n.81.

¹²⁸ See *id.*

¹²⁹ See Applications of AT&T Inc. and Dobson Communications Corporation for Consent To Transfer Control of Licenses and Authorizations, WT Docket No. 07-153, *Memorandum Opinion and Order*, 22 FCC Rcd 20295, 20307-8 ¶ 17 (2007).

¹³⁰ See Applications of Sprint Nextel Corporation and Clearwire Corporation for Consent To Transfer Control of Licenses, Leases, and Authorizations, WT Docket No. 08-94, *Memorandum Opinion and Order*, 23 FCC Rcd 17570, 17599 ¶ 72 (2008) (“*Sprint Nextel-Clearwire Order*”).

¹³¹ Most BRS spectrum is considered available in those markets where the transition of BRS spectrum to the new band plan has been completed. See *Sprint Nextel-Clearwire Order*, 23 FCC Rcd at 17598-99 ¶ 70; Amendment of Part 27 of the Commission’s Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band, WT Docket No. 07-293, *Report and Order*, 25 FCC Rcd 11710, 11711 ¶ 1 (2010).

¹³² See *AT&T WCS Order*, 27 FCC Rcd at 16470-71 ¶ 31.

¹³³ See *Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6172-87 ¶¶ 82-125.

¹³⁴ See *id.*, 29 FCC Rcd at 6171-72, 6176-79 ¶¶ 76-81, 94-102. The Commission also subtracted 12.5 megahertz of Specialized Mobile Radio Service (“SMR”) and 10 megahertz that was the Upper 700 MHz D Block. See *id.*, 29 FCC Rcd at 6187-90 ¶¶ 126-34.

Table IV.A.1
Spectrum Included in the Spectrum Screen

Spectrum Band	Megahertz (Amount)
700 MHz	70
Cellular	50
SMR	14
Broadband PCS	130
AWS-1 ^a	90
H-Block	10
AWS-4	40
WCS	20
BRS ^b	67.5
EBS	89
Total Amount of Spectrum	580.5

^a AWS-1 is not attributable in markets where federal government users have not been relocated.

^b BRS is not attributable in markets where previous BRS licensees have not been transitioned.

56. For those markets identified by the spectrum screen, or where the Commission encounters other factors that may bear on the public interest inquiry,¹³⁵ the Commission generally conducts further competitive review to determine whether the proposed transaction would result in an increased incentive or ability for the assignee or transferee to behave in an anticompetitive manner. Further, as well as modifying the spectrum screen, the *Mobile Spectrum Holdings Report and Order* requires that any increase in spectrum holdings of below 1 GHz be treated as an “enhanced factor” for case-by-case review if post-transaction the acquiring entity would hold approximately one-third or more of the suitable and available spectrum below 1 GHz,¹³⁶ such that further concentration of such spectrum will not have adverse competitive effects either in particular local markets or on a broader regional or national level.¹³⁷ The case-by-case review that the Commission undertakes considers factors that are important in predicting the incentives and ability of service providers to successfully reduce competition on price or non-price terms, and evaluates transaction-specific public interest benefits that may mitigate or outweigh any public interest harms that might arise.¹³⁸ The Commission can condition approval of a transaction

¹³⁵ For example, the Commission also considered whether harms in numerous local markets may result in nationwide harms and has considered potential harms from concentration in a particular band with an important ecosystem. *See, e.g., Applications of Cellco Partnership d/b/a Verizon Wireless and SpectrumCo LLC and Cox TMI, LLC for Consent To Assign AWS-1 Licenses*, WT Docket No. 12-4, *Memorandum Opinion and Order*, 27 FCC Rcd 10698, 10721-22, 10727 ¶¶ 64, 76 (2012) (“*Verizon Wireless-SpectrumCo Order*”).

¹³⁶ *See Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6233, 6240 ¶ 267, ¶¶ 286-88. The Commission applied the below-1-GHz review, as set forth in paragraph 286 of the *Mobile Spectrum Holdings Report and Order*, for the first time in the *AT&T-Plateau Wireless Order*. More recently, the Commission applied the below-1-GHz review as set forth in paragraph 287 of this *Report and Order* for the first time in the *AT&T-Club 42 Order*. *See generally AT&T-Plateau Wireless Order*, 30 FCC Rcd 5107; *Application of AT&T Mobility Spectrum LLC and Club42CM Limited Partnership for Consent To Assign Licenses*, WT Docket No. 14-145, *Memorandum Opinion and Order*, FCC 15-150 (rel. Nov. 12, 2015) (“*AT&T-Club 42 Order*”).

¹³⁷ *See Mobile Spectrum Holdings Report and Order*, 29 FCC Rcd at 6240 ¶ 288.

¹³⁸ These competitive variables include, but are not limited to: the total number of rival service providers; the number of rival firms that can offer competitive service plans; the coverage by technology of the firms’ respective networks; the rival firms’

on the divestiture of licenses or certain other commitments in markets where necessary to find an application serves the public interest.¹³⁹

57. Since the *Seventeenth Report*, a number of small transactions involving the transfer of spectrum licenses, as well as, in certain cases, network infrastructure and other assets, have been filed with the Commission.¹⁴⁰ Among the smaller transactions that have occurred in the past couple of years are a number in which a nationwide service provider acquired spectrum or other assets from a small or regional licensee. Not including intra-market spectrum swaps of equal amounts of spectrum or transactions involving increased aggregation of low-band spectrum, from January 2014 through June 2015 the Commission approved approximately 110 applications in total filed by the four nationwide providers to acquire PCS, AWS-1, Cellular, and/or 700 MHz licenses from a non-nationwide licensee or lease additional BRS/EBS spectrum from a non-nationwide licensee.

c. Additional Spectrum Initiatives

58. The 3.5 GHz Band¹⁴¹ proceeding is a Commission initiative that will make more spectrum available to facilitate the provision of mobile wireless service. On April 17, 2015, the Commission adopted a Report and Order that will advance the use of this band.¹⁴² This Report and Order established a three-tiered spectrum authorization framework to facilitate a variety of small cell and other broadband uses of the 3.5 GHz Band¹⁴³ on a shared basis with incumbent federal and non-federal users of the band.¹⁴⁴ The three tiers of users, in order of priority, are: Incumbent Access, Priority Access, and General Authorized Access (“GAA”).¹⁴⁵ Incumbent Access users include: (1) military radar systems; (2) non-federal fixed satellite service (“FSS”) earth stations; and (3) for a finite period, grandfathered terrestrial wireless broadband service licensees in the 3650-

market shares; the combined entity’s post-transaction market share and how that share changes as a result of the transaction; the amount of spectrum suitable for the provision of mobile telephony/broadband services controlled by the combined entity; and the spectrum holdings of each of the rival service providers. *See, e.g., AT&T-Plateau Wireless Order*, 30 FCC Rcd at 5120 ¶ 29; *AT&T-Leap Order*, 29 FCC Rcd at 2745-46 ¶ 21.

¹³⁹ *See, e.g., AT&T-Leap Order*, 29 FCC Rcd at 2743-44 ¶ 16; *Verizon Wireless-SpectrumCo Order*, 27 FCC Rcd at 10711 ¶ 30.

¹⁴⁰ *See, e.g., AT&T-Club 42 Order*, FCC 15-150; *AT&T-Plateau Wireless Order*, 30 FCC Rcd 5107; Application of AT&T Mobility Spectrum LLC and Kaplan Telephone Company, Inc. for Consent To Assign Licenses, WT Docket 14-167, *Memorandum Opinion and Order*, 30 FCC Rcd 8502 (WTB 2015); Applications of AT&T Mobility Spectrum LLC and KanOkla Telephone Association, WT Docket No. 14-199, *Memorandum Opinion and Order*, 30 FCC Rcd 8555 (WTB 2015); Application of AT&T Mobility Puerto Rico Inc. and Worldcall Inc. for Consent To Assign Licenses, WT Docket No. 14-206, *Memorandum Opinion and Order*, 30 FCC Rcd 9763 (WTB 2015); Application of AT&T Mobility Spectrum LLC and Consolidated Telephone Company for Consent To Assign Licenses, WT Docket No. 14-254, *Memorandum Opinion and Order*, 30 FCC Rcd 9797 (WTB 2015); Application of Hardy Cellular Telephone Company and McBride Spectrum Partners, LLC for Consent To Assign License, WT Docket No. 14-240, *Memorandum Opinion and Order*, 30 FCC Rcd 9899 (WTB 2015); Application of TeleGuam Holdings, LLC and Club 42 CM Limited Partnership for Consent To Assign Licenses, WT Docket No. 15-7, *Memorandum Opinion and Order*, 30 FCC Rcd 10213 (WTB 2015).

¹⁴¹ The 3.5 GHz Band encompasses 3550-3700 MHz. *See* Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, *Report and Order and Second Further Notice of Proposed Rulemaking*, 30 FCC Rcd 3959, 3961 ¶ 1 (2015) (“3.5 GHz Order and 2nd FNPRM”).

¹⁴² *See generally 3.5 GHz Order and 2nd FNPRM*, 30 FCC Rcd 3959.

¹⁴³ Priority Access Licenses will not be available in the 3650-3700 MHz portion of the band, which is reserved for GAA and Grandfathered Wireless Broadband Licensees. *See id.*, 30 FCC Rcd at 3978 ¶ 54.

¹⁴⁴ *See id.*, 30 FCC Rcd at 3967 ¶ 24, 3978 ¶ 54.

¹⁴⁵ *See id.*

3700 MHz portion of the band.¹⁴⁶ These users will be protected from harmful interference from Priority Access and GAA users. Priority Access licensees¹⁴⁷ will receive protection from interference from GAA users.¹⁴⁸ Access and operations will be coordinated by a dynamic spectrum access system (“SAS”),¹⁴⁹ conceptually similar to – but more technologically advanced than – the databases used to manage Television White Spaces devices.¹⁵⁰ The innovative spectrum sharing techniques adopted in this Order will allow the introduction of 150 megahertz of contiguous spectrum for the Citizens Broadband Radio Service, while protecting critical federal uses, which will enable the exploration of new technologies and spectrum sharing with a focus on relatively low-powered applications.

59. The Commission has also taken steps to explore other technologies,¹⁵¹ including, for example, uses of spectrum above 24 GHz. On October 22, 2015, the Commission adopted a Notice of Proposed Rulemaking (“NPRM”) promoting uses of spectrum above 24 GHz for commercial purposes.¹⁵² The Commission’s “spectrum frontiers” proceeding holds the potential to unlock vast millimeter-wave bands for mobile use, particularly for use by Fifth Generation (“5G”) mobile services.¹⁵³ Previously, bands above 24 GHz were believed to be infeasible for mobile use due to their straight line propagation and atmospheric absorption characteristics.¹⁵⁴ However, as technologies continue to evolve, innovators are working to tap into the potential of using millimeter-wave bands for mobile services,¹⁵⁵ and the promise of high capacity data transfers from these millimeter-wave bands could be a useful supplement to the mobile services offered in lower bands. The NPRM also proposes a variety of licensing mechanisms with the goal of developing flexible rules that will accommodate a wide variety of current and future technologies.¹⁵⁶

¹⁴⁶ See *id.*, 30 FCC Rcd at 3961-62 ¶¶ 3-4, 4035-40 ¶¶ 247-68, 4042-48 ¶¶ 276-96; see also Wireless Telecommunications Bureau Seeks Comment On An Appropriate Method for Determining The Protected Contours For Grandfathered 3650-3700 MHz Band Licensees, GN Docket No. 12-354, *Public Notice*, DA 15-1208 (WTB rel. Oct. 23, 2015).

¹⁴⁷ A Priority Access License (“PAL”) is defined as a non-renewable authorization to use a 10 megahertz channel in a single census tract for three years. PALs will be assigned via competitive bidding in up to seventy megahertz of the 3550-3650 MHz portion of the band. See *3.5 GHz Order and 2nd FNPRM*, 30 FCC Rcd at 3961 ¶ 4. One licensee may hold up to forty megahertz of PALs in any given census tract at any given time. See *id.*, 30 FCC Rcd at 3998 ¶ 117.

¹⁴⁸ GAA users could be a diverse group of stakeholders, including consumers, enterprises, and service providers. See *3.5 GHz Order and 2nd FNPRM*, 30 FCC Rcd at 4009 ¶ 156. GAA users would be permitted opportunistic use of all spectrum from 3550-3700 MHz that is not being used at the time by PAL holders or incumbents. See *id.*, 30 FCC Rcd at 3983 ¶¶ 72-73. The definition of “use” has not yet been resolved. See *id.*, 30 FCC Rcd at 4081 ¶ 419.

¹⁴⁹ See *id.*, 30 FCC Rcd at 3962 ¶ 4, 3984-87 ¶¶ 75-86, section III.H.

¹⁵⁰ See *id.*, 30 FCC Rcd at 4035 ¶ 247, 4069-71 ¶¶ 379-86.

¹⁵¹ We note that in May, 2015, the Commission released a Public Notice seeking more information on Long Term Evolution (“LTE”)-Unlicensed. The Commission plans to continue to monitor the development of unlicensed technologies, including LTE-U. See Office of Engineering and Technology and Wireless Telecommunications Bureau Seek Information on Current Trends in LTE-U and LAA Technology, ET Docket No. 15-105, *Public Notice*, 30 FCC Rcd 4457 (2015) (“*LTE-U Public Notice*”).

¹⁵² See Use of Spectrum Bands Above 24 GHz for Mobile Radio Services, GN Docket No. 14-177, *Notice of Proposed Rulemaking*, FCC 15-138 (rel. Oct. 23, 2015) (“*Spectrum Frontiers NPRM*”).

¹⁵³ See *id.*, FCC 15-138, at ¶¶ 1, 6. We note that we do not intend to define what qualifies as “5G.” Standard bodies like 3GPP and the International Telecommunications Union (“ITU”) plan to develop the requirements by early 2017. See “Tentative 3GPP Timeline for 5G,” available at http://www.3gpp.org/news-events/3gpp-news/1674-timeline_5g (Mar. 2015). See also *id.*, FCC 15-138, at ¶ 1.

¹⁵⁴ See *id.*, FCC 15-138, at ¶ 5.

¹⁵⁵ See *id.*, FCC 15-138, at ¶¶ 5, 12.

¹⁵⁶ See *id.*, FCC 15-138, at ¶ 3.

3. Analysis of Spectrum Holdings

60. Table IV.A.2 (Percentage Spectrum Holdings, by Provider, by Frequency Band) and Table IV.A.3 (Population-Weighted Average Megahertz Holdings by Provider, by Frequency Band) below present spectrum holdings by service provider including all spectrum bands currently considered suitable and available. Table IV.A.3 shows megahertz holdings for each service provider, weighted by population, and Chart IV.A.1 is a graph of providers' spectrum holdings by frequency band, measured on a MHz-POPs basis. As of October 2015, Verizon Wireless, AT&T, Sprint, and T-Mobile, together, hold over 80 percent of all spectrum suitable and available for the provision of mobile wireless services, measured on a MHz-POPs basis.

Table IV.A.2
Percentage Spectrum Holdings, Measured on a MHz-POPs Basis
by Licensee, by Frequency Band*

	700 MHz	Cell.	SMR	PCS	H Block	AWS-1	AWS-4	WCS	BRS	EBS
Spectrum	70 MHz	50 MHz	14 MHz	130 MHz	10 MHz	90 MHz	40 MHz	20 MHz	67.5 MHz	112.5 MHz***
VZW	31.0%	48.1%	0.0%	16.3%	0.0%	38.8%	0.0%	0.0%	0.0%	0.0%
AT&T	41.6%	44.6%	0.0%	29.4%	0.0%	16.3%	0.0%	100.0%	0.0%	0.0%
Sprint	0.0%	0.0%	96.5%	28.0%	0.0%	0.0%	0.0%	0.0%	86.8%	69.8%
T-Mobile	9.5%	0.1%	0.0%	21.8%	0.0%	40.9%	0.0%	0.0%	0.0%	0.0%
USCC	3.6%	4.2%	0.0%	1.3%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%
DISH**	6.6%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	0.0%
Other***	7.8%	3.0%	3.5%	3.1%	0.0%	3.4%	0.0%	0.0%	13.2%	30.2%

* Staff estimates as of Oct. 19, 2015. Abbreviations for spectrum bands: Cell. (Cellular); SMR (Specialized Mobile Radio Service), BRS (Broadband Radio Service), EBS (Educational Broadband Service).

** Dish Network Corporation currently does not provide mobile service.

*** In the application of the spectrum screen in secondary market transactions, 89 megahertz of EBS spectrum is included.

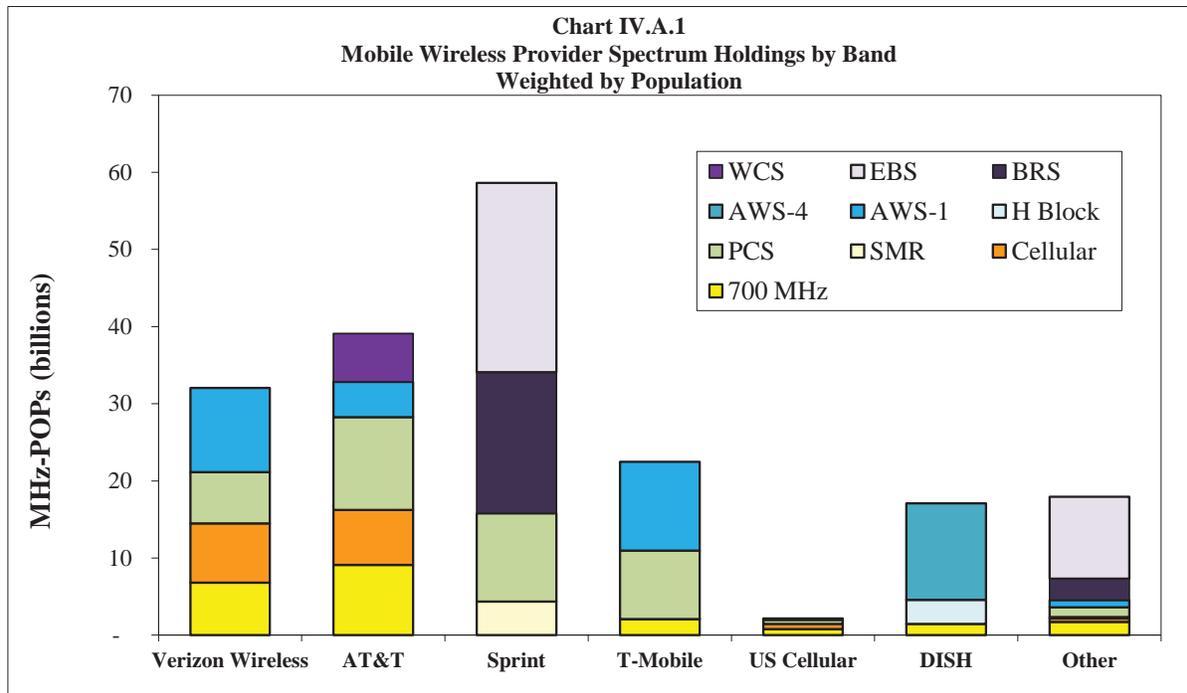
Table IV.A.3
Population-Weighted Average Megahertz Holdings by Licensee, by Frequency Band*

	700 MHz	Cell.	SMR	PCS	H Block	AWS-1	AWS-4	WCS	BRS	EBS
Spectrum Counted	70 MHz	50 MHz	14 MHz	130 MHz	10 MHz	90 MHz	40 MHz	20 MHz	67.5 MHz	112.5 MHz***
VZW	21.7	24.6	0.0	21.3	0.0	34.9	0.0	0.0	0.0	0.0
AT&T	29.1	22.9	0.0	38.4	0.0	14.7	0.0	20.0	0.0	0.0
Sprint	0.0	0.0	13.9	36.6	0.0	0.0	0.0	0.0	58.6	78.5
T-Mobile	6.7	0.0	0.0	28.4	0.0	36.8	0.0	0.0	0.0	0.0
USCC	2.5	2.2	0.0	1.7	0.0	0.6	0.0	0.0	0.0	0.0
DISH**	4.6	0.0	0.0	0.0	10.0	0.0	40.0	0.0	0.0	0.0
Other***	5.4	1.5	0.5	4.1	0.0	3.0	0.0	0.0	8.9	34.0

* Staff estimates as of Oct. 19, 2015.

** Dish Network Corporation currently does not provide mobile service.

*** In the application of the spectrum screen in secondary market transactions, 89 megahertz of EBS spectrum is included.



Note: Staff estimates as of Oct. 19, 2015.

61. Chart IV.A.1 above shows the population-weighted spectrum holdings of nationwide wireless service providers by frequency. It provides a side-by-side comparison of each licensee's total spectrum holdings by band, measured by population-weighted average megahertz.¹⁵⁷ All four nationwide service providers hold substantial amounts of above-1-GHz spectrum. Verizon Wireless, AT&T, and T-Mobile each hold a substantial number of PCS and AWS-1 spectrum licenses, while Sprint holds significant amounts of PCS spectrum. Verizon Wireless holds approximately 26 percent of the licensed MHz-POPs of the combined PCS and AWS-1 band spectrum, while the comparable percentages are approximately 24 percent for AT&T, approximately 17 percent for Sprint, and approximately 30 percent for T-Mobile. Regional service provider, US Cellular, holds approximately one percent of the combined PCS and AWS-1 band spectrum, while other smaller service providers hold the remainder. In addition to its PCS and AWS-1 holdings, AT&T holds all 20 megahertz of the licensed WCS spectrum,¹⁵⁸ while Sprint holds a predominant amount of 2.5 GHz spectrum, comprised of the BRS and EBS bands, the highest frequencies currently considered "suitable" and "available" for the provision of mobile broadband service.¹⁵⁹ Finally, while the granted AWS-3 spectrum licenses are not currently included in the screen, we note that AT&T holds approximately 36 percent of the licensed MHz-POPs, while Verizon Wireless, T-Mobile, and DISH each hold approximately 20 percent, 6 percent, and 37 percent, respectively, and other smaller service providers hold the remaining 1 percent.

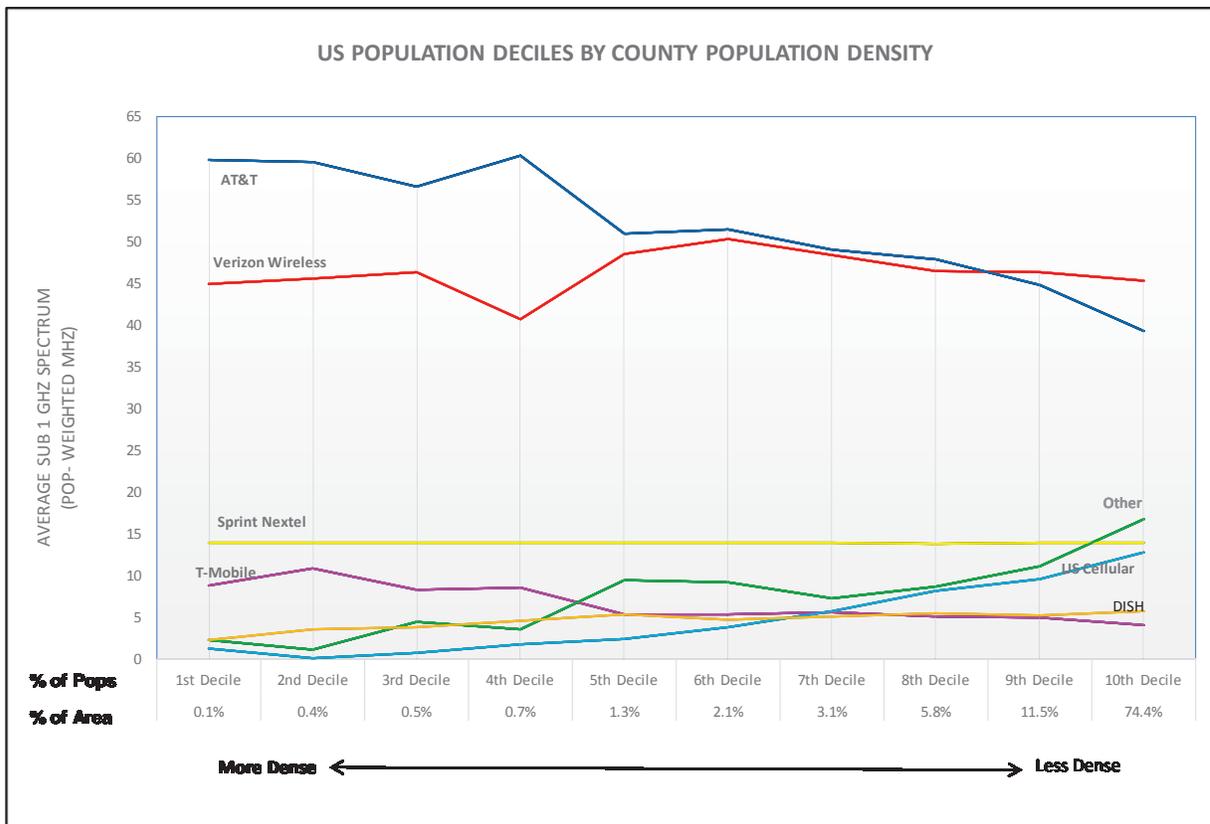
¹⁵⁷ We consider population-weighted spectrum holdings in order to account for customer density in different geographic areas. A spectrum license in Los Angeles or New York City, for example, covers more customers than a spectrum license over the same amount of land area in White Sands, New Mexico.

¹⁵⁸ See *AT&T WCS Order*, 27 FCC Rcd at 16461-62 ¶¶ 4-6; Application of AT&T and Sprint Seek FCC Consent to the Assignment of WCS Licenses, WT Docket No. 14-83, ULS File No. 0006344543 (filed May 6, 2014); Application, Appendix A – Spectrum Aggregation. See also Application of AT&T and Sprint Seek FCC Consent to the Assignment of WCS Licenses, WT Docket No. 14-83, *Public Notice*, 29 FCC Rcd 5879, 5879-80 (WTB 2014).

¹⁵⁹ See *SoftBank-Sprint-Clearwire Order*, 28 FCC Rcd at 9645 ¶ 11.

62. Below-1-GHz spectrum currently includes the 700 MHz band, SMR (800 MHz), and Cellular (850 MHz) spectrum. The two largest nationwide service providers, AT&T and Verizon Wireless, each hold a significant amount of the available low-band spectrum. In particular, when measured on a licensed MHz-POP basis, AT&T holds approximately 38 percent, while Verizon Wireless holds approximately 35 percent. In addition, Sprint holds approximately 10 percent, T-Mobile holds approximately five percent, and a number of other smaller licensees, combined, hold the remaining approximately 12 percent. Service providers also vary with respect to their below-1-GHz spectrum holdings according to population density, as seen in Chart IV.A.2 below. Specifically, AT&T and T-Mobile hold relatively more of their low-band spectrum in urban areas, Sprint’s and Verizon Wireless’s low-band spectrum covers both urban and rural areas, and the other smaller licensees hold more low-band spectrum in rural areas than in urban areas.

Chart IV.A.2
Average Below-1-GHz Spectrum by Population Density Deciles, Oct. 2015



B. Non-Spectrum Input Segments

1. Wireless Infrastructure

63. Wireless infrastructure facilities are one of the major inputs in the provision of mobile wireless services and host cellular base stations.¹⁶⁰ In addition to the use of towers and other tall structures, wireless

¹⁶⁰ These facilities include towers and other tall structures for macro sites, such as lattice towers, guyed towers, monopoles, rooftops, water towers, and steeples, for macro sites.

infrastructure also includes distributed antenna systems (“DAS”)¹⁶¹ and facilities for small cell technologies¹⁶² that are generally deployed to address coverage and capacity issues indoors, in densely populated areas outdoors, and even underground.¹⁶³ For example, small cells and DAS antennas can be placed on utility poles, buildings, or traffic signal poles, in areas where constructing towers is not feasible or wireless traffic demands are too great to be met solely with fewer large cells.¹⁶⁴

64. In order to expand geographic service area coverage, to improve coverage in existing service areas, and to accommodate newer technologies, mobile service providers have historically deployed more cell sites. However, after many years of consecutive growth, the number of cell sites in use by mobile service providers appears to have stabilized. According to CTIA, there were 298,055 cell sites in use at year-end 2014, down approximately 2 percent (or 6,305) from 304,360 as of year-end 2013,¹⁶⁵ after a continuous increase since 1985.¹⁶⁶ In addition to macro cell sites, mobile service providers, in recent years, have started to deploy small cells and DAS sites to fill local coverage gaps or to increase local capacity.¹⁶⁷

65. A specialized communications tower industry has developed to provide and manage the support structures for the cell sites, and leases space to mobile wireless service providers. Today, there are more than 110 tower and DAS operators in the United States,¹⁶⁸ and a majority of towers are now owned or operated by

¹⁶¹ A DAS network consists of three primary components: (i) a number of remote communications nodes (DAS node(s)), each including at least one antenna for the transmission and reception of a wireless service provider’s RF signals; (ii) a high capacity signal transport medium (typically fiber optic cable) connecting each DAS node back to a central communications hub site; and (iii) radio transceivers or other head-end equipment located at the hub site that propagates and/or converts, processes or controls the communications signals transmitted and received through the DAS nodes. See The DAS Forum, “Distributed Antenna Systems (DAS) and Small Cell Technologies Distinguished,” at 3 (Feb. 2013), available at <http://www.thedasforum.org/resources/send/2-resources/24-das-and-small-cell-technologies-distinguished>.

¹⁶² “Small cells” is an umbrella term for operator-controlled, low-powered radio access nodes, including those that operate in licensed spectrum and unlicensed carrier-grade Wi-Fi. Small cells typically have a range from 10 meters (*e.g.*, femtocells) to several hundred meters (*e.g.*, microcells). See Small Cell Forum, “Small Cell Definition,” available at <http://www.smallcellforum.org/about/about-small-cells/small-cell-definition/>.

¹⁶³ See The DAS Forum, “Distributed Antenna Systems (DAS) and Small Cell Technologies Distinguished,” at 6 (Feb. 2013), available at <http://www.thedasforum.org/resources/send/2-resources/24-das-and-small-cell-technologies-distinguished>.

¹⁶⁴ Because DAS sites are less visible than tower structures, they may be particularly desirable in areas with stringent siting regulations, such as historic districts.

¹⁶⁵ See CTIA Year-End 2014 Wireless Indices Report, at p. 101. Because multiple cell sites can be co-located in the same “tower” site, the reported cell sites should not be equated with “towers.” The reported cell sites include repeaters and other cell-extending devices (*e.g.*, femtocells, or distributed antenna systems). See *id.* at pp. 101, 102.

¹⁶⁶ See *id.*, at p. 104. The decrease in the total number of commercial cell sites in 2014 is likely due to “a combination of consolidation and the retirement of older generation of technologies.” *Id.* at p. 101.

¹⁶⁷ See Phil Goldstein, “AT&T drops goal of deploying 40,000 small cells by end of 2015, citing benefits of Leap deal” (Mar. 5, 2015), available at <http://www.fiercewireless.com/story/att-drops-goal-deploying-40000-small-cells-end-2015-citing-benefits-leap-de/2015-03-05>. See also Jeff Moore, “Verizon facing small cell ‘deployment difficulties,’ but forging ahead aggressively” (July 29, 2015), available at <http://www.fierceinstaller.com/story/verizon-facing-small-cell-deployment-difficulties-forging-ahead-aggressively/2015-07-29>; “T-Mobile and Nokia aim small: to deploy small LTE cells that use unlicensed spectrum” (Feb. 24, 2015), available at http://www.phonearena.com/news/T-Mobile-and-Nokia-aim-small-to-deploy-small-LTE-cells-that-use-unlicensed-spectrum_id66327; “Sprint to add ‘tens of thousands’ of small cells, bring 800 MHz and 2.5 GHz LTE to ‘nearly all’ macro sites” (Aug. 4, 2015), available at <http://www.fiercewireless.com/story/sprint-add-tens-thousands-small-cells-bring-800-mhz-and-25-ghz-lte-nearly-a/2015-08-04>.

¹⁶⁸ See Wireless Estimator, “Top 100 Tower Companies in the U.S.,” available at <http://wirelessestimator.com/top-100-us-tower-companies-list/>.

independent companies rather than by mobile wireless service providers.¹⁶⁹ Independent tower operators own, operate and lease shared wireless communications and broadcasting towers, manage other tall structure sites (such as rooftops, and water towers), and to a lesser extent, build and operate DAS networks and small cell facilities for mobile service providers.¹⁷⁰ In most cases, tower operators and property owners lease antenna, rooftop and other site space to multiple wireless service providers.¹⁷¹ One estimate indicates that the three largest publicly traded neutral host providers (Crown Castle, American Tower, and SBA Communications) own or operate more than 94,540 towers as of August 2015.¹⁷² The availability of leased space on existing towers for mobile wireless service providers may eliminate the need to build new towers, reduce the capital requirements for network deployment and capacity expansion, and facilitate the entry of new wireless service providers. As of July 2015, Chart IV.B.1 shows that there were three or more tower operators in 90 percent of counties, and six or more in 41 percent of counties based on data collected from 34 tower providers¹⁷³ in the United States in June and July 2015.¹⁷⁴

¹⁶⁹ Some major wireless service providers have sold or in the process of selling their tower business to third party tower operators. See American Tower News Release, “American Tower Corporation Announces Verizon Tower Portfolio Transaction” (Feb. 5, 2015); AT&T News Release, “AT&T and Crown Castle Close \$4.83 Billion Tower Transaction” (Dec. 16, 2013); Crown Castle News Release, “Crown Castle Completes Tower Transaction With T-Mobile USA” (Nov. 30, 2012); Sprint Nextel News Release, “Sprint Nextel Completes Tower Sale to TowerCo for Approximately \$670 Million in Cash” (Sept. 24, 2008).

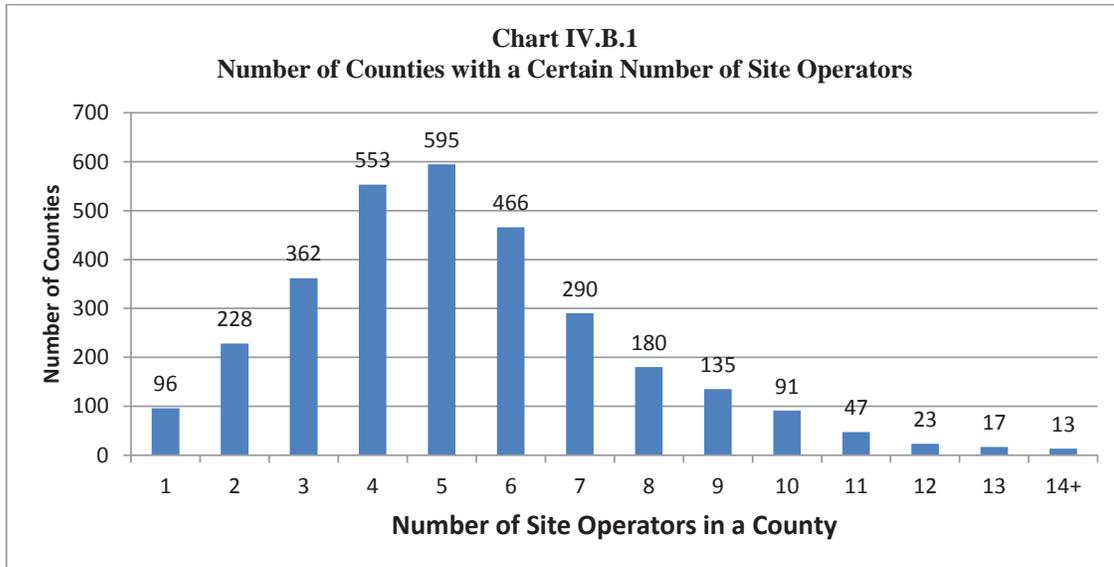
¹⁷⁰ See American Tower 2014 Annual Report (10-K) at 1, available at <http://www.americantower.com/corporateus/investor-relations/annual-reports-proxy-statements/index.htm>. Crown Castle 2014 Annual Report (10-K) at 1, available at http://investor.crowncastle.com/phoenix.zhtml?c=107530&p=irol-sec&seccat01.1_rs=49&seccat01.1_rc=6. SBA Communications 2014 Annual Report (10-K) at 1, available at <http://ir.sbasite.com/reports.cfm>.

¹⁷¹ See American Tower, 2014 Annual Report at 1 (“Our primary business is leasing antenna space on multiple-tenant communications sites to wireless service providers, radio and television broadcast companies, wireless data providers, government agencies and municipalities and tenants in a number of other industries”). See also Verizon Network Real Estate Inquires (“Verizon Wireless receives thousands of inquiries each year from property owners, property managers and customers who offer property on which our communications facilities can be located”), available at <http://www.verizonwireless.com/b2c/realestate/>.

¹⁷² See Wireless Estimator, “Top 100 Tower Companies in the U.S.,” available at http://www.wirelessestimator.com/t_content.cfm?pagename=US-Cell-Tower-Companies-Complete-List (list of tower operators, with Crown Castle at 39,928, American Tower at 39,739, and SBA Communications at 14,873 as of August 2015, not including DAS and small cells).

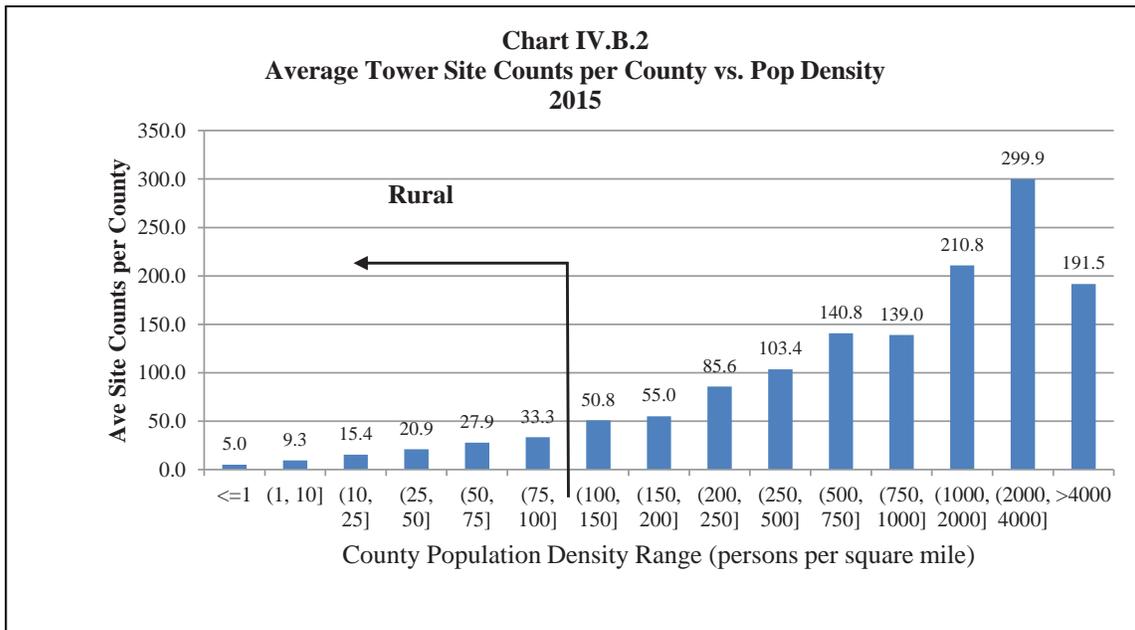
¹⁷³ Tower site information was either downloaded from the tower provider’s website or requested via telephone in June and July 2015. See Wireless Estimator, “Top 100 Tower Companies in the U.S.” (many tower providers’ websites), available at http://www.wirelessestimator.com/t_content.cfm?pagename=US-Cell-Tower-Companies-Complete-List. The 34 tower providers listed in this Report are Airwave Strategies, American Tower Corporation, AT&T, Badger Towers, Crown Castle, Communication Enhancement, Clearview Tower Company, Central States Tower Holdings, Com Sites West, CTI Towers, Diamond Communications, Day Wireless Systems, ERS Antenna Site Management, Hemphill Tower, Horizon Tower, Horvath Communications, InSite Towers, Industrial Tower and Wireless, KGI Wireless, Message Center Management, Nsight Tower Holdings, Pegasus Tower Company, SBA Communications Corporation, Skyway Towers, Sprint, Subcarrier Communications, Tarpon Towers, T-Mobile, Tower Acquisition, TowerCo, Tower Ventures, Unison Site Management, Vertical Bridge Holdings, and Wireless Properties.

¹⁷⁴ Excluding Alaska, Guam, Puerto Rico, and the U.S. Virgin Islands. In the *Seventeenth Report*, 50% of counties had more than six tower operators based on data collected from 11 tower providers in September 2013. See *Seventeenth Report*, 29 FCC Rcd at 15367 ¶ 111. Given that we analyzed data from 34 tower providers in this Report, the data are not comparable across the two Reports, although we note that the decrease from 50% to 40% in this Report, despite the fact that more tower operators’ data are included, is likely due to a combination of consolidation and the retirement of old technologies. See CTIA Year-End 2014 Wireless Indices Report, at p. 101. For example, American Tower Corporation (“ATC”) bought General Tower Partners (“GTP”) in September 2013. Crown Castle bought AT&T Towers in December 2013.



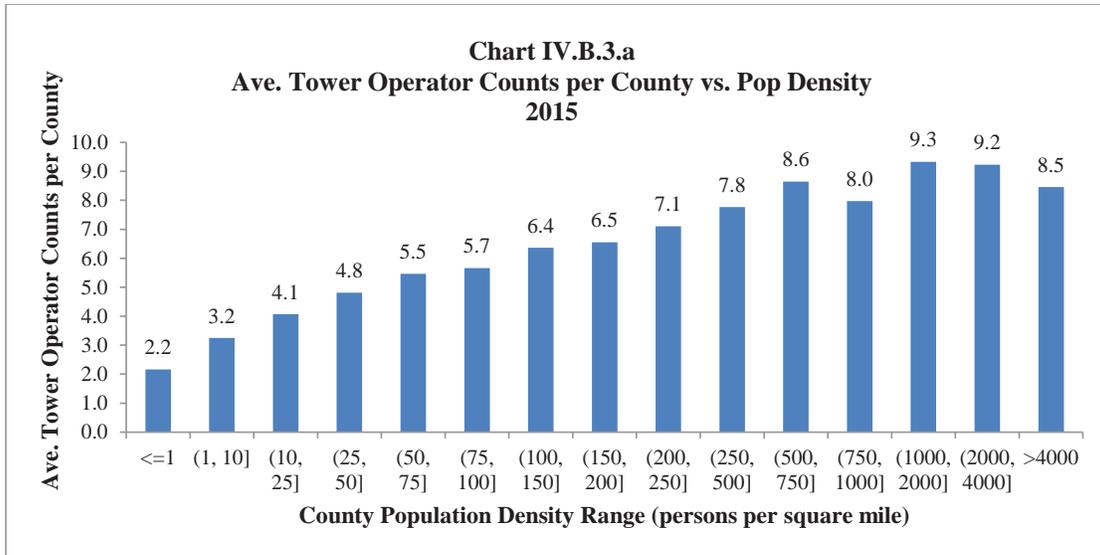
Source: Data collected from 34 tower companies (data include towers and rooftops) in June and July 2015.

66. As shown in Chart IV.B.2 below, tower operators tend to build and operate more towers in more densely populated areas. For example, as of July 2015, the average number of tower sites per county is 33 for counties with a population density between 75 and 100 people per square mile, compared to 300 per county for counties with a population density between 2000 and 4000 people per square mile.

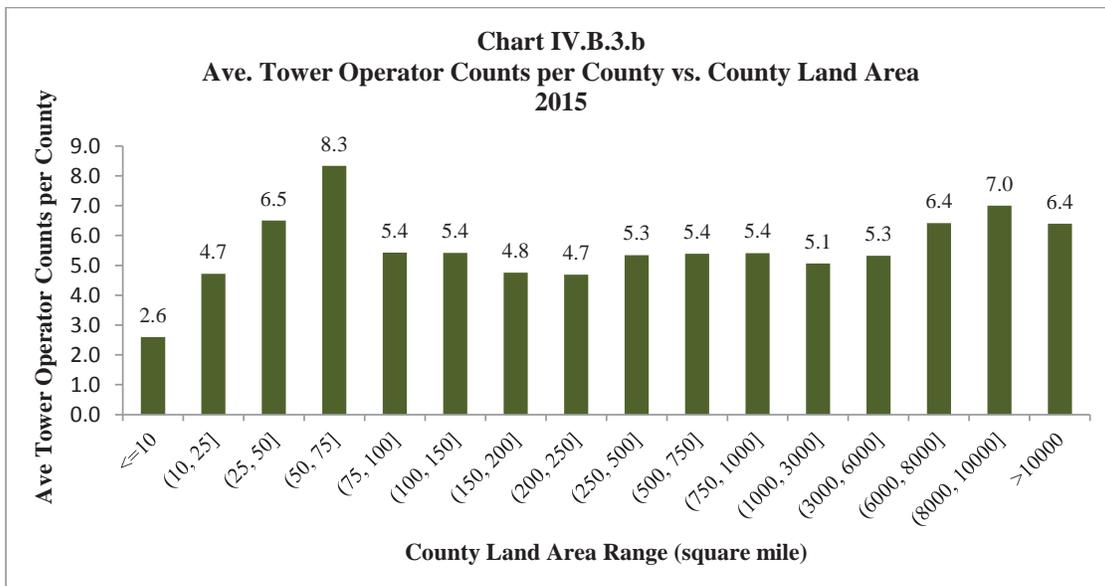


Note: Data based on 34 tower companies referenced above. Counties considered rural are those with fewer than 100 people per square mile. Population density is from the 2010 U.S. Census.

67. In addition, as shown in Chart IV.B.3.a below, there are more tower operators in densely populated counties than in less densely populated counties. The number of tower site operators per county ranges from two site operators per county in the least densely populated counties to more than seven site operators in the most densely populated counties. Chart IV.B.3.b below indicates that counties with larger land areas generally have more tower operators than counties with smaller land areas.



Source: Data are based on the 34 tower companies referenced above. Rural counties are those with fewer than 100 people per square mile. Population density and land area are from the 2010 U.S. Census.



Source: Data are based on the 34 tower companies referenced above. Rural counties are those with fewer than 100 people per square mile. Population density and land area are from the 2010 U.S. Census.

68. There are two factors that have a significant effect on the deployment or modification of tower and DAS sites: (i) capital expenditure; and (ii) obtaining the necessary regulatory and zoning approvals from local and federal authorities.¹⁷⁵ In terms of capital expenditure, co-locating wireless equipment on existing structures is often the most efficient and economical solution for mobile wireless service providers that need new cell sites, either to expand their existing coverage area, increase their capacity, or deploy a new generation of mobile broadband technology. The average cost to build a new tower is between \$250,000 and \$300,000, whereas the average cost of co-location on an existing tower is about 25 percent of the total cost of a new tower.¹⁷⁶ The three largest publicly-traded infrastructure companies alone made capital expenditures of approximately \$1.58 billion in building new sites and upgrading existing sites in 2014, up from \$1.17 billion in 2013.¹⁷⁷ The total annual expenditure for structures by wireless service providers (excluding satellite service providers) was \$9.952 billion for 2013, almost a 74 percent increase from \$5.723 billion in 2012.¹⁷⁸

2. Backhaul

69. Backhaul facilities link a mobile wireless service provider's cell sites to the mobile switching centers that provide connections to the provider's core network, the public switched telephone network, or the Internet, carrying wireless voice and data traffic for routing and onward transmission. Backhaul connections are an integral component of a wireless service provider's network, and the cost of backhaul is approximately 30 percent of the operating cost of providing wireless service.¹⁷⁹ Backhaul services are generally provided by incumbent local exchange carriers ("ILECs"), competitive local exchange carriers ("CLECs"), competitive fiber and microwave wholesalers, cable providers, and independent backhaul operators.¹⁸⁰

70. As mobile data traffic has grown rapidly in recent years, the leading mobile wireless service providers have deployed or are in the process of deploying Ethernet backhaul either over fiber or microwave to their cell sites. For example, as of June 2013, over 90 percent of AT&T's data traffic was already on enhanced backhaul.¹⁸¹ As of March 2015, of its 54,000 cell sites, T-Mobile already has fiber backhaul connections to 50,000 sites.¹⁸² Sprint's network modernization was substantially completed in 2014 which utilizes Ethernet for

¹⁷⁵ See *Seventeen Report*, 29 FCC Rcd at 15369-70 ¶ 114. See also IV.B.3. *infra* (recent FCC initiatives on wireless facilities siting).

¹⁷⁶ See American Tower, 2015 Q1 Earnings Presentation at 12 (\$850 - \$950 million to build 2,750 - 3,250 new towers, or \$292K - \$309K per new tower), available at <http://www.americantower.com/corporateus/investor-relations/earnings-materials/index.htm>. See also Statistic Brain Research Institute, "Cell Phone Tower Statistics" (average cost of building a cell phone tower is \$145K, while the average yearly cell phone tower lease rate is \$45K, about 25% of the cost of building a new cell tower) (Mar. 15, 2015), available at <http://www.statisticbrain.com/cell-phone-tower-statistics/>.

¹⁷⁷ See PCIA Comments at 6, 7.

¹⁷⁸ See CTIA Year-End 2014 Wireless Indices Report, Chart 20, at p. 108 (citing information from the U.S. Census and CTIA).

¹⁷⁹ See Sprint Comments at 7.

¹⁸⁰ See FierceTelecom.com, "Telco Backhaul Strategies," at 1-2 (November 2011). Providers of backhaul services include ILECs such as AT&T, Verizon, and CenturyLink; CLECs such as Level 3, tw telecom inc., Cbeyond, Inc., and XO Communications; competitive fiber and microwave wholesalers such as Level 3, FPL FiberNet, IP Networks, and Zayo; cable providers such as Charter Communications, Comcast Business, Cox Carrier Services, and Time Warner Cable Business Class; independent backhaul operators, including backhaul specialists such as Telecom Transport Management, and Tower Cloud, and potentially certain tower operators.

¹⁸¹ See "AT&T 4G LTE Network Ranked Fastest For Second Straight Year," AT&T news release (June 10, 2013).

¹⁸² See Phil Goldstein, "T-Mobile's Carter: We'd be a 'very interesting' partner for Dish" (Mar. 6, 2015), available at <http://www.fiercewireless.com/story/t-mobiles-carter-wed-be-very-interesting-partner-dish/2015-03-05>.

its backhaul¹⁸³ and its LTE network covered more than 280 million people as of May 2015.¹⁸⁴ Some analysts have predicted that Sprint will use some of its 2.5 GHz spectrum as an alternative to fiber backhaul.¹⁸⁵ Verizon Wireless also deployed fiber backhaul facilities for its 4G LTE sites,¹⁸⁶ and its LTE network carried 87 percent of its data traffic as of the second quarter of 2015.¹⁸⁷

3. Recent FCC Initiatives

71. Section 6409(a) of the Middle Class Tax Relief and Job Creation Act of 2012 provides that a state or local government “may not deny, and shall approve” any request for co-location, removal, or replacement of transmission equipment on an existing wireless tower or base station, provided this action does not substantially change the physical dimensions of the tower or base station.¹⁸⁸ On October 21, 2014, the Commission released an order that implemented section 6409(a) and took other actions to eliminate unnecessary reviews, and therefore reduce costs and delays, for wireless facilities siting.¹⁸⁹ The Commission has also entered into two Nationwide Programmatic Agreements (“NPAs”) with the Advisory Council on Historic Preservation (“ACHP”) and the National Conference of State Historic Preservation Officers (“NCSHPOs”) to clarify the National Historic Preservation Act (“NHPA”) section 106 process for (1) new tower construction, and (2) collocations of communications equipment on existing towers and other structures.¹⁹⁰ In August 2014, the Commission adopted a Report and Order to streamline and eliminate outdated provisions of the Part 17 Rules governing the construction, marking, and lighting of antenna structures.¹⁹¹ In addition, the Commission has taken steps with relevant government and non-governmental stakeholders to develop a process for “clearing” existing towers that did not complete section 106 historic preservation review prior to construction, including “twilight towers” that were constructed prior to the specification of detailed section 106 review procedures in the 2005 NHPA,¹⁹² while respecting historic preservation values. This effort will potentially make thousands of additional towers available

¹⁸³ See Sprint’s 10-K filing (Annual Report) for 2014, at 27, available at <http://investors.sprint.com/financial-information/sec-filings/sec-filings-details/default.aspx?FilingId=10724268>.

¹⁸⁴ See Sprint Comments at 5.

¹⁸⁵ See e.g., Phil Goldstein, “Analysts: Sprint’s Network Densification Plans Up in the Air, But Wireless Backhaul Could Play a Key Role” (July 17, 2015), available at <http://www.fiercewireless.com/story/analysts-sprints-network-densification-plans-air-wireless-backhaul-could-pl/2015-07-17>.

¹⁸⁶ See Transcript for Verizon at Oppenheimer Holdings Inc Technology, Internet & Communications Conference, at 7 (Aug. 15, 2012), available at <http://www.verizon.com/about/investors/oppenheimers-15th-annual-technology-internet-communications-conference>.

¹⁸⁷ See Verizon presentation for the 2nd Quarter 2015 earnings results, at 8, available at <http://www.verizon.com/about/investors/quarterly-reports/2q-2015-quarter-earnings-conference-call-webcast>.

¹⁸⁸ Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, § 6409(a) (2012), codified at 47 U.S.C. § 1455(a).

¹⁸⁹ See Acceleration of Broadband Deployment by Improving Wireless Facilities Siting Policies; Acceleration of Broadband Deployment: Expanding the Reach and Reducing the Cost of Broadband Deployment by Improving Policies Regarding Public Rights of Way and Wireless Facilities Siting; 2012 Biennial Review of Telecommunications Regulations, WT Docket Nos. 13-238, WT Docket No. 11-59, WT Docket No. 13-32, *Report and Order*, 29 FCC Rcd 12865 (2014) (“*Wireless Infrastructure Report and Order*”).

¹⁹⁰ 47 C.F.R. Pt. 1, Apps. B and C; see Section 106 of the National Historic Preservation Act, 54 U.S.C. § 306108.

¹⁹¹ See 2004 and 2006 Biennial Regulatory Reviews – Streamlining and Other Revisions of Parts 1 and 17 of the Commission’s Rules Governing Construction, Marking and Lighting of Antenna Structures, WT Docket No. 10-88, *Report and Order*, 29 FCC Rcd 9787 (2014).

¹⁹² Specifically, “twilight towers” are non-compliant towers built between March 16, 2001 and March 7, 2005.

for co-location.¹⁹³ The Commission has also initiated a process to develop further exclusions from section 106 review for DAS and small cell facilities that are unlikely to adversely affect historic properties.¹⁹⁴

72. The Commission has also examined issues related to backhaul including special access services and the use of microwave spectrum for backhaul services in the past few years.¹⁹⁵ On September 15, 2014 the Commission's Wireline Competition Bureau issued an *Order on Reconsideration* that set a deadline of December 15, 2014 for service providers to submit data on networks, prices, and terms for special access in order to enable the Commission to assess the state of competition.¹⁹⁶ Although the Bureau kept the December 15, 2014 deadline for streamlined certifications, it extended this deadline to January 29, 2015 for large businesses with more than 1500 employees, and to February 27, 2015 for small businesses with less than 1500 employees.¹⁹⁷ Comments on the data submissions are currently due on January 6, 2016, with replies due on February 6, 2016.¹⁹⁸ In addition, on October 16, 2015, the Wireline Competition Bureau initiated an investigation into the terms and conditions of certain ILEC tariff pricing plans of AT&T, CenturyLink, Frontier, and Verizon for special access services.¹⁹⁹ In April 2015, the Commission adopted rules for commercial use of 150 megahertz in the 3550-3700 MHz band (3.5 GHz Band), enabling innovative use cases such as wireless backhaul.²⁰⁰

V. PRICING LEVELS AND TRENDS

73. Most U.S. mobile telephone subscribers are billed monthly after their service has been provided (postpaid service). Other U.S. mobile telephone subscribers, including those lacking the necessary credit history, are required to pay for their service in advance (prepaid service). Until 2013, most postpaid subscribers signed a two-year service contract in return for receiving a significant upfront discount on the price of a handset, with service providers recovering the balance of the handset cost over the course of the contract through the higher monthly fees charged for mobile service. Since then, many postpaid subscribers have taken advantage of the option to purchase a handset separately from the service plan via an installment payment plan (equipment

¹⁹³ See *Wireless Infrastructure Report and Order*, 29 FCC Rcd at 12867 ¶ 4.

¹⁹⁴ See Wireless Telecommunications Bureau Seeks Comment on Revising the Historic Preservation Review Process for Small Facility Deployments, WT Docket No. 15-180, *Public Notice*, 30 FCC Rcd 8160 (WTB 2015).

¹⁹⁵ See *Seventeenth Report*, 29 FCC Rcd at 15372 ¶ 119.

¹⁹⁶ See Special Access for Price Cap Local Exchange Carriers; AT&T Corporation Petition for Rulemaking to Reform Regulation of Incumbent Local Exchange Carrier Rates for Interstate Special Access Services, WC Docket No. 05-25, RM-10593, *Order on Reconsideration*, 29 FCC Rcd 10899 (WCB 2014) ("*Order on Reconsideration*"). On August 22, 2012, the Commission had adopted a Report and Order that suspended, on an interim basis, rules that allowed for automatic grants of pricing flexibility for special access services in light of evidence in the record the rules failed to accurately reflect the state of competition in the market for special access. See Special Access for Price Cap Local Exchange Carriers; AT&T Corporation Petition for Rulemaking to Reform Regulation of Incumbent Local Exchange Carrier Rates for Interstate Special Access Services, WC Docket No. 05-25, RM-10593, *Report and Order*, 27 FCC Rcd 10557 (2012).

¹⁹⁷ See Special Access for Price Cap Local Exchange Carriers; AT&T Corporation Petition for Rulemaking to Reform Regulation of Incumbent Local Exchange Carrier Rates for Interstate Special Access Services, WC Docket No. 05-25, RM-10593, *Order*, 29 FCC Rcd 14346 (WCB 2014) ("*Extension Order*").

¹⁹⁸ See Special Access for Price Cap Local Exchange Carriers; AT&T Corporation Petition for Rulemaking to Reform Regulation of Incumbent Local Exchange Carrier Rates for Interstate Special Access Services, WC Docket No. 05-25, RM-10593, *Order*, DA 15-1239 (WCB rel. Nov. 2, 2015).

¹⁹⁹ See Investigation of Certain Price Cap Local Exchange Carrier Business Data Services Tariff Pricing Plans, WC Docket No. 15-247, *Order Initiating Investigation and Designating Issues for Investigation*, DA 15-1194 (WCB rel. Oct. 16, 2015).

²⁰⁰ See Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, *Report and Order and Second Further Notice of Proposed Rulemaking*, 30 FCC Rcd 3959, 4024 ¶ 207 (2015).

installment plan, or EIP), leading to a rapid shift from traditional postpaid contract plans to no-contract plans.²⁰¹ As a result, the requirement to sign a service contract is no longer a key distinction between postpaid and prepaid service. The following discussion of developments in mobile service pricing is divided into two sections – postpaid and prepaid – and focuses on pricing changes during the period covered by this *Report*.

A. Postpaid Service

74. As also discussed in the *Seventeenth Report*, we have continued to see a range of postpaid pricing changes and promotions.²⁰² In August 2014, Sprint launched shared data plans that offered higher monthly data allowances than similarly-priced shared data tiers then being offered by Verizon Wireless and AT&T, and cut the price of its unlimited data plan for EIP and other non-subsidized subscribers. Sprint's move to what analysts characterize as a more aggressive pricing strategy, followed a similarly disruptive shift in pricing strategy by T-Mobile beginning in March 2013.²⁰³ The following discussion highlights some of the pricing changes and promotions that have been introduced in postpaid service during the period covered by this *Report*.

i. Promotional Pricing Offers and Potential Stabilization

75. Service providers continued to compete for customers by increasing the monthly data allowances on certain tiers of shared data plans while leaving unchanged the existing monthly data charges. Some of these pricing changes were limited-time promotional offers. For example, there was a wave of “double data” promotions in the fall of 2014.²⁰⁴ Then, in August 2015, AT&T launched a new limited-time promotional offer of “15GB for the price of 10GB.”²⁰⁵ Otherwise, service providers used this type of pricing change to restructure their rate plans. In November 2014, AT&T increased the monthly data allowances on two mid-range shared data tiers (from 2GB to 3GB for \$40, and from 4GB to 6GB for \$70).²⁰⁶ In February 2015, Verizon Wireless added

²⁰¹ While such offerings have no contracts for the service, cancellation of services before the end of the installment plan period results in a balance due for the unpaid handset charges.

²⁰² See David W. Barden *et al.*, “3Q14 Preview and Model Book – Wireless Pricing is Top of Mind,” Bank of America Merrill Lynch, Equity Research, at 3 (Oct. 17, 2014) (arguing that recent pricing changes reflect “the intersection of T-Mobile and Sprint’s initiatives to gain or sustain subscriber momentum after years of losses, and AT&T and Verizon Wireless’s efforts to hold share and keep churn low.”)

²⁰³ See Philip Cusick, “Wireless Competition Intensifies as Verizon, AT&T and Sprint Issue Promotional Price Cuts,” J.P. Morgan, North America Equity Research, at 1 (Nov. 18, 2014); Simon Flannery, *et al.*, “3Q14 Trend Tracker: ‘Tis the Season for Competition and Uncertainty,” Morgan Stanley, Equity Research, at 14 (Nov. 18, 2014).

²⁰⁴ AT&T doubled the data allowances on high-end shared data tiers (15GB to 50GB) through the end of October 2014, and both Verizon Wireless and Sprint followed suit by doubling or commensurately increasing the data allowances on comparable high-end shared data tiers. See David W. Barden, *et al.*, “3Q14 Preview and Model Book – Wireless Pricing is Top of Mind,” Bank of America Merrill Lynch, Equity Research, at 3 (Oct. 17, 2014); “Sprint Doubles the Data of AT&T Promotion with Sprint Family Share Pack and Sprint Business Share Offers,” available at <http://newsroom.sprint.com/news-releases/sprint-stands-behind-pledge-to-deliver-double-the-data.htm>. AT&T subsequently extended its double data promotion on high-end tiers through mid-November 2014. See “AT&T Adds More Data to New Mobile Share Value Plans on the Nations Most Reliable 4G LTE Network,” available at http://about.att.com/story/att_adds_more_data_to_new_mobile_Share_value_plans_on_the_nations_most_reliable_4g_lte_network.html; John C. Hodulik, *et al.*, “AT&T and Verizon Tweak Pricing, Yet Again,” UBS, Global Research, at 1 (Nov. 3, 2014).

²⁰⁵ See “AT&T Introduces New AT&T Mobile Share Value Plans,” available at <http://www.fiercewireless.com/press-releases/att-introduces-new-att-mobile-share-value-plans>. See also Phil Goldstein, “AT&T Shakes Up Mobile Share Value Plan Pricing, Increases \$100/10 GB plan to 15 GB,” FierceWireless (Aug. 14, 2015).

²⁰⁶ See “AT&T Adds More Data to New Mobile Share Value Plans on the Nation’s Most Reliable 4G LTE Network,” available at http://about.att.com/story/att_adds_more_data_to_new_mobile_Share_value_plans_on_the_nations_most_reliable_4g_lte_ne

1GB of data to the data allowances of its low-end (1GB to 3GB) shared data tiers for the same price as before, in addition to cutting the price of selected higher data tiers and introducing several new data tiers.²⁰⁷

76. Price rivalry in the fall of 2014 also took the form of limited-time promotional pricing offers on selected large data plans, focusing on the four-line (“quad-play”) pricing segment targeted at families.²⁰⁸ The pricing models of the four nationwide service providers are differentiated in this segment. Verizon Wireless, AT&T, and Sprint offer shared data plans in which a single bucket of data can be shared among multiple (up to ten) persons or devices. In contrast, T-Mobile competes in the multiple-line family segment through its family plan offering. T-Mobile’s version of a family plan comes with a dedicated LTE data bucket for each person or device to use on an exclusive basis, but it gives subscribers the option of adding additional lines at reduced prices. After Sprint launched its version of a shared data plan, T-Mobile expanded its family plan offering by increasing the number of lines customers can add from five to ten lines per account, with the price of adding each new line reduced to \$10 per month after the second line.²⁰⁹

77. In early November 2014, Verizon Wireless introduced promotional pricing offers of 10GB for \$80 per month and 15GB for \$100 per month.²¹⁰ Although Verizon Wireless characterized the offers as a limited-time promotion, no specific end date was set at the time the offer was announced.²¹¹ Sprint countered by cutting the prices of its 12GB and 16GB shared data plans to \$80 and \$100 per month, respectively, specifying that the promotion would be available from November 14, 2014 to January 15, 2015.²¹² AT&T matched Verizon Wireless’s 15GB for \$100 per month offer on November 18, but discontinued this promotion at the end of November.²¹³ In April 2015, Verizon Wireless reintroduced the same two promotional pricing offers, once again with no specified end date.²¹⁴

78. In late July 2015, T-Mobile ended its existing “10GB for \$100” family plan promotion and launched a new limited-time promotional offer that gives each customer 10GB of LTE data per month, with the first two lines priced at \$100 per month and each additional line thereafter \$20 per month.²¹⁵ In conjunction with

work.html. *See also* John C. Hodulik, *et al.*, “AT&T and Verizon Tweak Pricing, Yet Again,” UBS, Global Research, at 1 (Nov. 3, 2014).

²⁰⁷ *See* “More Options and Even More Value Coming More Everything,” available at <http://www.fiercewireless.com/press-releases/more-options-and-even-more-value-coming-more-everything>; Philip Cusick, “Wireless Pricing Update,” J.P. Morgan, North America Equity Research, at 1 (Feb. 12, 2015).

²⁰⁸ *See* Philip Cusick, “Wireless Competition Intensifies as Verizon, AT&T and Sprint Issue Promotional Price Cuts,” J.P. Morgan, North America Equity Research, at 1 (Nov. 18, 2014).

²⁰⁹ *See* “T-Mobile Expands Industry-Leading Family Plan,” available at <http://www.fiercewireless.com/press-releases/t-mobile-expands-industry-leading-family-plan-0>; Phil Goldstein, “T-Mobile Cuts Prices on Family Plans With 7-10 Lines, Launches \$10/Month Tablet Plan,” FierceWireless (Aug. 28, 2014).

²¹⁰ *See* John C. Hodulik, *et al.*, UBS, Global Research, at 3 (Nov. 3, 2014).

²¹¹ *See* Ben Rooney, “Verizon is Upping its Game – Offering New Data Plans that Give Smartphone Users More Bang for Their Buck,” CNN Money (Nov. 3, 2014).

²¹² *See* Mike Dano, “Sprint Cuts \$10 From 12 GB and 16 GB Shared Data Plans,” FierceWireless (Nov. 12, 2014).

²¹³ *See* Phil Goldstein, “AT&T Cuts Price of 15 GB Shared Data Plan by \$30,” FierceWireless (Nov. 18, 2014); Mike Dano, “AT&T Ends 15 GB Promotion After 13 Days,” FierceWireless (Dec. 4, 2014).

²¹⁴ *See* Phil Goldstein, “Verizon Reintroduces \$80/10 GB and \$100/15 GB Shared Data Plans,” FierceWireless (Apr. 24, 2015).

²¹⁵ *See* “T-Mobile Amps Up its Family Plan: Family Members get 10GB Each – for Just \$30 a Line,” available at <http://newsroom.t-mobile.com/news/t-mobile-amps-up-its-family-plan-family-members-get-10gb-each--for-just-30-a-line.htm>; Phil Goldstein, “T-Mobile Launches New Family Plan With 10 GB of Data, But Drops Existing Unlimited Promotion,” FierceWireless (July 14, 2015).

an additional promotion allowing customers to add a fourth line free of charge through September 7, 2015, the new plan offered a family of four 40GB of LTE data for \$120 per month – more data than the expired promotion but at a higher price point. Sprint quickly countered with two limited-time promotional pricing offers of 10GB of shared data for \$100 per month and 40GB of shared data for \$120 per month.²¹⁶ In August 2015, AT&T introduced a revamped version of its shared data pricing plan that included the “15GB for the price of 10GB” promotional offer discussed above.²¹⁷ Among other pricing changes, AT&T’s new plan also brought its pricing down closer to that of T-Mobile and Sprint for lower data tiers targeted at single-line subscribers.²¹⁸ Although the “15GB for the price of 10GB” offer was the most heavily promoted pricing change, AT&T characterized the entire package as a “promotional plan” and a “limited-time special offer.”²¹⁹ In November 2015, T-Mobile announced that customers on their Simple Choice plans would be able to access certain video streaming services without depleting their data allowance.²²⁰ Binge-On is similar to T-Mobile’s earlier Music-Freedom promotion,²²¹ and both cover a range of popular free and subscription based streaming services.

79. In addition to its other promotional pricing offers, in December 2014 Sprint launched a promotional offer to cut the monthly bills in half for AT&T and Verizon Wireless customers if they switch to Sprint.²²² Though originally scheduled to end in January 2015, the offer was subsequently extended through the end of 2015 and to cover T-Mobile customers.²²³ As analysts have pointed out, because many customers were still on traditional subsidy plans but the promotion only applied to the service fee component of the customer’s bill, this promotion did not necessarily cut targeted customers’ bills in half when the cost of the handset is taken into account.²²⁴ According to one analyst, Sprint conceded that the average customer who signed up via the “Cut Your Bill in Half” promotion actually saw about a 20 percent reduction in their aggregate bill (monthly service fees plus equipment payments) after adjusting for a full device installment or leasing payment.²²⁵ Analysts also noted that Sprint’s other promotional pricing offers or shared data plans often offered customers a better deal than the “Cut Your Bill in Half” promotion, so that many of the customers that the promotion succeeded in drawing

²¹⁶ See “Sprint Introduces Best Plan for Families,” available at <http://www.fiercewireless.com/press-releases/sprint-introduces-best-plan-families>; Phil Goldstein, “Sprint Targets T-Mobile With New 10 GB/\$100, 40 GB/\$120 Shared Family Plan,” FierceWireless (July 30, 2015).

²¹⁷ See “AT&T Introduces New AT&T Mobile Share Value Plans,” available at <http://www.fiercewireless.com/press-releases/att-introduces-new-att-mobile-share-value-plans>; Phil Goldstein, “AT&T Shakes Up Mobile Share Value Plan Pricing, Increases \$100/10 GB Plan to 15 GB,” available at <http://www.fiercewireless.com/story/att-shakes-mobile-share-value-plan-pricing-increases-10010-gb-plan-15-gb/2015-08-14>, FierceWireless (Aug. 14, 2015).

²¹⁸ See Philip Cusick, *et al.*, “Verizon Simplifies Pricing and Drops Subsidy Option; AT&T Also Reshuffles Its Pricing,” J.P. Morgan, North America Equity Research, at 1, 3 (Aug. 18, 2015).

²¹⁹ See “AT&T Introduces New AT&T Mobile Share Value Plans,” available at <http://www.fiercewireless.com/press-releases/att-introduces-new-att-mobile-share-value-plans>; “AT&T Mobile Share Value Plans,” available at <http://www.att.com/shop/wireless/data-plans.html>.

²²⁰ See “T-Mobile Unleashes Mobile Video with Binge On,” available at <https://newsroom.t-mobile.com/media-kits/un-carrier-x.htm>.

²²¹ See *Seventeenth Report*, 29 FCC Rcd at 15386 ¶ 152.

²²² See “Sprint’s Offer: Cut Your Wireless Bill in Half Event,” available at <http://www.fiercewireless.com/press-releases/sprints-offer-cut-your-wireless-bill-half-event>; Phil Goldstein, “Sprint Offers to Cut Monthly Bills in Half for Verizon, AT&T Customers Who Switch,” FierceWireless (Dec. 2, 2014).

²²³ See William Ho, “Sprint, T-Mobile Will Keep Sparking Pricing Moves in 2015,” FierceWireless (Feb. 25, 2015).

²²⁴ See Craig Moffett, “U.S. Wireless: The Race to the Bottom?,” MoffettNathanson Research (June 22, 2015); William Ho, “Sprint, T-Mobile Will Keep Sparking Pricing Moves in 2015,” FierceWireless (Feb. 25, 2015).

²²⁵ See Craig Moffett, “U.S. Wireless: The Race to the Bottom?,” MoffettNathanson Research (June 22, 2015).

into Sprint retail stores ended up choosing other Sprint plan options instead.²²⁶ Sprint has subsequently relabeled the promotion to “Cut Your Rate Plan in Half.”²²⁷

80. Despite the wave of promotional pricing activity, analysts have recently noted signs of a possible stabilization of pricing.²²⁸ For example, AT&T did not respond to Verizon Wireless’s reintroduction of its promotional pricing offers in April 2015, and although it matched one of the same offers when they were first launched in November 2014, AT&T discontinued the promotion long before Verizon Wireless did.²²⁹ In addition, although both Sprint and T-Mobile continue to offer unlimited data plans, one analyst noted that both companies “are deemphasizing unlimited data plans and instead they are promoting their shared data bucket plans,” a trend the same analyst characterized as being “good for profitability.”²³⁰ Finally, in August 2015, Verizon Wireless ended its existing promotional pricing offers and launched a greatly simplified version of its shared data plan, called “The Verizon Plan.”²³¹ The effect of Verizon Wireless’s new shared data plan on customers’ monthly bills depends on the size of their data allowance and the number of smartphone lines used.²³² Customers on data tiers with less than 6GB of data will see a price cut as a result of reductions in monthly data and smartphone access charges. The price will remain unchanged for customers on the 6GB data tier with two smartphones. Customers on data tiers with a monthly data allowance greater than 6GB and with more than two lines may end up paying slightly higher prices than they had been previously.²³³ The day after “The Verizon Plan” went into effect, AT&T launched its revamped shared data promotional plans, lowering AT&T’s pricing for low-end single-line data plans and replacing the 10GB plan with its “15GB for the price of 10GB” offer.

81. As summarized by one analyst, following the launches of Verizon Wireless’s and AT&T’s new plans, “Sprint and T-Mobile continue to have the most competitively priced plans at all levels and Verizon

²²⁶ See William Ho, “Sprint, T-Mobile Will Keep Sparking Pricing Moves in 2015,” FierceWireless (Feb. 25, 2015); Craig Moffett, “U.S. Wireless: The Race to the Bottom?,” MoffettNathanson Research (June 22, 2015); Joseph Mastrogiovanni, “Sprint Making a Push for Subs into Year-End,” Credit Suisse, Equity Research (Dec. 2, 2014).

²²⁷ See “Switch to Sprint and save 50% on Verizon, AT&T or T-Mobile rates,” available at <https://www.sprint.com/apps/save50percent/index.html#!/..>

²²⁸ See Craig Moffett, *et al.*, “U.S. Wireless: Hell Freezes Over . . . Upgrading Sector to Overweight and Verizon to Buy, Price Target \$54,” MoffettNathanson Research, at 11-12 (Aug. 11, 2015); Phil Goldstein, “Analyst: U.S. Wireless Service Revenue Dropped in Q2 But May Be Stabilizing,” FierceWireless (Aug. 12, 2015).

²²⁹ See Phil Goldstein, “Analysts: Verizon’s New Plans Could Hurt Net Adds Short-Term, Will Boost Profits Long-Term,” FierceWireless (Aug. 10, 2015).

²³⁰ See Phil Goldstein, “Analyst: U.S. Wireless Service Revenue Dropped in Q2 But May Be Stabilizing,” FierceWireless, (Aug. 12, 2015) (quoting Chetan Sharma Consulting).

²³¹ The new plan comes in four basic sizes, ranging from small (1GB for \$30 per month) to extra-large (12GB for \$80 per month). Larger data buckets are available for customers who need them. In addition to reducing the number of data tiers, Verizon established a uniform monthly access line charge for each smartphone of \$20 across the board for EIP subscribers, replacing the previous two-tiered pricing structure in which EIP subscribers paid \$25 per smartphone for data tiers with less than 6GB and \$15 per smartphone for data tiers with 6GB or more. See “One Plan. Pick a Size. Simple,” available at http://www.verizonwireless.com/landingpages/verizon-plan/?intcmp=INT-MAR-NON-AW-The_Verizon_Plan-081315-1MPB1-DE-HP-PP-NP; “S-M-L-XL: Choose the Right Size on the Nation’s Best 4G LTE Network,” available at <http://www.fiercewireless.com/press-releases/s-m-l-xl-choose-right-size-nations-best-4g-lte-network>; Phil Goldstein, “Verizon Cuts Prices on Shared Data Plans and Smartphone Access Charges,” FierceWireless (Aug. 7, 2015).

²³² See Phil Goldstein, “Analysts: Verizon’s New Plans Could Hurt Net Adds Short-Term, Will Boost Profits Long-Term,” FierceWireless (Aug. 10, 2015).

²³³ See *id.*; Philip Cusick, *et al.*, “Verizon Simplifies Pricing and Drops Subsidy Option; AT&T Also Reshuffles Its Pricing,” J.P. Morgan, North America Equity Research, at 1 (Aug. 18, 2015).

Wireless remains the most expensive option.”²³⁴ Finally, effective November 15, 2015, T-Mobile raised prices on its unlimited data plan and two out of three of its usage-based data pricing tiers in conjunction with an increase in the latter two tiers’ monthly high-speed 4G LTE data caps and the launch of Binge On, a free video streaming option that is only available on T-Mobile’s new \$65/6GB tier (previously \$60/3GB) and above.²³⁵ T-Mobile left the price of its base data tier unchanged at \$50, but increased the monthly high-speed data cap on this tier as well (from 1GB to 2GB).

ii. Device Financing

82. *iPhone Promotions.* A number of promotional offers during this period were timed to take advantage of Apple’s annual fall release of new iPhone models. In the fall of 2014, rival promotional offers around the iPhone 6/6 Plus release focused on the trade-in value of used devices,²³⁶ and also featured the launch of the first handset leasing program. For example, shortly before the fall 2014 iPhone 6/6 Plus release, T-Mobile announced that it would guarantee the best trade-in value on customers’ used devices when they upgrade to a new device,²³⁷ and in response, Sprint offered to match any major national competitor’s trade-in value,²³⁸ and Verizon Wireless made a similar offer.²³⁹ Promotional activity in advance of the fall 2015 iPhone 6s/6s Plus release focused on handset pricing, with handset leasing promotions playing a leading role.²⁴⁰

83. *Handset Leasing.* The first handset leasing program was Sprint’s “iPhone for Life,” under which monthly payments to lease an iPhone are lower than the monthly installment payments would be under Sprint’s “Easy Pay” EIP, but customers do not get to keep the phone free of charge after two years.²⁴¹ In June 2015, T-Mobile launched its own version of a handset leasing program called “JUMP! On Demand.”²⁴² T-Mobile subsequently used its new leasing program to launch new promotions featuring discounted monthly leasing

²³⁴ Philip Cusick, *et al.*, “Verizon Simplifies Pricing and Drops Subsidy Option; AT&T Also Reshuffles Its Pricing,” J.P. Morgan, North America Equity Research, at 1 (Aug. 18, 2015).

²³⁵ Philip Cusick, *et al.*, “Wireless Pricing Update: T-Mobile Raises Prices While Sprint Now Offers Unlimited 2G Data; Binge On seems Fine,” J.P. Morgan, North America Equity Research (Nov. 16, 2015).

²³⁶ See Philip Cusick, “Carriers Now Offer Competitive Trade-in Values Compared to Retailers for Used Smartphones,” J.P. Morgan, North America Equity Research, at 1 (Oct. 27, 2014).

²³⁷ See “T-Mobile Guarantees Industry’s Best Trade-In Value on Used Devices,” available at <http://newsroom.t-mobile.com/news/t-mobile-guarantees-industrys-best-trade-in.htm>; Mike Dano, “T-Mobile Launches Phone Trade-in Guarantee, Promises to Beat Any Offer by \$50,” FierceWireless (Sept. 8, 2014).

²³⁸ See Phil Goldstein, “Sprint Hits Back at T-Mobile With its Own Phone Trade-in Guarantee,” FierceWireless (Sept. 9, 2014).

²³⁹ See Philip Cusick, “Carriers Now Offer Competitive Trade-in Values Compared to Retailers for Used Smartphones,” J.P. Morgan, North America Equity Research, at 1 (Oct. 27, 2014).

²⁴⁰ See John C. Hodulik, *et al.*, “Kicking Up Competition for Handset Pricing,” UBS, Equity Research (Sept. 24, 2015).

²⁴¹ See “iPhone 6s,” available at <http://www.sprint.com/landings/iphone/index.html#whysprint?ECID=vanity:iphone>; Philip Cusick, “3Q14 Preview and Industry Update,” J.P. Morgan, North America Equity Research, at 9 (Oct. 20, 2014). Sprint later expanded the handset leasing program to include other high-end 4G smartphones. See also Philip Cusick, “Wireless Pricing Update,” J.P. Morgan, North America Equity Research, at 1 (Feb. 12, 2015).

²⁴² See “T-Mobile Unveils All-New “Jump! On Demand” – a Whole New Way to Get a Phone Whenever You Want,” available at <http://newsroom.t-mobile.com/news/t-mobile-unveils-all-new-jump-on-demand--a-whole-new-way-to-get-a-phone-when-ever-you-want.htm>; Simon Flannery, “UnCarrier Amped Reinforces Competitive Environment,” Morgan Stanley, Equity Research (June 26, 2015); Jennifer M. Fritzsche, “TMUS: Launches First Un-Carrier Amped Initiative – JUMP! On Demand,” Wells Fargo, Equity Research (June 25, 2015).

payments for the next iPhone model, first in July 2015 and then again in September 2015.²⁴³ Sprint quickly countered both promotions.²⁴⁴ In the second round, T-Mobile offered to lease a new iPhone 6s for \$5 per month (\$9 per month for the iPhone 6s Plus) with trade-in of an iPhone 6 or other qualifying smartphone, but with eligibility limited to customers who already own their current device. Sprint countered with a monthly leasing rate of \$1 per month (\$5 per month for the 6s Plus) under similar terms.²⁴⁵

84. While the low monthly leasing payments have the appearance of a price cut, the discounts to monthly leasing payments effectively replace the provider's standard upfront payment for the trade-in value of the customer's existing device, and in T-Mobile's case the cumulative monthly discount (\$15) over the 18-month leasing term amounts to less than the \$350 upfront payment the provider previously offered for an iPhone 6 trade-in.²⁴⁶ Absent a handset leasing plan, Verizon Wireless responded with a new program that allows customers to upgrade to a new iPhone every year with trade-in of their current device, provided they have paid off more than half the cost of the current device and purchase the new phone through Verizon Wireless's EIP.²⁴⁷ Under Verizon Wireless's non-promotional upgrade policy, EIP customers are required to pay off the full cost of their old device before upgrading, though they are able to upgrade at any time without a trade-in.

85. *Tablet Subsidies and Promotions.* The growth of tablet subsidies to encourage subscribers to use tablets on mobile networks as well as Wi-Fi continued during the period covered by this *Report*.²⁴⁸ At various times, service providers offered significant discounts on selected tablets, and in some cases, service providers practically gave certain tablet models away free of charge, to qualifying customers (e.g., those who sign a two-year service contract, sign up for a qualifying data plan, or purchase a smartphone through an EIP program.)²⁴⁹ Service providers also offered discounts on other types of devices, including wearables and accessories. This type of promotional activity is particularly intense during the holiday shopping season.

iii. Efforts to Promote No-Contract Service Plans

86. The *Seventeenth Report* discussed the rise of the EIP, together with the no-contract service plan, as an alternative to the traditional handset subsidy model.²⁵⁰ Beginning with T-Mobile, all four nationwide service providers and some regional providers introduced versions of an EIP and encouraged customers to adopt EIPs through two types of incentives. First, providers offered early handset upgrade options that allow customers to upgrade earlier and more frequently than under traditional subsidized plans but require customers who take advantage of this early upgrade option to pay for their new handsets with an EIP. Second, providers offered lower

²⁴³ See Phil Goldstein, "T-Mobile Offers iPhone 6s for as Low as \$5/Month in Device Payments if Customers Trade in an iPhone 6," *FierceWireless* (Sept. 23, 2015); Phil Goldstein, "T-Mobile Lets Customers Get Free Upgrade to Next iPhone, Lock in \$15 Monthly Fee," *FierceWireless* (July 28, 2015).

²⁴⁴ See Phil Goldstein, "Sprint Undercuts T-Mobile, Offers iPhone 6s for \$1/Month in Leasing Payments With an iPhone Trade-In," *FierceWireless* (Sept. 24, 2015); "Sprint Customers Can Upgrade Their iPhone Anytime, Included in Their Monthly Rate," available at <http://newsroom.sprint.com/news-releases/sprint-customers-can-upgrade-their-iphone-anytime-included-in-their-monthly-rate.htm>; Phil Goldstein, "Sprint Hits Back at T-Mobile With Its Own \$15/Month iPhone Promotion, Says Customers Can Upgrade to a New iPhone Any Time," *FierceWireless* (Aug. 17, 2015).

²⁴⁵ See John C. Hodulik, *et al.*, "Kicking Up Competition for Handset Pricing," UBS, Equity Research (Sept. 24, 2015).

²⁴⁶ *See id.*

²⁴⁷ See Phil Goldstein, "Apple's iPhone 6s, 6s Plus Go On Sale as Verizon Looks to Match Sprint, T-Mobile Offers," *FierceWireless* (Sept. 25, 2015).

²⁴⁸ See Phil Goldstein, "As U.S. Tablet Sales Fall Overall, Verizon, AT&T and Sprint See Increasing Sales of Cellular Tablets," *FierceWireless* (May 14, 2015).

²⁴⁹ See Phil Goldstein, "Verizon, AT&T, Sprint, T-Mobile and More Unleash Device Deals for Black Friday," *FierceWireless* (Nov. 26, 2014).

²⁵⁰ See *Seventeenth Report*, 29 FCC Rcd at 15381 ¶ 140.

monthly service fees to customers who sign a contract to pay for a new handset in monthly installments, as well as customers who pay the full price for their handset upfront, new customers who bring their own devices (“BYOD”), and existing customers who have already paid for their handset under a traditional contract plan that has expired.

87. In the period since the *Seventeenth Report*, providers continued to adjust the incentives offered to encourage subscribers to choose EIPs and no-contract service plans over the traditional handset subsidy option. For example, in a series of pricing changes from October 2014 to August 2015, Verizon Wireless further reduced the already discounted monthly access line charges that EIP subscribers on small and medium-sized data plans pay for each smartphone.²⁵¹ Sprint waived the monthly access line charges for new subscribers on qualifying data plans in conjunction with some of its promotions, but only if subscribers purchased their devices through its EIP or handset leasing options or brought their own.²⁵² The introduction of handset leasing programs can also be viewed as a way of encouraging subscribers to shift to no-contract plans. To the extent subscribers find the terms of these handset leasing programs more attractive than the terms of existing EIP programs, the launch of handset leasing programs by Sprint and T-Mobile may enhance incentives to choose no-contract service plans.

88. Service providers also moved beyond the use of incentives to promote the shift to no-contract plans. During the period covered by the *Seventeenth Report*, T-Mobile remained the only nationwide provider that had ceased offering handset subsidies. Although the other nationwide service providers promoted EIPs and no-contract plans to varying degrees, all three continued to offer customers the traditional contract plan with handset subsidy option. Since then, the remaining nationwide providers have taken steps to limit sales of contract plans and bring an end to handset subsidies or have announced plans to do so. AT&T opted to limit sales of subsidized handsets through third-party retail partners such as Walmart and Apple. Beginning in June 2015, third-party national retailers and local authorized dealers progressively discontinued selling two-year service contracts with subsidized handsets to AT&T customers, and instead required them to purchase handsets at full retail price or through AT&T’s EIP.²⁵³ For the time being, however, AT&T will continue to offer two-year service contracts with subsidized handsets in its company-owned retail stores and through its online sales channels. Significantly, the revamped Mobile Share Value promotional plans that AT&T introduced in August 2015 included the option to purchase a subsidized smartphone through a two-year service contract.²⁵⁴

89. Verizon Wireless moved in the same direction with the introduction of its new shared data plan “The Verizon Plan” in August 2015. Unlike Verizon Wireless’s previous shared data plan, the new plan does not include the option to purchase a handset at a discounted price through a two-year service contract. All new customers and also existing customers who move to the new plan will buy or upgrade to new smartphones either by using Verizon Wireless’s EIP device payment option or by paying the full retail price upfront.²⁵⁵ Note that like

²⁵¹ See John C. Hodulik, *et al.*, “AT&T and Verizon Tweak Pricing, Yet Again,” UBS, Global Research, at 3 (Nov. 3, 2014); “More Options and Even More Value Coming for More Everything,” available at <http://www.fiercewireless.com/press-releases/more-options-and-even-more-value-coming-more-everything>; “S-M-L-XL: Choose the Right Size on the Nation’s Best 4G LTE Network,” available at <http://www.fiercewireless.com/press-releases/s-m-l-xl-choose-right-size-nations-best-4g-lte-network>.

²⁵² See “Sprint Stands Behind Pledge to Deliver ‘Double the Data,’” available at <http://newsroom.sprint.com/news-releases/sprint-stands-behind-pledge-to-deliver-double-the-data.htm>; “Sprint Introduces Best Plan for Families,” available at <http://www.fiercewireless.com/press-releases/sprint-introduces-best-plan-families>.

²⁵³ See Phil Goldstein, “Report: AT&T to Abandon 2-Year Contracts at National Retailers and Local Dealers,” FierceWireless, May 20, 2015; Phil Goldstein, “Report: Apple Stores to Sell Only Unsubsidized AT&T iPhones, Will Adopt Verizon Edge Changes,” FierceWireless (June 2, 2015).

²⁵⁴ See Philip Cusick, *et al.*, “Verizon Simplifies Pricing and Drops Subsidy Option; AT&T Also Reshuffles Its Pricing,” J.P. Morgan, North America Equity Research at 1 (Aug. 18, 2015).

²⁵⁵ See “S-M-L-XL: Choose the Right Size on the Nation’s Best 4G LTE Network,” available at <http://www.fiercewireless.com/press-releases/s-m-l-xl-choose-right-size-nations-best-4g-lte-network>.

AT&T, existing Verizon Wireless subscribers on two-year contracts will not be required to switch to “The Verizon Plan” even to upgrade their phone, but instead will be able to keep and renew their existing contract plan and continue to take advantage of subsidized devices offered by Verizon Wireless when they upgrade to a new smartphone.²⁵⁶ Finally, in August 2015, Sprint CEO Marcelo Claure disclosed that Sprint will no longer offer two-year contracts and handset subsidies by the end of 2015 and will move entirely to the device leasing model.²⁵⁷

iv. Early Termination Fee Buyouts and Other Switching Incentives

90. With the shift away from handset subsidies, marketing tactics have increasingly focused on Early Termination Fee (“ETF”) buyouts to encourage customers to switch from rivals. ETF buyouts typically include a cash payment or credit to reimburse ETFs for customers on traditional contract plans, or alternatively, to pay off the remaining balance of an EIP, plus a separate device credit for trading in a customer’s current handset.²⁵⁸ For example, T-Mobile maintained its offer to reimburse up to \$650 in ETFs for customers switching from the other three nationwide service providers since it was first introduced in January 2014.²⁵⁹ In May 2015, T-Mobile supplemented this offer with its “Never Settle” free two-week trial promotion targeted specifically at Verizon Wireless customers.²⁶⁰ Under the promotion, Verizon Wireless customers port their number to a new T-Mobile smartphone while holding on to their Verizon Wireless phone. If customers decide to switch permanently to T-Mobile after the trial, T-Mobile will reimburse them for up to \$650 in Verizon’s ETFs and outstanding device payments, provided customers trade in their Verizon Wireless phone and purchase a new phone from T-Mobile.²⁶¹

91. Rival service providers tended to rely on a series of limited-time ETF buyout offers, often timed to coincide with the launch of other types of pricing changes and promotions. For example, Verizon Wireless offered a one-time \$100 bill credit per qualified line to new EIP customers who port in their wireless number from another service provider when it restructured the pricing of its shared data offerings in February 2015.²⁶² Sprint’s “Cut Your Bill in Half” offer for customers switching from Verizon Wireless and AT&T, as described above, included an ETF buyout of up to \$350 per line to reimburse any remaining balance on their EIP as well as early termination fees.²⁶³ From January 23 through April 9, 2015, Sprint guaranteed customers who switch from T-Mobile a minimum trade-in value of \$200 for their used smartphones in addition to up to \$350 per line to cover switching costs.²⁶⁴ One analyst notes that, while ETF switching credits are “an essential component to subscriber

²⁵⁶ See “Simplified Data Choices Match Customer Lifestyles,” available at <http://www.verizonwireless.com/news/article/2015/08/simplified-data-choices-match-customer-lifestyles.html>; Phil Goldstein, “Verizon: Existing Customers With 2-Year Contracts and Subsidized Smartphones Can Keep Them,” *FierceWireless* (Aug. 31, 2015).

²⁵⁷ See Phil Goldstein, “Sprint to Abandon 2-Year Contracts By Year-End, Embrace Leasing Exclusively,” *FierceWireless* (Aug. 17, 2015).

²⁵⁸ See *Seventeenth Report*, 29 FCC Rcd at 15382 ¶ 145.

²⁵⁹ See “Switch Carriers: No Early Termination Fee,” available at http://www.t-mobile.com/offer/switch-carriers-no-early-termination-fee.html?icid=WMD_TM_Q115CRRRFR_LNN5NV72F4X1691.

²⁶⁰ See Phil Goldstein, “T-Mobile Targets Verizon Customers With Free 2-Week Trial,” *FierceWireless* (May 5, 2015).

²⁶¹ See Phil Goldstein, “T-Mobile Extends ‘Never Settle’ Free 2-Week Trial With Promotion Targeting Verizon,” *FierceWireless* (June 3, 2015).

²⁶² See “More Options and Even More Value Coming for More Everything,” available at <http://www.fiercewireless.com/press-releases/more-options-and-even-more-value-coming-more-everything>.

²⁶³ See Phil Goldstein, “Sprint Offers to Cut Monthly Bills in Half for Verizon, AT&T Customers Who Switch,” *FierceWireless* (Dec. 2, 2014).

²⁶⁴ See Phil Goldstein, “Sprint Offers \$200 Trade-in Credit, \$350 to Cover ETFs for Switching T-Mobile Customers,” *FierceWireless* (Jan. 23, 2015).

growth” for T-Mobile, Sprint, AT&T, and Verizon Wireless, they “have tended to play around with lesser (*e.g.*, \$100-\$150) values.”²⁶⁵

v. Rollover Data Programs

92. One novel pricing change during this period was the launch of rollover data programs enabling mobile subscribers on usage-based data plans to roll over unused data from their monthly data allowances from month to month. Although the practice of allowing mobile subscribers to roll over unused voice minutes from their monthly voice buckets from month to month was first introduced by Cingular Wireless (predecessor to AT&T) in 2002, the application of the rollover concept to unused data was new. Regional operator C Spire was the first service provider to apply the rollover concept to unused data. In November 2014, C Spire launched several rollover data plans that let subscribers carry over unused data to the following month, and touted the plans as a means of eliminating surprise data overage charges.²⁶⁶ In January 2015, T-Mobile launched a rival rollover data program called “Data Stash” that is automatically available to new and existing postpaid subscribers on qualifying data plans at no additional charge, and offered to deposit 10GB of data free of charge in every customer’s Data Stash through the end of 2015.²⁶⁷ AT&T launched its own version of the rollover data concept shortly thereafter, limiting its availability to EIP and other non-subsidized subscribers on no-contract shared data plans.²⁶⁸

93. One of the differentiating features of rival rollover data programs is how long unused data remains available for use. Under T-Mobile’s program, subscribers can use data any time for up to one year from the date it is deposited into their Data Stash, but after that date they will lose any of their unused data. Under AT&T’s program, any unused data in a given month automatically rolls over and is available to be used within the next month. Within a given month, customers use their monthly shared data allowance first, before they begin to use any unused rollover data from the previous month, and any unused rollover data from the previous month does not carry over to the following month.

B. Prepaid Service

94. The four nationwide service providers offer prepaid service under their own prepaid brands, in addition to selling mobile wireless service wholesale to MVNOs, which then resell service on the nationwide networks under other prepaid brands. Prepaid strategies vary across providers.²⁶⁹ Verizon Wireless, the nationwide service provider with the smallest share of prepaid subscribers, has one prepaid brand with what one analyst characterizes as a “thin portfolio” of offerings.²⁷⁰ In contrast, the largest U.S. reseller, Tracfone, has multiple prepaid brands that target different market and demographic segments. To varying degrees, the other three nationwide service providers pursue a multi-brand prepaid strategy similar to that of Tracfone.

95. One factor that used to differentiate prepaid service from postpaid was the presence of multi-regional prepaid service providers, such as MetroPCS and Leap (which offered service under the Cricket brand).

²⁶⁵ See William Ho, “Sprint, T-Mobile Will Keep Sparking Pricing Moves in 2015,” FierceWireless (Feb. 25, 2015).

²⁶⁶ See “C Spire Debuts Customer-Inspired Rolling Data Plans that Promise to Save Consumers Money and Eliminate Surprise Data Overages,” available at http://www.cspire.com/company_info/about/news_detail.jsp?entryId=22400005.

²⁶⁷ See “Data Stash: Don’t Lose What You Don’t Use,” available at <http://www.t-mobile.com/offer/data-stash-data-roll.html>; Phil Goldstein, “T-Mobile Launches Rollover Data Program, Gives Customers 10GB for Free to Start,” FierceWireless (Dec. 16, 2014). Eligibility was limited to subscribers on qualifying postpaid Simple Choice plans who have purchased at least 3GB of 4G LTE data for smartphones, or 1GB or more of 4G LTE data for postpaid tablet plans.

²⁶⁸ See “AT&T Gives More Than 50 Million Mobile Share Value Subscribers Shareable Rollover Data,” available at http://about.att.com/story/att_gives_50_million_customers_shareable_rollover_data_at_no_charge.html; “Rollover Data,” available at <http://www.att.com/shop/wireless/rollover-data.html>.

²⁶⁹ See William Ho, “Is Prepaid Still Relevant? Yes!,” FierceWireless (Oct. 27, 2014).

²⁷⁰ See *id.*

During the period covered by the *Seventeenth Report*, T-Mobile acquired MetroPCS and AT&T acquired Leap. As one analyst put it, the prepaid segment has become “a big-4 game.”²⁷¹ Analysts sub-divide prepaid service offerings into a high-end segment for the recurring monthly plan user and the traditional segment with pay-as-you-go pricing. Like postpaid service plans, prepaid monthly plans are typically offered in multiple tiers with different rates and usage levels. Prepaid offerings include pay-as-you-go pricing and “plans with features that mimic postpaid.”²⁷² In this regard, one noteworthy trend is an increase in prepaid subscribers switching to postpaid service in response to more attractive postpaid plan pricing and the recent postpaid pricing changes and promotions.²⁷³ Analysts believe the option available to postpaid subscribers to purchase a handset on an installment payment plan with no down payment is an added attraction for prepaid subscribers because prepaid subscribers ordinarily do not have access to the device financing options available to postpaid subscribers, but instead have to pay the full price of handsets upfront.

96. The migration of former prepaid subscribers to postpaid service in response to postpaid pricing and promotional changes is important background to changes in prepaid plan pricing in the period since the *Seventeenth Report*. To a significant extent, service providers implemented the same or similar types of pricing changes and promotions in their high-end prepaid monthly service offerings as they did in their postpaid service offerings. In some cases, pricing changes and promotions originally launched for postpaid service were subsequently extended to one or more prepaid brands, while in other cases, the prepaid brand was the first to launch a particular type of pricing change. The list of pricing and promotional changes common to both postpaid and high-end prepaid service offerings includes additions to data for the same monthly rate (including “double data” promotions), the “cut your bill in half” promotion, switching incentives, shared data plans, rollover data programs, and handset financing options. As explained below, however, the prepaid and postpaid versions of a given pricing change or promotion often differ due to the remaining distinctions between postpaid and prepaid service. The remaining differences largely reflect the different characteristics of postpaid and prepaid subscribers: “prepaid subscribers are typically prepaid for a reason, relating to their income and credit.”²⁷⁴ To prevent credit losses and mitigate the credit risk associated with the prepaid segment, service providers require advance payment for both prepaid service and handsets, and as explained below, most prepaid service providers impose speed reductions for data usage in excess of monthly data allowances, rather than the overage charges that are typical of postpaid data plans.

i. More Data for the Same Price and Other Pricing Offers

97. On numerous occasions, prepaid service providers added more data for the same monthly rate to service plans, either on a limited-time promotional basis or in the form of permanent changes to non-promotional rate plans. In the context of prepaid service, this type of pricing change generally consists of an addition to the subscriber’s monthly high-speed data allowance (typically either LTE or HSPA+). As a general rule, prepaid subscribers who reach the limit of their high-speed data allowance in a given month may continue to use their handsets for data service on an unlimited basis, but at reduced speeds.²⁷⁵ In contrast, postpaid subscribers who use

²⁷¹ See Philip Cusick, “3Q14 Preview and Industry Update,” J.P. Morgan, North America Equity Research, at 13 (Oct. 14, 2014).

²⁷² See William Ho, “Is Prepaid Still Relevant? Yes!,” FierceWireless (Oct. 27, 2014).

²⁷³ See *id.*; Philip Cusick, *et al.*, “Postpaid Outperformed From Tablets While Prepaid Underperformed From Migration to Postpaid and Lifeline Recertification,” J.P. Morgan, North America Equity Research, at 1-2 (May 28, 2015); David W. Barden, *et al.*, “3Q14 Preview and Model Book – Wireless Pricing is Top of Mind,” Bank of America Merrill Lynch, Equity Research, at 7 (Oct. 17, 2014).

²⁷⁴ See David W. Barden, *et al.*, “3Q14 Preview and Model Book – Wireless Pricing is Top of Mind, Bank of America,” Merrill Lynch, Equity Research, at 7 (Oct. 17, 2014). “The prepaid segment churn is as much as 3x higher than postpaid and it is by definition 100% voluntary. The reason for the elevated churn rate here is that prepaid customers may not be able to make consistent payments or they are quick to churn off for the next, lower-priced deal at another carrier.” *Id.*

²⁷⁵ See *Seventeenth Report*, 29 FCC Rcd at 15387, 15390 ¶¶ 155, 159.

up their plan's data allowance in a given month generally incur overage charges if they exceed the allowance.²⁷⁶ T-Mobile, an exception, has eliminated overage charges as part of its "uncarrier" strategy and generally uses speed reductions to control the data usage of both postpaid and prepaid subscribers.²⁷⁷

98. Prior to the wave of "double data" promotions in postpaid service in the fall of 2014, there was a similar wave of promotions in prepaid service. For example, in September 2014, Sprint's Boost Mobile launched a limited-time promotion in which it doubled the monthly data allowances of its plans and cut the price by \$5 per month.²⁷⁸ Shortly thereafter, AT&T's Cricket launched a rival promotion, offering double the usual monthly data allowance for the same price on two plans and a smaller increase in high-speed data for the same price on a third plan.²⁷⁹ In November 2014, Boost Mobile renewed its promotion, and T-Mobile's GoSmart prepaid unit likewise doubled the data allowances for several of its rate plans.²⁸⁰ In late December 2014, Boost Mobile announced that its double data promotional pricing would now be its permanent pricing.²⁸¹ Subsequently, GoSmart and Cricket implemented similar types of pricing changes, in both cases increasing the high-speed data allowances of their existing rate plans.²⁸² Other prepaid service providers also added more data to their rate plans during the same period. In September 2014, T-Mobile's MetroPCS doubled the data allowance on its entry-level plan and increased the data allowance on its next highest tier.²⁸³ The following January, MetroPCS announced that every customer with an LTE data bucket would automatically get an additional gigabyte of LTE data for the same monthly rate.²⁸⁴ Tracfone increased the monthly data allowances of rate plans for its Simple Mobile²⁸⁵ and Straight Talk prepaid brands.²⁸⁶

99. In June 2015, Sprint's Boost Mobile launched a "Slash Your Payment in Half" promotion targeted at MetroPCS and Cricket customers.²⁸⁷ From June 19 through July 20 of that year, Boost offered to cut those customers' monthly service bills in half for a full year if they switch to Boost and port their phone number. After the 12-month period expires and the introductory rate ends, customers will automatically be migrated to a

²⁷⁶ See *id.*, 29 FCC Rcd at 15385 ¶¶ 148-49.

²⁷⁷ See *id.*, 29 FCC Rcd at 15385 ¶ 151.

²⁷⁸ See Phil Goldstein, "Sprint's Boost Mobile Cuts Prices, Doubles Data on Prepaid Plans," FierceWireless (Sept. 2, 2014); "Boost Mobile Introduces 'Data Boost Plans' That Offer Big Data at a Small Price," available at <http://www.fiercewireless.com/press-releases/boost-mobile-introduces-data-boost-plans-offer-big-data-small-price-0>.

²⁷⁹ See "Cricket Offers Customers More High-Speed Data in Unlimited Plans with Taxes and Fees Included," available at <http://cricketwireless.mediaroom.com/index.php?s=20295&item=122435>.

²⁸⁰ See Phil Goldstein, "Sprint's Boost, T-Mobile's GoSmart Offer New Double-Data Promotions," FierceWireless (Nov. 5, 2014).

²⁸¹ See Phil Goldstein, "Sprint's Boost Makes Promotional Plans Permanent, Launches ZTE Speed," FierceWireless (Dec. 23, 2014).

²⁸² See Phil Goldstein, "T-Mobile's GoSmart and AT&T's Cricket Add Data to Plans, U.S. Cellular Drops Prepaid Pricing," FierceWireless (Jan. 30, 2015).

²⁸³ See David W. Barden, *et al.*, 3Q14 Preview and Model Book – Wireless Pricing is Top of Mind, Bank of America Merrill Lynch, Equity Research, at 3 (Oct. 17, 2014).

²⁸⁴ See Phil Goldstein, "T-Mobile's MetroPCS, Verizon Beef Up Data Offerings for Prepaid Plans," FierceWireless (Jan. 21, 2015).

²⁸⁵ See Dennis Bournique, "Simple Mobile Adds More Data to Most Plans," Prepaid Phonenews (Jan. 23, 2015).

²⁸⁶ See "Tracfone's Straight Talk Boosts Monthly Data Bucket to 5 GB; Nvidia's Forecast Depressed on Sluggish PC Sales," FierceWireless (May 8, 2015).

²⁸⁷ See "Boost Mobile Invites All Cricket and MetroPCS Customers to Slash Their Payment in Half," available at http://newsroom.sprint.com/article_display.cfm?article_id=11916; Phil Goldstein, "Sprint's Boost Mobile Offers to Cut MetroPCS, Cricket Customers' Bills in Half If They Switch," FierceWireless (June 19, 2015).

comparable higher-priced plan. Compared with Sprint's "Cut Your Bill in Half" promotion for postpaid service, Boost's promotion resulted in much larger effective percentage discounts on prepaid service because there are no device subsidies and prepaid devices are purchased at full price upfront.²⁸⁸

100. *Switching Incentives.* Service providers also offered incentives to encourage their rivals' subscribers to switch to their prepaid brands. The types of switching incentives offered included \$100 switching or porting credits and one month of free service.²⁸⁹ For example, AT&T's Cricket began offering a \$100 bill credit for T-Mobile and MetroPCS subscribers who switch to Cricket in August 2014,²⁹⁰ and then renewed the promotion in December 2014, but expanded the offer to include subscribers switching from a wider range of service providers, including Cincinnati Bell Wireless (which later exited the wireless business), Sprint's Boost Mobile and Virgin Mobile prepaid brands, and also Sprint postpaid service.²⁹¹ In April 2015, Cricket offered customers who switch from MetroPCS, Boost Mobile, and other service providers one month of service free of charge after completing two months of service.²⁹² Similarly, at various times in late 2014 and the first quarter of 2015, Sprint's Boost Mobile offered a \$100 credit or discount for the purchase of a new device to customers who switch and port their number to Boost from other service providers, or the first month of service free of charge for new customers who do not port their number from another service provider.²⁹³

ii. Shared Data Plans and Rollover Data

101. *Shared Data Plans.* In January 2015, Sprint's Virgin Mobile launched "Data Done Right," the first shared data plans for prepaid subscribers.²⁹⁴ Like the postpaid version, the monthly data allowance of Virgin's shared data plans can be shared by multiple persons, and each tier also includes unlimited talk and text. In other respects, the prepaid version of shared data plans is structured differently than its postpaid counterpart. Under postpaid shared data plans, there is a monthly fee for the data allowance, and a separate monthly line access fee for each smartphone or other device added to the account, with a limit of up to ten devices per account. Under Virgin's prepaid version, there are no additional monthly line access fees. Instead, there is a set limit on the number of lines for each data tier (two, three, or four depending on the size of the data allowance), and a single monthly fee that covers the cost of both the data allowance and the multiple lines. The plan also features a preloaded app that enables customers to manage data sharing directly from their device.

102. *Rollover Data Programs.* Following the launch of rollover data programs for postpaid service, several service providers launched prepaid versions of rollover data programs. In March 2015, T-Mobile extended its "Data Stash" rollover data program to its prepaid customers on qualifying data plans, including its offer to start off every subscriber's Data Stash with a deposit of 10GB of LTE data free of charge through the end

²⁸⁸ See Craig Moffett, "U.S. Wireless: The Race to the Bottom?," MoffettNathanson Research (June 22, 2015).

²⁸⁹ See William Ho, "Is Prepaid Still Relevant? Yes!," FierceWireless (Oct. 27, 2014).

²⁹⁰ See Phil Goldstein, "AT&T's Cricket Targets T-Mobile and MetroPCS Subs With \$100 Credit to Switch," FierceWireless, (Aug. 22, 2014); "Cricket Offers Customers More High-Speed Data in Unlimited Plans with Taxes and Fees Included," available at <http://cricketwireless.mediaroom.com/index.php?s=20295&item=122435>.

²⁹¹ See Phil Goldstein, "AT&T's Cricket Takes Aim at Sprint, T-Mobile and Cincinnati Bell with \$100 Credit," FierceWireless (Dec. 11, 2014).

²⁹² See Phil Goldstein, "AT&T's Cricket Launches New Device Financing Options, Kills Promotional 20 GB Plan," FierceWireless (Apr. 8, 2015).

²⁹³ See Phil Goldstein, "AT&T's Cricket Takes Aim at Sprint, T-Mobile and Cincinnati Bell with \$100 Credit," FierceWireless (Dec. 11, 2014); Phil Goldstein, "Sprint's Boost Pumps Up Data from 1 GB to 2.5 GB for \$35/Month Plan With Auto-Pay," FierceWireless (Jan. 23, 2015).

²⁹⁴ See "Virgin Mobile USA to Offer Industry's First No-Contract Data Sharing Plans Only at Walmart," available at <http://newsroom.sprint.com/news-releases/virgin-mobile-usa-to-offer-industrys-first-no-contract-data-sharing-plans-only-at-walmart.htm>.

of 2015.²⁹⁵ In May 2015, AT&T started letting GoPhone customers who own a smartphone and have signed up for a qualifying data plan access the service provider's rollover data program provided they renew their plan on time every month.²⁹⁶ In June 2015, Sprint launched a rollover data program for customers of its Sprint Prepaid brand.²⁹⁷ Under the "Monthly Rolling Data" program, Sprint prepaid customers on certain plans can roll over unused data from month to month and store up to 30GB of data with no expiration date. The offer was made available exclusively through Best Buy for a limited time.

iii. Handset Financing

103. Both traditional subsidized contract plans and no-contract EIP plans give postpaid subscribers the option to reduce the upfront cost of purchasing a new handset by spreading the cost of the handset over a specified period of time. In contrast, prepaid subscribers typically have to pay in full for the device upfront. This difference in the availability of device financing tends to limit the options available to prepaid subscribers. In the words of one analyst, "While halo devices such as the iPhone are offered in prepaid, the bread and butter devices sub-\$100 draw the most attention. These price points are usually populated with less known brands, such as Alcatel One Touch and ZTE, or lower-end models of global brands not seen in postpaid."²⁹⁸ In April 2015, AT&T's Cricket launched three new credit financing options that enable prepaid subscribers to obtain a smartphone for a small upfront payment.²⁹⁹ Two of the options are versions of an installment loan, both requiring a credit check. The third is a rent-to-own leasing option. The leasing option does not require a credit check, though a third party may be used to verify financial information, but does require a larger upfront payment than the installment loan options.

C. Price Indicators for Mobile Wireless Services

104. As the discussion above shows, there is wide variety of pricing plans offered by the different mobile wireless service providers that vary along several dimensions, and that may frequently change.³⁰⁰ As discussed earlier³⁰¹ and in previous *Reports*, it is difficult to identify sources of information that track actual mobile wireless service prices in a comprehensive and consistent manner. Chart V.C.1 below presents monthly postpaid prices for the four nationwide service providers. Table V.C.1 below shows the current monthly prepaid prices. As reflected in these two charts, sharing data among different lines in an account is a common feature of postpaid pricing plans, but is not an option for prepaid plans.

²⁹⁵ See Phil Goldstein, "T-Mobile Brings 'Data Stash' Rollover Data Plan to Prepaid Customers," FierceWireless (Mar. 16, 2015).

²⁹⁶ See Phil Goldstein, "AT&T Brings Rollover Data to Some of its GoPhone Prepaid Customers," FierceWireless (May 11, 2015).

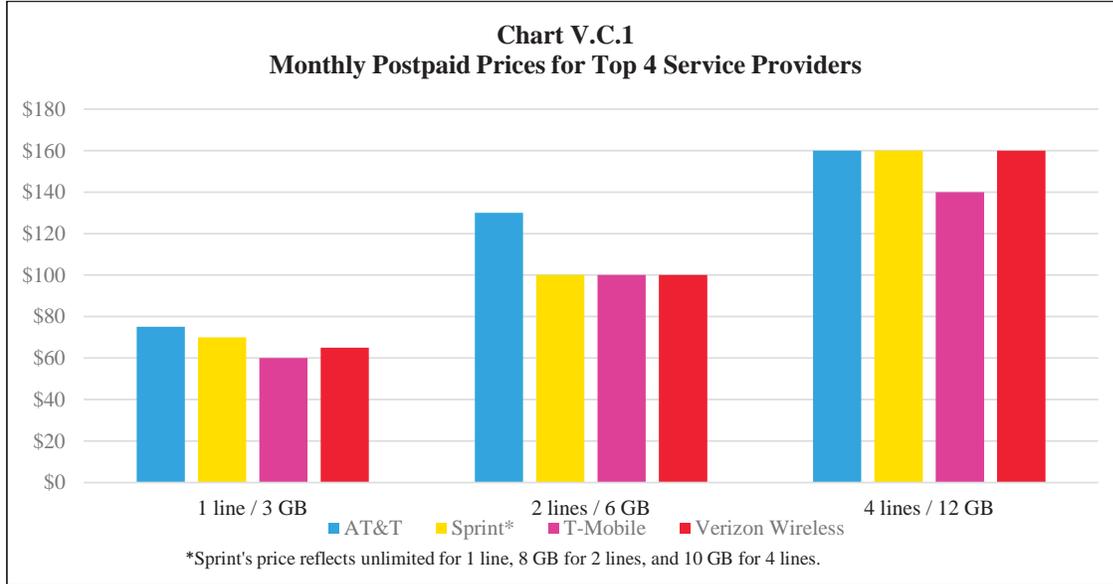
²⁹⁷ See Phil Goldstein, "Sprint Unveils Rollover Data for Some Prepaid Customers, Boost Mobile TV Service Geared Toward Sports," FierceWireless (June 2, 2015).

²⁹⁸ See William Ho, "Is Prepaid Still Relevant? Yes!," FierceWireless (Oct. 27, 2014).

²⁹⁹ See Phil Goldstein, "AT&T's Cricket Launches New Device Financing Options, Kills Promotional 20 GB Plan," FierceWireless (Apr. 8, 2015); "New Cricket Phone Payment Plans Help Customers Get the Phone They Want When They Want It – Including the Upcoming Galaxy S6," available at <http://www.fiercewireless.com/press-releases/new-cricket-phone-payment-plans-help-customers-get-phone-they-want-when-the>.

³⁰⁰ See Appendix V, which provides additional information, based on data from RBC Capital Markets, on pricing over time for the four nationwide service providers.

³⁰¹ See section II.D.1 *supra*.



Note: The above prices were taken from service providers' websites on Oct. 21, 2015. Prices include any per line charges indicated by the provider. Prices do not include any additional charges such as equipment installment plans, insurance, international use, or data overage; however, if a service provider includes any such feature in its basic plan, the above price would include this feature. Further, the above prices do not include any one-time charges paid, such as activation fees and termination fees. Prices and the specifics of the plans are subject to change.

**Table V.C.1
Monthly Prepaid Prices for Major Service Providers**

Provider	GB per line	1 line	2 lines	4 lines
Cricket (AT&T)	2.5	\$40	\$70	\$130
Boost (Sprint)	2	\$35	\$70	\$140
Metro (T-Mobile)	2	\$40	\$75	\$145
Straight Talk	5	\$45	\$90	\$180

Note: The above prices were taken from service providers' websites on Oct. 21, 2015. Prices include any per line charges indicated by the service provider. Prices and the specifics of the plans are subject to change.

VI. NON-PRICE RIVALRY

105. Mobile wireless service providers also compete for customers on dimensions other than price, including investment, capacity, network coverage and technology, service quality, and advertising and marketing. Service providers take these actions in an attempt to differentiate themselves from competitors, as well as to adopt certain initiatives of their competitors that have been successful in attracting customers. Such non-price rivalry can influence a customer's choice of a service provider and impose significant competitive constraints, especially in high technology industries that experience rapid innovation.³⁰² This section presents data in four broad categories reflecting various elements of non-price rivalry among mobile wireless service providers: investment; network coverage and technology upgrades; quality of service; and differentiation in handsets/devices and advertising/marketing.

A. Investment

106. Service providers can expand their network coverage and capacity through increased investment in, and expansion of, their existing assets and infrastructure.³⁰³ Providers may make such strategic capital expenditure ("CAPEX") decisions to differentiate their service offerings from those of their rivals by becoming the first to deploy a particular upgrade or new network technology. Over the past five years, wireless providers in the U.S. have made capital investments of approximately \$146 billion.³⁰⁴

107. As shown in Chart VI.A.1, wireless providers spent an incremental \$32.1 billion in 2014, which is a decline of approximately 3 percent from the \$33.1 billion invested in 2013. Based on UBS data, AT&T, Verizon Wireless, Sprint, and T-Mobile spent a combined \$13.9 billion in the first half of 2015 and \$31.1 billion in 2014, accounting for close to 100 percent of total industry capital investment as tracked by UBS in these time periods. As seen in Chart VI.A.1, AT&T and Verizon Wireless consistently made more capital investments in absolute CAPEX dollars in each quarter than did either Sprint or T-Mobile. However, if calculated as a percentage of service revenues, as of the second quarter of 2015, for example, both Sprint and T-Mobile invested approximately 19 percent of their total service revenues, as compared to approximately 14 percent for AT&T, and approximately 18 percent for Verizon Wireless.³⁰⁵ In addition, one should not place too much emphasis on absolute capital expenditures at any given point in time, as that will not provide the full picture of a service provider's investment strategy given the cyclical nature of such investments.³⁰⁶

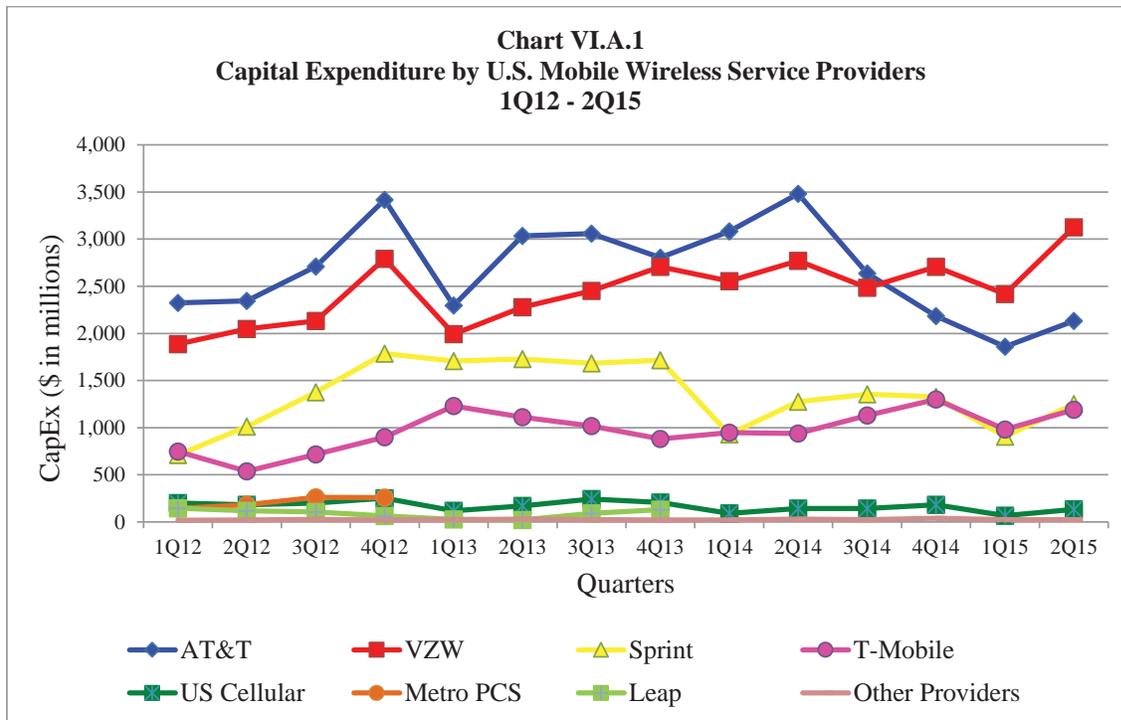
³⁰² See *Seventeenth Report*, 29 FCC Rcd at 15393 ¶ 168.

³⁰³ Importantly, service providers also expand into new geographic areas and/or upgrade networks in existing markets after adding to their spectrum portfolios through participation in spectrum auctions and secondary market transactions, as discussed above.

³⁰⁴ See CTIA Year-End 2014 Wireless Indices Report, Table 35, at p. 98. CTIA's figure includes incremental investment in currently operational systems, including expenditures for building operating systems, land and capital leases, and all tangible non-system capital investment, but does not include the cost of spectrum licenses purchased at auctions or other acquisition processes or greenfield builds.

³⁰⁵ See UBS US Wireless 411: Version 57, Figure 62. This compares to percentages of approximately 20% for AT&T, approximately 13% for Sprint, approximately 18% for T-Mobile, and approximately 14% for Verizon Wireless, as of the first quarter of 2014. See *id.*

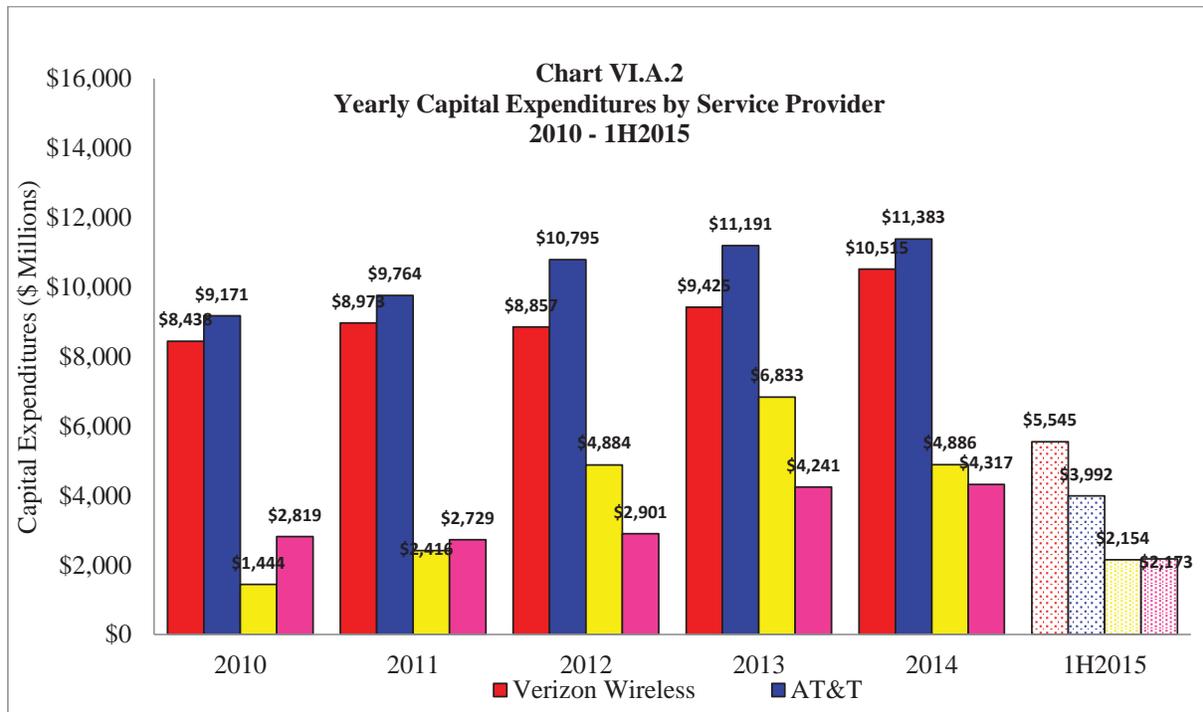
³⁰⁶ The *Sixteenth Report* noted that CAPEX in system/network assets may be cyclical or "lumpy" because technological change in the mobile wireless service industry is commercially implemented in successive generations of technologies. Consequently, CAPEX may vary between periods and fluctuations in measures of CAPEX are consistent with the cyclical nature of technological adoption in the mobile wireless service industry. See *Sixteenth Report*, 28 FCC Rcd at 3842 ¶ 215.



Source: UBS US Wireless 411: Version 55, Figure 54. UBS US Wireless 411: Version 57, Figure 60. T-Mobile and MetroPCS merged in 2013; AT&T acquired Leap in 2014.

108. Looking beyond the quarterly data in Chart VI.A.1, we see the variation in capital expenditures by the four nationwide service providers during the last five and a half years. Chart VI.A.2 below presents annual capital expenditures for the four nationwide service providers from 2010 through the first half of 2015. From 2010 through the end of 2014, AT&T and Verizon Wireless increased their nominal investment (with the exception of a dip in investment in 2012 for Verizon Wireless). Sprint increased its capital investment from 2010 to 2013, but decreased its capital investment in 2014, while T-Mobile's capital expenditures decreased between 2010 and 2011, and then increased, with a sharp spike from 2012 to 2013. Variations in CAPEX may vary across service providers for several reasons. First, service providers follow different technological migration paths, which may be on different timeframes. Recently, the industry has followed multiple technological migration paths for LTE upgrades, with each service provider implementing its own sequence of upgrades. Second, service providers often base their investment decisions on an assessment of how network deployments and upgrades may affect future earnings. Third, the timing of network investments often has a strategic component vis-à-vis rivals, as noted above. Finally, access to capital may be more constrained for some service providers, and this may require reallocation of their investment.³⁰⁷

³⁰⁷ According to NTCA – The Rural Broadband Association (“NTCA”), which consists exclusively of small, rural service providers, 62% of the rural providers who were surveyed described the process of obtaining financing for their wireless projects as “somewhat difficult” or “very difficult,” while another 5% found it “virtually impossible.” NTCA 2014 Wireless Survey Report, at pp. 3, 10 (Dec. 2014), available at <https://www.ntca.org/images/stories/Documents/Advocacy/SurveyReports/2014ntcawirelessurvey.pdf>.



Source: UBS US Wireless 411: Version 55, Figure 54. UBS US Wireless 411: Version 57, Figure 60.

B. Network Coverage and Technology Upgrades

109. One critical way in which mobile wireless service providers differentiate themselves is through the coverage and speed of their mobile broadband networks. During 2014 and early 2015, as discussed in more detail below, several service providers continued to upgrade and expand their networks with technologies that enable faster data transfer speeds, while other service providers announced plans to make additional upgrades in the near future. We consider in this section current network coverage by service provider, technology and roaming by provider, and future network deployment plans by service provider.

1. Current Coverage by Service Provider

110. This section of the *Report* presents mobile wireless coverage and LTE broadband coverage. Similar to the analysis of nationwide mobile coverage in section III, our analysis is based on U.S. census blocks overlaid on coverage maps that are provided to the Commission through a contract with Mosaik Solutions. We note that these coverage estimates represent deployment of mobile networks and do not indicate the extent to which service providers actually offer service to any or all residents in the covered areas. While recognizing that this analysis likely results in an overstatement of the coverage experienced by consumers because of limitations in Mosaik data and the coverage calculation methodology,³⁰⁸ we find that this analysis is useful because it provides a general baseline that can be compared over time across network technologies and service providers.³⁰⁹ In addition to the Mosaik data, this *Report* introduces our initial summary analysis of nationwide mobile coverage based on Form 477 data provided by the wireless service providers themselves. These data will be analyzed using the same

³⁰⁸ The centroid methodology considers a census block as covered if the centroid falls within the boundaries of the census block. By definition, this implies that for regular shaped blocks, at least 50% of the area is covered. This methodology may potentially overstate actual coverage, especially for larger rural blocks.

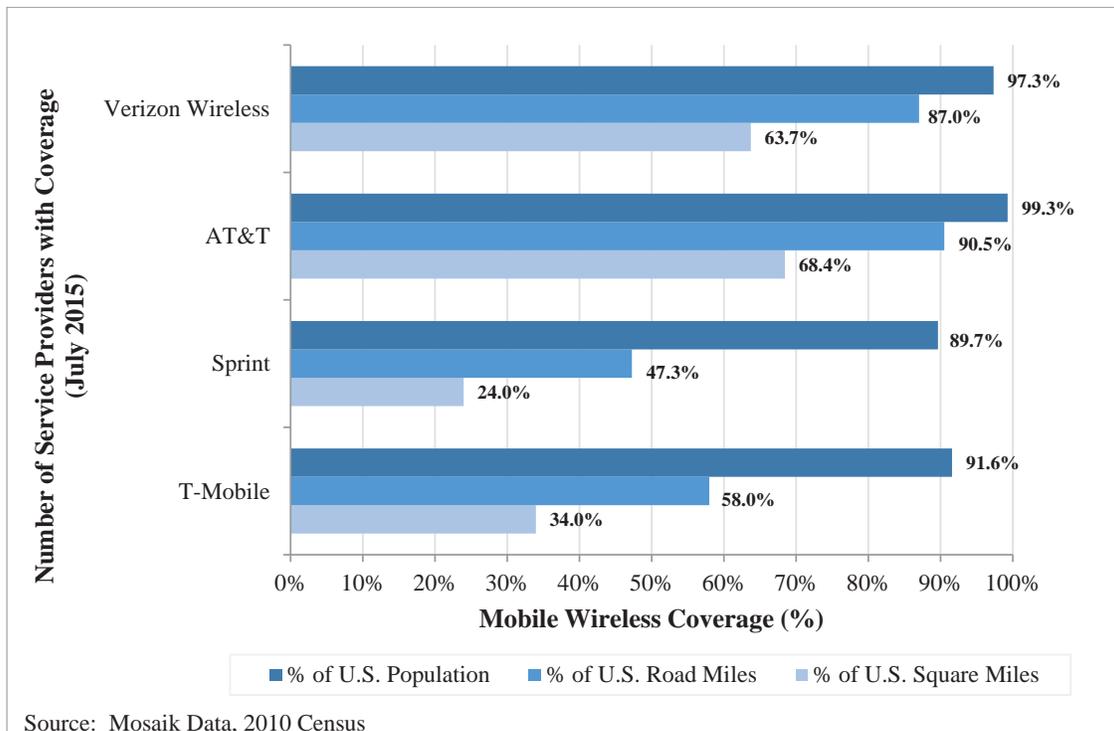
³⁰⁹ See section III.A. *supra*.

methods described above for the Mosaik data. We note that moving forward, and as also indicated in section III above, we anticipate that the Form 477 data will be our primary source for the analysis of coverage in the mobile wireless marketplace.

a. Mobile Wireless Network Coverage by Service Provider

111. Subject to the data limitations just noted, and as set out in more detail in section III. above, mobile wireless coverage by service provider, estimated using Mosaik data, is presented in Chart VI.B.1.³¹⁰ Each of the four nationwide service providers covered census blocks containing at least approximately 90 percent of the population with their respective mobile wireless networks as of July 2015. In terms of road miles, Chart VI.B.1 shows that Verizon Wireless covered around 87 percent, AT&T covered around 90.5 percent, Sprint covered around 47 percent, and T-Mobile covered around 58 percent as of that date. Verizon Wireless and AT&T each covered over 60 percent of the U.S. land area with their respective mobile wireless networks, while T-Mobile and Sprint each covered less than 35 percent of the U.S. land area. Chart VI.B.2 presents the results from the same analysis using Form 477 data. Both sources indicate, in general, that at least 90 percent of the population is covered by each of the nationwide service providers, but network coverage by land area is much more limited.

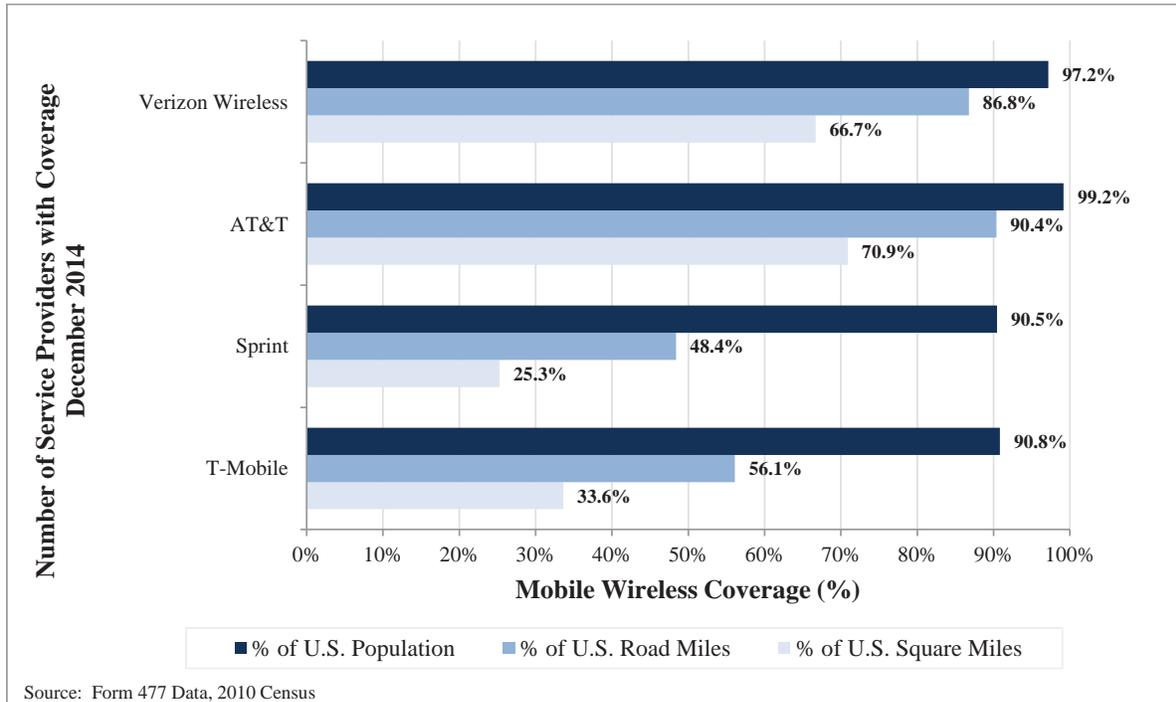
Chart VI.B.1
Estimated Mobile Wireless Coverage in the U.S. by Service Provider, Mosaik, July 2015



Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

³¹⁰ See Appendix Tables VI.B.i and VI.B.ii for more detailed data on estimated mobile wireless voice coverage and mobile 3G or better coverage by service provider.

Chart VI.B.2
Estimated Mobile Wireless Coverage in the U.S. by Service Provider, Form 477, December 2014



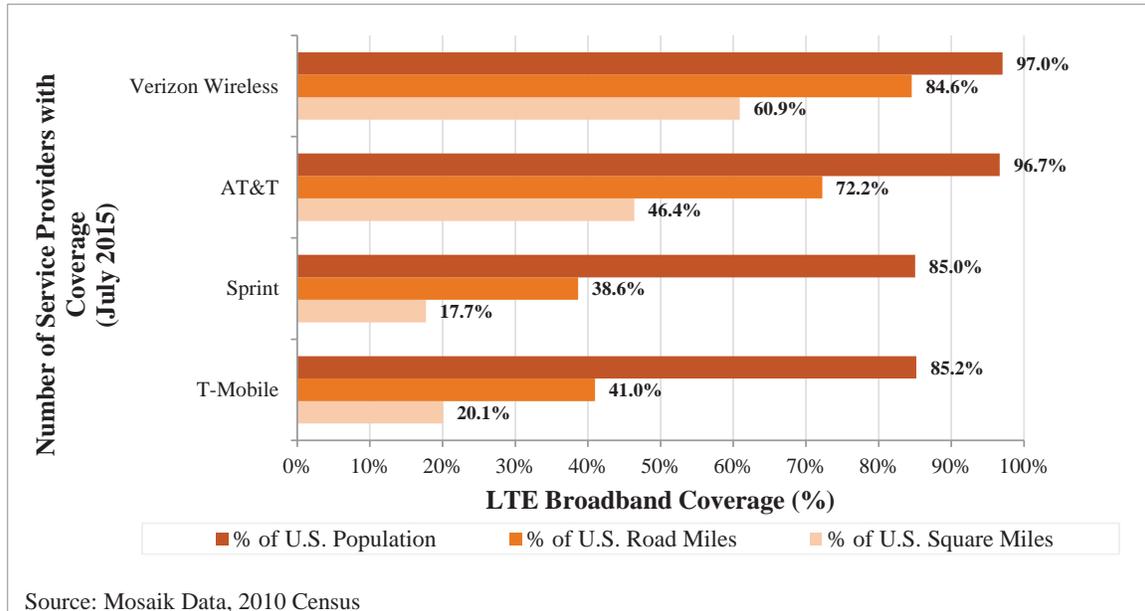
Note: The coverage calculation methodology has certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

b. LTE Broadband Coverage by Service Provider

112. LTE broadband coverage by service provider, estimated using Mosaik data, is presented in Chart VI.B.3.³¹¹ Verizon Wireless and AT&T each covered census blocks containing more than 96 percent of the population with LTE as of July 2015, while Sprint and T-Mobile each covered approximately 85 percent. Verizon Wireless covered approximately 85 percent of road miles and 61 percent of the land area, while AT&T covered approximately 72 percent of road miles and 46 percent of the land area. Sprint and T-Mobile each covered approximately 40 percent of U.S. road miles and no more than approximately 20 percent of the U.S. land area with LTE. Chart VI.B.4 presents the results from the same analysis using Form 477 data as of December 31, 2014. According to both Mosaik and Form 477 data, over 80 percent of the population is covered by each of the nationwide service providers, but network coverage by land area is much more limited.

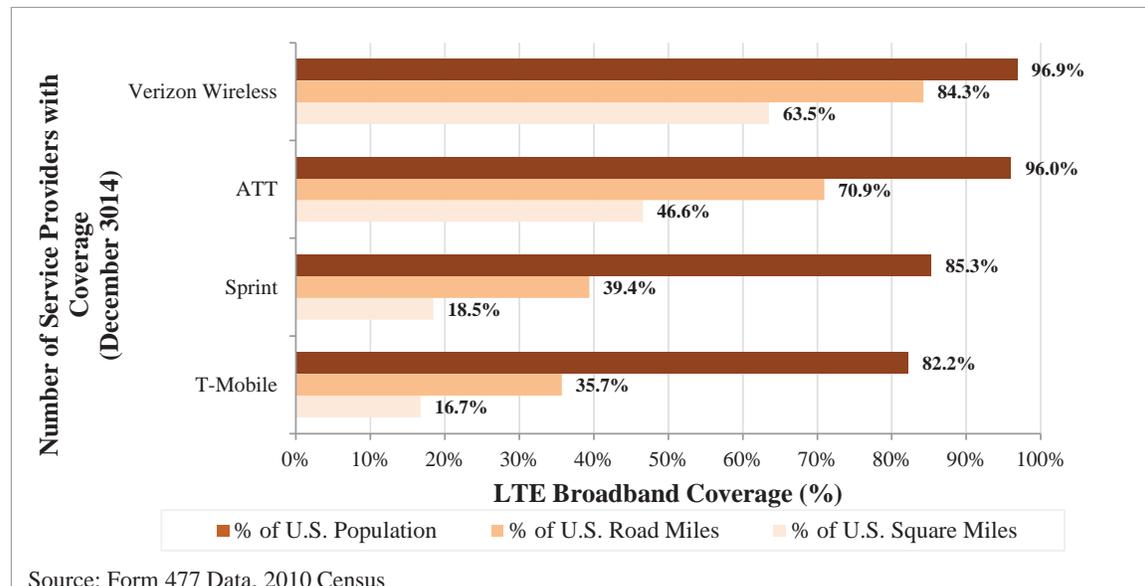
³¹¹ See Appendix Table VI.B.iii.

Chart VI.B.3
Estimated Mobile LTE Broadband Coverage in the U.S. by Service Provider, Mosaik, July 2015



Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

Chart VI.B.4
Estimated Mobile LTE Broadband Coverage in the U.S. by Service Provider, Form 477, December 2014



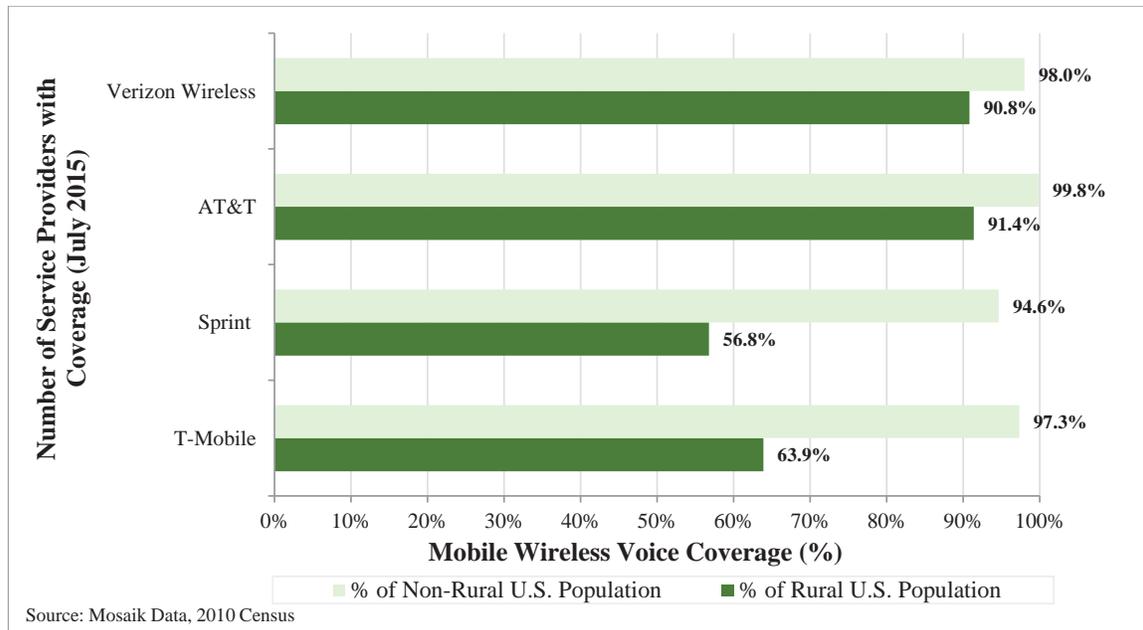
Note: The coverage calculation methodology has certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

c. **Urban/Rural Comparisons**

(i) **Mobile Wireless Network Coverage**

113. A comparison of rural and non-rural coverage by service provider, estimated using Mosaik data, is presented in Chart VI.B.5.³¹² Each of the four nationwide service providers covered census blocks containing more than 94 percent of the non-rural population with their mobile wireless voice networks, as of July 2015.³¹³ In terms of the rural population, Verizon Wireless and AT&T covered census blocks containing approximately 91 percent, respectively, while Sprint and T-Mobile covered census blocks containing approximately 57 and 64 percent, respectively. Each of the four nationwide service providers covered a significantly higher percentage of non-rural than rural land area and road miles. The results based on the Form 477 data are similar.

Chart VI.B.5
Estimated Mobile Wireless Voice Coverage in Non-Rural and Rural Areas by Provider; July 2015



Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

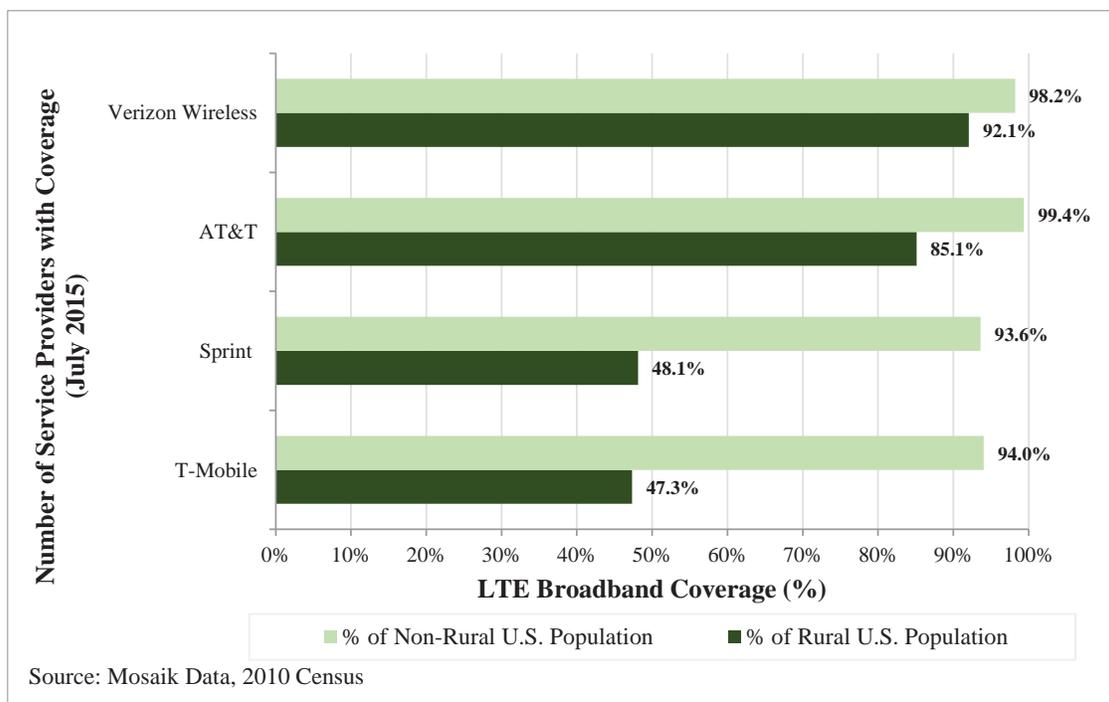
³¹² As noted above, while the Communications Act does not include a statutory definition of what constitutes a rural area, since its 2004 *Report and Order* concerning the deployment of wireless services in less populated areas, the Commission has used a “baseline” definition of rural as a county with a population density of less than 100 people per square mile. See *Facilitating the Provision of Spectrum-Based Services to Rural Areas and Promoting Opportunities for Rural Telephone Companies To Provide Spectrum-Based Services*, WT Docket 02-381, *Report and Order*, 19 FCC Rcd 19078, 19087-88 (2004).

³¹³ See Appendix Tables VI.B.iv through VI.B.vii for more detailed data on estimated mobile wireless voice coverage and mobile 3G or better coverage by provider in rural and non-rural areas, respectively.

(ii) LTE Broadband Coverage

114. As seen in Chart VI.B.6, each of the four nationwide providers covered census blocks containing at least 95 percent of the non-rural population with their LTE networks, as of July 2015.³¹⁴ In terms of the rural population, Verizon Wireless and AT&T covered census blocks containing approximately 92 percent and 85 percent, respectively, while Sprint and T-Mobile covered census blocks containing approximately 48 and 47 percent of the rural population, respectively. Each of the four nationwide providers covered a higher percentage of non-rural than rural land area and road miles. There are still significant amounts of the rural population in the United States without LTE broadband coverage, as compared to the urban population. The results based on the Form 477 data are similar.

Chart VI.B.6
Estimated Mobile LTE Coverage in Non-Rural and Rural Areas by Service Provider, July 2015



Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

2. Service Provider Network Deployments

115. Network investment remains a centerpiece of service providers' efforts to improve their customers' mobile wireless service experience. Over the past several years, service providers have upgraded and expanded their networks with technologies that enable faster data transfer speeds, and all of the major mobile wireless providers have now deployed LTE to a significant extent. The following section includes a discussion of the deployment strategies and mobile network upgrades for each of the top five service providers.

³¹⁴ See Appendix Tables VII.B.viii and VII.B.ix for more detailed data on estimated LTE broadband coverage by service provider in rural areas and non-rural areas, respectively.

Table VI.B.1
LTE Deployment Reported by Selected Mobile Wireless Service Providers, October 2015

Service Provider	LTE Deployment as of October 2015
Verizon Wireless	Verizon Wireless covers 308 million people in over 500 US markets with LTE, and over 400 of the LTE markets are served by XLTE. ³¹⁵ Voice and Non-4G LTE data services are available outside their 4G LTE coverage area. ³¹⁶
AT&T	AT&T covers over 320 million people with its voice and data service, with over 308 million people covered by its 4G LTE network. ³¹⁷
Sprint	Sprint's 4G LTE network reaches more than 280 million people. ³¹⁸ Sprint Spark (enhanced LTE) is available in limited markets, and on devices with enabled tri-band LTE capability. ³¹⁹
T-Mobile	T-Mobile's 4G LTE network will reach over 300 million people by year-end 2015. ³²⁰ It has launched its Extended Range LTE, which it claims reaches 2 times farther and works 4 times better in buildings compared to traditional LTE. ³²¹

116. *Verizon Wireless:* Verizon Wireless's LTE network covered approximately 308 million people as of October 2015, as seen in Table VI.B.1 above. Verizon Wireless continued to augment its Upper 700 MHz C Block LTE network with AWS-1 spectrum, and has now launched XLTE in more than 400 markets.³²² The company has also begun to re-farm PCS spectrum to use for LTE.³²³ This type of carrier aggregation, along with

³¹⁵ See "The Verizon Wireless 4G LTE Network," available at <http://www.verizonwireless.com/news/LTE/Overview.html>; "Our Technology: Network," available at <https://www.verizonwireless.com/aboutus/technology/network.html>.

³¹⁶ See "4G LTE," available at <http://www.verizonwireless.com/landingpages/4g-lte/>.

³¹⁷ See "About Our Network," available at <http://about.att.com/news/wireless-network.html>; "About AT&T," available at <https://www.att.com/network/en/index.html>; "1Q 2015 AT&T," available at http://www.att.com/Common/about_us/pdf/att_btn.pdf.

³¹⁸ See "Sprint Network Information Center," available at <http://newsroom.sprint.com/presskits/sprint-network-vision-information-center.htm>.

³¹⁹ As noted above, the Sprint WiMax network was shut down in November 2015. See "Sprint to Shutter WiMAX Network Around Nov. 6, 2015," available at <http://www.fiercewireless.com/story/sprint-shutter-wimax-network-around-nov-6-2015/2014-10-07>.

³²⁰ See "Coverage," available at <http://www.t-mobile.com/coverage.html>. See also "T-Mobile Doubles 4G Coverage to Take on AT&T and Verizon," available at <http://www.cnet.com/news/t-mobile-doubles-4g-coverage-to-take-on-at-t-and-verizon/>; "We've Doubled Our 4G LTE Coverage in the Last Year," available at <https://explore.t-mobile.com/4G-lte-network>.

³²¹ See "Coverage," available at <http://www.t-mobile.com/coverage.html>; "T-Mobile Adds 2.3 Million New Customers in Q3 2015," available at <http://www.tmonews.com/2015/10/t-mobile-adds-2-3-million-new-customers-in-q3-2015/>; "We've Doubled Our 4G LTE Coverage in the Last Year," available <https://explore.t-mobile.com/4G-lte-network>.

³²² See "Customers Celebrate One Year of XLTE," available at <http://www.verizonwireless.com/news/article/2015/05/customers-celebrate-one-year-of-xlte.html>.

³²³ See "Verizon to Launch Carrier Aggregation, More LTE Advanced Features in 2015," available at <http://www.fiercewireless.com/story/verizon-launch-carrier-aggregation-more-lte-advanced-features-2015/2014-12-04>. "In addition to New York City, Verizon has started refarming PCS spectrum for LTE in Cleveland and around 10 other markets."

a heterogeneous network of macrocells and small cells, will be combined with other network improvements to implement LTE advanced.³²⁴ In addition, Verizon Wireless has started to roll out VoLTE service nationwide.³²⁵ In August 2015, Verizon Wireless announced that it was aggressively working on VoLTE transition and already had 4 million customers using the service.³²⁶ Moving forward, Verizon Wireless plans to deploy LTE-Unlicensed technology in 2016,³²⁷ and in order to promote this technology, Verizon Wireless formed the LTE-U forum in 2014, in cooperation with Alcatel-Lucent, Ericsson, and Qualcomm Technologies, Inc., and Samsung.³²⁸

117. *AT&T*: AT&T's LTE network covered over 308 million people as of October 2015, as seen in Table VI.B.1 above. AT&T continues to focus on DAS and small cells,³²⁹ and to deploy commercial mobile broadband services using carrier aggregation technology – which is part of the LTE Advanced specifications – to combine transmissions across either AWS-1 or PCS spectrum with Lower 700 MHz B and C Block spectrum.³³⁰ In addition, AT&T began deploying LTE on its 2.3 GHz WCS spectrum in the summer of 2015.³³¹ AT&T continues to launch HD Voice and Voice over LTE (“VoLTE”) in select markets, and has stated that VoLTE is in fact necessary to support voice roaming for CDMA service providers.³³² Further, AT&T will trial LTE-Unlicensed technology in late 2015 or early 2016, but will wait to deploy it until the Wi-Fi sharing rules are more defined.³³³

118. *Sprint*: Sprint's 4G LTE service was available to approximately 280 million Americans in October 2015, as shown in Table VI.B.1, above. In its comments, Sprint notes the importance of its Network Vision project, which is an initiative to consolidate Sprint's networks and technologies into a single nationwide

See also “Oppenheimer 18th Annual Technology, Internet and Communications Conference,” at 3, available at <http://www.verizon.com/about/investors/oppenheimer-18th-annual-technology-internet-communications-conference>, Aug. 11, 2015.

³²⁴ *See* “The Verizon Wireless 4G LTE Network,” available at <http://www.verizonwireless.com/news/LTE/Overview.html>.

³²⁵ *See* “Introducing HD Voice and Video Calling,” available at <http://www.verizonwireless.com/wcms/consumer/advanced-calling.html>; <http://www.verizonwireless.com/support/advanced-calling-faqs/>.

³²⁶ *See* “Verizon Aggressively Working on VoLTE Transition,” available at <http://www.lightreading.com/mobile/volte-rich-communications/verizon-aggressively-working-on-volte-transition-/d/d-id/717538>.

³²⁷ *See* “Verizon's LTE-U Forum Completes LTE Unlicensed Tests on Way Toward Carrier's 2016 Deployment in 5 GHz, 3.5 GHz,” available at <http://www.fiercewireless.com/tech/story/verizons-lte-u-forum-completes-lte-unlicensed-tests-way-toward-carriers-201/2015-03-03>.

³²⁸ *See* LTE-U Forum website, available at <http://www.lteforum.org/>.

³²⁹ *See* William Ho, “As T-Mobile and Sprint Catch Up to Verizon and AT&T on LTE Coverage, Capacity Comes into Focus,” available at <http://www.fiercewireless.com/story/hos-perspective-t-mobile-and-sprint-catch-verizon-and-att-lte-coverage-capacity/2015-05-19>.

³³⁰ *See* “AT&T's Keathley Shares a 5G Vision that Includes LTE-A, Wi-Fi, SON and More,” available at <http://www.fiercewireless.com/tech/story/atts-keathley-shares-5g-vision-includes-lte-wi-fi-son-and-more/2015-01-21>; William Ho, “As T-Mobile and Sprint Catch Up to Verizon and AT&T on LTE Coverage, Capacity Comes into Focus,” available at <http://www.fiercewireless.com/story/hos-perspective-t-mobile-and-sprint-catch-verizon-and-att-lte-coverage-capacity/2015-05-19>.

³³¹ *See* “AT&T Begins Deploying 2.3 GHz WCS Spectrum for LTE,” available at <http://www.fiercewireless.com/story/att-begins-deploying-23-ghz-wcs-spectrum-lte/2015-09-09>.

³³² *See* FCC website, AT&T April 3, 2015 *Ex Parte*, Promoting Interoperability in the 700 MHz Commercial Spectrum, WT Docket No. 12-69, available at <http://apps.fcc.gov/ecfs/document/view?id=60001042267&cmpid=horizontalcontent>; AT&T website, “AT&T HD Voice,” available at <http://www.att.com/shop/wireless/features/hd-voice.html>.

³³³ *See* “AT&T to Trial LTE-U by Early 2016,” available at <http://www.fiercewireless.com/tech/story/att-trial-lte-u-early-2016/2015-09-09>.

3G and 4G network.³³⁴ In addition, Sprint has been promoting Wi-Fi calling on its network.³³⁵ In June 2015, Sprint indicated as part of its network densification plan, the company also planned on deploying VoLTE technology.³³⁶

119. *T-Mobile*: T-Mobile's LTE coverage has just now reached over 300 million people.³³⁷ T-Mobile has also continued to launch 4G LTE in a 15×15 megahertz deployment in certain markets.³³⁸ In addition, T-Mobile now offers Wi-Fi calling.³³⁹ T-Mobile has launched VoLTE across its 4G LTE network.³⁴⁰ T-Mobile plans to launch LTE-Unlicensed in the coming year.³⁴¹

120. *U.S. Cellular*: In March of 2015, U.S. Cellular announced that it plans to add over 600 4G LTE cell sites in 2015, providing access to 4G LTE to 98 percent of its approximately 4.8 million customers.³⁴² Currently, nearly 90 percent of customers have access to 4G LTE in U.S. Cellular network coverage areas.³⁴³ In addition, U.S. Cellular is testing VoLTE but has not announced a timeline for its commercial launch.³⁴⁴

3. FCC Initiatives Related to Coverage, Technology, and Roaming

121. When competing mobile wireless service providers deploy compatible network technologies, greater economies of scale in the production of both end-user devices and network infrastructure equipment can result, lowering the unit cost of handsets, chipsets, and other network equipment. This, in turn, may promote more rapid adoption of mobile wireless services, a greater variety of handsets, and more price competition. On October 25, 2013, the Commission adopted the *700 MHz Interoperability Report and Order and Order of*

³³⁴ See Sprint Comments at 5.

³³⁵ See Sprint Comments at 5-6. See also "FAQs About Wi-Fi Calling," available at <http://support.sprint.com/support/article/FAQs-about-Wi-Fi-Calling/173e331f-8423-453e-93cb-4688f6a91f67#!>; "Sprint iPhone Customers Take Full Advantage of Wi-Fi Calling with Apple's Latest Software Update," available at <http://investors.sprint.com/news--investor-events/newsroom/press-release-details/2015/Sprint-iPhone-Customers-Take-Full-Advantage-of-Wi-Fi-Calling-with-Apples-Latest-Software-Update/default.aspx>.

³³⁶ See "Sprint Gets OK From SoftBank To Move Ahead On Network Densification Plan," available at <http://www.fiercewireless.com/story/sprint-gets-ok-softbank-move-ahead-network-densification-plan/2015-06-03>.

³³⁷ See "T-Mobile US Inc. at Morgan Stanley European Technology, Media and Telecom Conference," Thomason Reuters, at 6 (Nov. 12, 2015) ("We just crested over 300 million covered people in the U.S. with our LTE network. We are just north of 302 million . . . A third of our traffic now is on VoLTE, so voiceover LTE." Also, at 9 "We currently sell in about 230 million POPs so that's our effective selling footprint . . . our organic network covers over 300 now.")

³³⁸ See "Why 20×20 4G LTE is Awesome," available at <https://support.t-mobile.com/community/coverage/blog>.

³³⁹ See "Now Every Wi-Fi Connection Works Like a T-Mobile Tower," available at <http://www.t-mobile.com/offer/wifi-calling-wifi-extenders.html>.

³⁴⁰ See "Firing on All Cylinders," available at <http://newsroom.t-mobile.com/issues-insights-blog/firing-on-all-cylinders-earnings-jdp.htm>.

³⁴¹ See "Verizon, T-Mobile Push Unlicensed LTE Forward – But Concerns Remain," available at <http://www.fiercewireless.com/story/verizon-t-mobile-push-unlicensed-lte-forward-concerns-remain/2015-03-03>; "T-Mobile Will Launch LTE in the Wi-Fi Airwaves in 2016," available at <https://gigaom.com/2015/03/01/t-mobile-will-launch-lte-in-the-wi-fi-airwaves-in-2016/>.

³⁴² See "U.S. Cellular Announces New Markets To Receive 4G LTE Service in 2015," available at <http://www.uscellular.com/about/press-room/2015/USCELLULAR-ANNOUNCES-NEW-MARKETS-TO-RECEIVE-4G-LTE-SERVICE-IN-2015.html>.

³⁴³ See "Press Room FAQs," available at <http://www.uscellular.com/uscellular/support/faq/faqDetails.jsp?topic=press-room.html>.

³⁴⁴ See "U.S. Cellular is Testing VoLTE in 3 Markets But Has No Timeline For Commercial Launch," available at <http://www.fiercewireless.com/story/us-cellular-testing-volte-3-markets-has-no-timeline-commercial-launch/2015-11-10>.

Proposed Modification to implement a voluntary industry solution that is designed to establish interoperable LTE devices in the Lower 700 MHz band.³⁴⁵ Since the Order was adopted, service providers have progressively deployed the Lower 700 MHz A Block spectrum and are continuing to offer more Band Class 12 devices, facilitating the creation of a robust Band Class 12 devices ecosystem.³⁴⁶ In addition, the Commission has also adopted specific interoperability requirements for the AWS-3 band, as well as for the 600 MHz Band.³⁴⁷

122. In order to encourage mobile network deployment into unserved or underserved areas, the Commission adopted rules creating the Mobility Fund in November 2011.³⁴⁸ The Mobility Fund uses Universal Service Fund reserves to support the deployment of current- or future-generation mobile network technologies that provide mobile voice and Internet services.³⁴⁹ For Mobility Fund Phase I, the Commission is providing up to \$300 million in one-time support payments, plus up to \$50 million dedicated to Tribal lands, which were awarded through reverse auctions.³⁵⁰ The Commission is currently exploring whether to retarget Mobility Fund Phase II ongoing support to ensure the continued deployment and preservation of LTE mobile broadband service and preservation of mobile voice and broadband service in areas that otherwise would not have such service through marketplace forces.³⁵¹

123. No facilities-based service provider – including the four nationwide service providers – has built out its entire licensed service area, and consequently all employ roaming to some extent to fill gaps in their

³⁴⁵ See Promoting Interoperability in the 700 MHz Commercial Spectrum, Requests for Waiver and Extension of Lower 700 MHz Band Interim Construction Benchmark Deadlines, WT Docket Nos. 12-69, 12-332, *Report and Order and Order of Proposed Modification*, 28 FCC Rcd 15122 (2013) (“700 MHz Interoperability Report and Order and Order of Proposed Modification”).

³⁴⁶ Band Class 12 devices support the Lower 700 MHz spectrum A, B, and C blocks whereas Band Class 17 devices only support the Lower 700 MHz spectrum B and C blocks. T-Mobile has continued to deploy LTE in “141 market areas”, through the second quarter of 2015, using its Lower 700 MHz A Block spectrum, while USCC has also deployed LTE using its Lower 700 MHz spectrum in “over 100 markets.” In addition, AT&T states that it has “fully deployed” the Multiple Frequency Band Indicator (“MFBI”) feature to support both Band Class 12 and Band Class 17 devices throughout its network, and will start transitioning to Band Class 12 devices “late in 2015 and/or early 2016.” AT&T also maintains that it is continuing discussions with several Band Class 12 service providers to offer LTE roaming service on its network. See AT&T’s Interoperability Status Report, Promoting Interoperability in the 700 MHz Commercial Spectrum, WT Docket No. 12-69, September 14, 2015, Attachment 1.

³⁴⁷ See *AWS-3 Report and Order*, 29 FCC Rcd at 4694-4700 ¶¶ 225-31; *Incentive Auctions Report and Order*, 29 FCC Rcd at 6866-69 ¶¶ 731-37.

³⁴⁸ See Connect America Fund; A National Broadband Plan for Our Future; Establishing Just and Reasonable Rates for Local Exchange Carriers; High-Cost Universal Service Support, Developing an Unified Intercarrier Compensation Regime; Federal-State Joint Board on Universal Service; Lifeline and Link-Up; Universal Service Reform – Mobility Fund, WC Docket No. 10-90, *et al.*, *Report and Order and Further Notice of Proposed Rulemaking*, 26 FCC Rcd 17663 (2011).

³⁴⁹ See *id.*

³⁵⁰ See Mobility Fund Phase I Auction Closes; Winning Bidders Announced for Auction 901, AU Docket No. 12-25, *Public Notice*, 27 FCC Rcd 12031 (WTB 2012) (“*Auction 901 Closing Public Notice*”). Mobility Fund Phase I disbursements were authorized beginning April 2013 and are anticipated to continue through 2016. See Mobility Fund Phase I Support Authorized for Seven Winning Bidders; Defaults on Two Auction 901 Winning Bids Determined, AU Docket No. 12-25, *Public Notice*, 28 FCC Rcd 5599 (WTB, WCB 2013); Tribal Mobility Fund Phase I Auction Closes Winning Bidders Announced for Auction 902, *Public Notice*, 29 FCC Rcd 1974 (WTB 2014).

³⁵¹ See Connect America Fund; Universal Service Reform – Mobility Fund; ETC Annual Reports and Certifications; Establishing Just and Reasonable Rates for Local Exchange Carriers; Developing an Unified Intercarrier Compensation Regime, WC Docket No. 10-90, *et al.*, *Report and Order, Declaratory Ruling, Order, Memorandum and Order, Seventh Order on Reconsideration, and Further Notice of Proposed Rulemaking*, 29 FCC Rcd 7051 (2014).

coverage.³⁵² Many non-nationwide service providers are able to offer their customers coverage that is national in scope through roaming agreements with other mobile wireless service providers, and accordingly, roaming remains particularly important for small and regional service providers.³⁵³ In recent years, the Commission has taken actions to facilitate roaming arrangements: In 2007, for instance, it clarified that automatic voice roaming is a common carrier obligation for CMRS providers.³⁵⁴ In April 2010, the Commission adopted the *Roaming Order on Reconsideration*, which eliminated the home roaming exclusion and established the same general obligation to provide automatic voice roaming, regardless of whether the provider requesting roaming holds spectrum in an area.³⁵⁵ In April 2011, the Commission issued the *Data Roaming Order*,³⁵⁶ which requires facilities-based service providers of commercial mobile data services, whether or not such providers also offer CMRS, to offer data roaming arrangements to other mobile data service providers on commercially reasonable terms and conditions, subject to certain limitations.³⁵⁷

124. On May 27, 2014, T-Mobile USA, Inc. filed a petition for expedited declaratory ruling in which it asked the Commission to provide guidance for determining whether the terms of a data roaming agreement meet the “commercially reasonable” standard adopted in the *Data Roaming Order*.³⁵⁸ The petition proposed four benchmarks for assessing commercial reasonableness: (i) retail rates; (ii) international roaming rates; (iii) MVNO/resale rates; and (iv) other domestic roaming rates. The petition also sought guidance on the extent and nature of service providers’ build-out as a factor in determining commercial reasonableness and the presumption of reasonableness for existing data roaming agreements. The Wireless Telecommunications Bureau released an order on December 18, 2014, granting the T-Mobile petition.³⁵⁹ The Order found that the data roaming rule was

³⁵² See *Seventeenth Report*, 29 FCC Rcd at 15399 ¶ 180.

³⁵³ See *id.*; see also CCA Comments at 18-19; NTCA Comments at 3-4 (arguing that regional and local service providers offer a small footprint and need to partner with other service providers through roaming agreement to offer their subscribers competitive expanded coverage).

By definition, MVNOs and resellers rely on using the networks of one or several facilities-based service providers to compete. Depending on the particular arrangement, customers of MVNOs and resellers may have limited or no access to networks other than that of the underlying wholesale provider. For example, the coverage experienced by customers of TracFone’s Straight Talk varies depending on the underlying wholesale provider. A Straight Talk customer obtaining service on an underlying CDMA network, for instance, will not have access to voice and SMS service when outside the coverage of that network, but a Straight Talk customer whose service is provided on an underlying GSM network, by contrast, may have voice and SMS service when outside that network’s coverage area. See “About Straight Talk,” available at <http://www.straighttalk.com/wps/portal/home/h/about>; “Terms and Conditions: Straight Talk Wireless,” available at <http://www.straighttalk.com/wps/portal/home/h/legal/terms-and-conditions>.

³⁵⁴ See Reexamination of Roaming Obligations of Commercial Mobile Radio Service Providers, WT Docket No. 05-265, *Report and Order and Further Notice of Proposed Rulemaking*, 22 FCC Rcd 15817, 15828 ¶ 27 (2007) (“2007 Roaming Order and FNPRM”) (“[W]e recognize that automatic roaming benefits mobile telephony subscribers by promoting seamless CMRS service around the country, and reducing inconsistent coverage and service qualities.”)

³⁵⁵ See Reexamination of Roaming Obligations of Commercial Mobile Radio Service Providers and Other Providers of Mobile Data Services, WT Docket No. 05-265, *Order on Reconsideration and Second Further Notice of Proposed Rulemaking*, 25 FCC Rcd 4181, 4182 ¶ 2 (2010) (“*Roaming Order on Reconsideration*”).

³⁵⁶ See Reexamination of Roaming Obligations of Commercial Mobile Radio Service Providers and Other Providers of Mobile Data Services, WT Docket No. 05-265, *Second Report and Order*, 26 FCC Rcd 5411 (2011) (“*Data Roaming Order*”).

³⁵⁷ See *id.*, 26 FCC Rcd at 5418-28 ¶¶ 13-31.

³⁵⁸ See Wireless Telecommunications Bureau Seeks Comment on Petition for Expedited Declaratory Ruling by T-Mobile USA, Inc. Regarding Data Roaming Obligations, WT Docket No. 05-265, *Public Notice*, 29 FCC Rcd 6035 (WTB 2014).

³⁵⁹ See Reexamination of Roaming Obligations of Commercial Mobile Radio Service Providers and Other Providers of Mobile Data Services, WT Docket No. 05-265, *Declaratory Ruling*, 29 FCC Rcd 15483 (WTB 2014) (“*Data Roaming*

intended to permit consideration of the totality of the facts and therefore to permit a complaining party to adduce evidence as to whether proffered roaming rates are substantially in excess of retail rates, international rates, and MVNO/resale rates, as well as a comparison of proffered roaming rates to domestic roaming rates as charged by other service providers.³⁶⁰ This Order noted that the probative value of these other rates as reference points will depend on the facts and circumstances of any particular case, including all of the factors set forth in the *Data Roaming Order*. In addition, the Order provided guidance with respect to the presumption regarding existing agreements and consideration of the build-out factor in determining commercial reasonableness.³⁶¹ We note that since then, a number of confidential staff-level mediations have occurred, and certain complaints were filed and remain pending.

C. Quality of Service

125. Key characteristics for mobile wireless performance include network speeds, latency, and packet loss. The Commission has recognized the importance of accurate and timely data on these characteristics. This *Report* will primarily analyze speed data using the Ookla Net Index data, data from the FCC Speed Test App, RootMetrics data, and the CalSPEED drive-test data gathered by the California Public Utility Commission (“CPUC”), subject to the limitations described below.

126. Mobile broadband network service quality experienced by consumers may vary greatly with a number of real world factors such as the service provider’s received signal quality, cell traffic loading and network capacity in different locations, as well as the capability of consumers’ devices.³⁶² First, mobile connection quality will vary based on the location of the receiving device in reference to the transmitting device, which is often a cellular tower. If the receiving device (and the person using it) is behind a wall, blocked by terrain or otherwise has an impaired connection with the tower, service will be degraded or not available. Second, the performance of the broadband connection degrades over distance to the tower, even with a clear line of sight. Performance at the edge of a tower’s coverage is not equal to performance close to the tower. Third, cellular signals are shared by many users – the more simultaneous usage, the lower the potential performance of any one connection.³⁶³ It is also important to note that for all mobile technologies, speed and performance measurements are only valid when a wireless connection can be accessed. “Dead zones” and loss of signal reduce wireless effectiveness.³⁶⁴ Moreover, from the customer’s perspective, overall network performance is the product of more than network quality alone and often reflects differences in device capability as well.³⁶⁵ For data services, network quality as perceived by the customer may also be use-, case-, or application-dependent (*e.g.*, a consumer

Declaratory Ruling”). We note that AT&T and Verizon Wireless filed applications for review of the declaratory ruling, and those applications for review remain pending.

³⁶⁰ See *id.*, 29 FCC Rcd at 15486 ¶ 9.

³⁶¹ See *id.*, 29 FCC Rcd at 15491, 15492 ¶¶ 25, 28.

³⁶² For example, the received signal quality is dependent on the service provider’s deployed cell site density, low/high frequency radio wave propagation losses, user locations, indoor obstructions and outdoor foliage or clutter, weather, inter-cell interference conditions, and wireless network optimization parameters. The cell traffic loading or demand is dependent on the overall number of concurrent active mobile broadband users sharing the same cell, which in turn depends on user locations, the day of the week, and the time of the day. The capacity of a service provider’s wireless network is dependent on the deployed mobile wireless technology, sites and equipment, available bandwidth, and enhanced backhaul connections. See *Sixteenth Report*, 28 FCC Rcd at 3894 ¶ 293.

³⁶³ See The FCC Omnibus Broadband Initiative (“OBI”); Broadband Performance: OBI Technical Paper No. 4, at p. 19, available at https://apps.fcc.gov/edocs_public/attachmatch/DOC-300902A1.pdf.

³⁶⁴ See *id.* at pp. 19-20.

³⁶⁵ The capability of consumer devices (*e.g.*, smartphones, tablets, USB dongles, and laptops) could result in users experiencing different data speeds on the same mobile wireless broadband network. Even differing capabilities within each device category, such as smartphone processing power and memory, could result in better user experiences on 4G networks.

who solely uses e-mail may view the quality of the network differently than one who streams video regularly). Further, consumers may place more weight on one particular aspect of network quality than another – such as coverage or peak data speeds – when choosing their mobile wireless services.

127. In recognition of the effects of these different parameters on mobile network performance, various methodologies are used in evaluating mobile network speeds. The two most prevalent rely on crowdsourced data or structured sample data. Crowdsourced data are user-generated data produced by consumers who voluntarily download speed test applications on their mobile devices.³⁶⁶ Generally, crowdsourced data can bring the benefits of generating a large volume of data at a very low cost and of measuring actual consumer experience on a network in a wide variety of locations, indoor and outdoor. We note, however, that crowdsourced data are often not collected pursuant to statistical sampling techniques, and may require adjustments to construct a representative sample from the raw data. For instance, crowdsourced mobile data come from a self-selected group of users, and there often is little control regarding such parameters as when people implement the test, whether the test is performed indoors or outdoors, the geographic location of the tester, and the vintage of the consumer's device.³⁶⁷ These issues can be reduced by creating default settings that run the test at random times, and not only when the consumer initiates the test. Structured sample data, by contrast, are generated from tests that control for the location and time of the tests as well as for the devices. Structured sample data may be collected using stationary indoor or outdoor tests, or drive tests. However, these tests are more expensive to conduct, involve significant judgment about when and where the tests are run, often do not involve significant testing indoors or in many rural areas, and typically produce datasets that are not as rich as crowdsourced data – all of which are likely to have some effects on reported results.

128. Ookla is one of the most prominent providers of crowdsourced data.³⁶⁸ The Commission has also made available a mobile app that gathers such data. CalSPEED measures mobile network speeds in California based primarily on drive tests. RootMetrics publishes broadband performance metrics that is largely based on drive test data in 125 U.S. metropolitan areas and in 50 airports, but also incorporates results of some crowdsourced data.³⁶⁹ We discuss our analysis of all four speed metrics in the section below.³⁷⁰

³⁶⁶ These apps commonly collect data on the provider, location of device, download and upload speeds, latency, and packet loss, which are then transmitted to the company or entity that developed the app. In some cases, the apps automatically schedule these tests to run at certain times during the day, while in others, the user has to choose to run the tests.

³⁶⁷ By contrast, crowdsourced fixed broadband speed data, such as those collected by the Commission through SamKnows, can be gathered with more control. The SamKnows whiteboxes are able to measure actual fixed network speed and are not dependent on the vintage of the client hardware or software. In addition, the testers are chosen according to a valid sampling technique.

³⁶⁸ In the *Seventeenth Report*, PC Magazine's speed test results were also reported. However, in 2015, PC Magazine used Ookla data to compare download and upload speeds across service providers and so is no longer an independent source. See "How Fast Is Your Internet Connection – Really?" available at <http://www.pcmag.com/speedtest>.

³⁶⁹ See RootMetrics website, available at <http://www.rootmetrics.com/us>.

³⁷⁰ In addition to the four speed metrics discussed, speed measurements are also performed by other entities such as by OpenSignal and M-Lab. OpenSignal gathers crowdsourced mobile speed data through the use of their mobile app. This app is available free of charge to Android and iOS users, and it is designed to collect data about cell phone towers and cell phone signal strength. OpenSignal uses these data to generate a publicly available interactive map. See "OpenSignal for Android," available at <http://opensignal.com/android/>; "OpenSignal for iPhone," available at <http://opensignal.com/iphone/>. The data can also be downloaded using OpenSignal's free NetworkStats API. See OpenSignal Developer website, available at <http://developer.opensignal.com/>.

Another open source application for measuring network performance on mobile platforms is MobiPerf by M-Lab. See MobiPerf website, available at <https://sites.google.com/site/mobiperfdev/>. This application is available for Android phones only, and data collected via the application are used to generate a publicly available interactive map. See Open Mobile data

1. Ookla

129. Ookla gathers crowdsourced mobile speed data through the use of their Speedtest mobile app.³⁷¹ This app is available free of charge to smart phone users, and is designed to test the performance of mobile cellular connections. Once the app is downloaded, the user can periodically measure the speed of their wireless connection. These data are then used to produce Ookla's Net Index dataset. Because the speed tests rely on the phone's connection to the server, factors such as congestion, location of the server, proximity and access to a cell tower, and phone quality can affect the result. As presented below and in Appendix VI., the Ookla data show significant variation in different geographies, as well as among service providers. In this *Report*, we present the nationwide mean and median download (and upload – see Appendix VI.) speeds by service provider. Table VI.C.1 presents Ookla's nationwide median LTE download speed measurements for the first half of 2015,³⁷² and shows that download speeds vary by service provider.³⁷³ The trends in download speeds from 2013 through the first half of 2015 are presented below in Table VI.C.2.³⁷⁴

Table VI.C.1

Ookla Speed Test - Estimated LTE Download Speeds by Service Provider, Nationwide³⁷⁵

Service Provider	LTE Download Speeds 1H2015		
	Mean (Mbps)	Median (Mbps)	Number of tests ('000s)
Verizon Wireless	16.67	13.23	2,867
AT&T	13.27	9.93	3,101
Sprint	10.00	7.73	2,130
T-Mobile	17.31	14.39	4,150
Total	11.20	9.51	12,495

Source: Ookla Internet performance data, © 2015 Ookla, LLC. All rights reserved. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers.

map, available at <http://openmobiledata.appspot.com/visualization>. Anonymized data are also available for download. See MobiPerf, "For researchers," available at <https://sites.google.com/site/mobiperfdev/for-researchers>.

³⁷¹ See Speedtest mobile app, available at <http://www.speedtest.net/mobile/>.

³⁷² More details can be found in Appendix Tables VI.C.i – VI.C.viii. These tables include data from the 2nd half of 2014, as well as the entire time period including the 2nd half of 2014 and the first half of 2015.

³⁷³ One factor that may lead to speed differences between wireless service providers is the composition of currently used smartphones. The Ookla Speedtest application is available for download on iOS, Android, or Windows Phones. Each of these operating systems has evolved over time. Vintage smartphones, which do not support 4G, or possibly even 3G service, are still in use. Based on current and past promotions and partnerships, each wireless service provider may have a customer base with a different smartphone profile, which can directly affect speed measurements.

³⁷⁴ The upload and download speeds for 2013 and the first half of 2014 were estimated using publicly available data, which were previously available at Ookla Net Index, <http://www.netindex.com/>. The Ookla dataset used for 2013 and the first half of 2014 speeds is based on daily mobile download and upload speed data by city and service provider for 2013 – June 2014. Ookla's daily, city-level observations can consist of thousands of speed measurements, averaged into one data point, therefore the median speed is actually a median of daily averages. We dropped cities that did not have sufficient observations as well as outliers. The upload and download speeds for the second half of 2014 and the first half of 2015 were provided to the Commission by Ookla.

³⁷⁵ Internet performance data, © 2015 Ookla, LLC. All rights reserved. Published with permission of Ookla. Total mean and median download speeds are calculated using aggregated regional data for the four nationwide providers, as well as any other wireless service providers that appear in the Ookla dataset. Only tests with identifiable regions (states) are included. In addition to the the current table, this is applicable to Table VI .C.2 and Appendix Tables VI.C.i – VI.C.viii.

Table VI.C.2
Ookla Median Download Speed by Service Provider, 2013 – 1H2015

Service Provider	Median Download Speed (Mbps)			
	2013	1H2014	2H2014	1H2015
Verizon Wireless	8.99	10.74	11.86	12.65
AT&T	9.04	9.79	7.29	7.86
Sprint	1.92	2.90	4.68	5.35
T-Mobile	6.16	9.89	10.23	11.04

Source: Net Index data by Ookla, 2013, 1H2014. Ookla Internet performance data, 2H2014, 1H2015. © 2015 Ookla, LLC. All rights reserved.

2. FCC

130. In September 2012, the Commission announced that it was expanding its Measuring Broadband America program to include information on mobile broadband service performance in the United States using a crowdsourced approach.³⁷⁶ The program uses the FCC Speed Test app for Android and iPhone devices to test the speed and performance of volunteers' smartphone mobile broadband services.³⁷⁷ The FCC Speed Test app is available free of charge for Android phones and for the iPhone.³⁷⁸ The FCC Speed Test app provides the benefits, and has the limitations, described above for crowdsourced mobile data.³⁷⁹ Nationwide median LTE download speed measurements for the first half of 2015, estimated using data collected with the FCC Speed Test App, are presented in Table VI.C.3 and Table VI.C.4 below. The first presents separately data associated with

³⁷⁶ See FCC website, "Measuring Mobile Broadband Performance," available at <http://www.fcc.gov/measuring-broadband-america/mobile>.

³⁷⁷ See FCC Speed Test, available at <https://play.google.com/store/apps/details?id=com.samknows.fcc&hl=en>; FCC Speed Test App, available at <https://itunes.apple.com/us/app/fcc-speed-test/id794322383?mt=8>. The data collected include speed, latency, and packet loss for both upload and download.

³⁷⁸ The FCC speed test can be set to run automatically in the background on Android phones, but iPhone users must execute the speed test manually. This app allows users to measure their mobile broadband performance and voluntarily report these data to the FCC. Collected data include upload and download speed, latency and packet loss, as well as the wireless performance characteristics of the broadband connection and the kind of handsets and versions of operating systems tested. Several other passive metrics are also recorded, including signal strength of the connection, and device manufacturer and model. See FCC website, "Measuring Mobile Broadband Performance," available at <http://www.fcc.gov/measuring-broadband-america/mobile>.

³⁷⁹ The results reported here do not incorporate all attempted tests reported to the Commission. Each individual test report includes information on whether the test completed successfully, whether it timed out due to connection problems, and whether any data from the test are missing. Missing data from a test reflect issues in the operation of the app for that particular test, so that particular test observation is dropped from the dataset. If the test timed out, we replaced the reported speed with a value of zero, under the assumption that no meaningful connection was made. In addition, the top 1% of download and upload speed observations were dropped, to account for outliers. Tests where the user was on a Wi-Fi network were also filtered out. Based on the remaining data, we calculated the overall mean and median download and upload speeds by service provider. We present additional results in Appendix Tables VI.C.ix – VI.C.xx. These tables include data from the second half of 2014, as well as the entire time period including the second half of 2014 and the first half of 2015.

the four nationwide service providers' flagship brands, while the second includes data we have from all brands offered by the four nationwide service providers, as we presented in the *Seventeenth Report*.³⁸⁰

Table VI.C.3
FCC Speed Test - Estimated LTE Download Speeds by a
Service Provider's Flagship Brand, Nationwide³⁸¹

Service Provider	1H2015		
	Mean LTE Download Speed (Mbps)	Median LTE Download Speed (Mbps)	Number of tests
Verizon Wireless	16.63	11.66	47,114
AT&T	11.38	7.53	20,905
Sprint	7.94	5.05	17,729
T-Mobile	18.07	13.58	28,008
Total	14.13	9.07	126,096

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers. Data are for January 2015 – May 2015.

Table VI.C.4
FCC Speed Test - Estimated LTE Download Speeds by
Service Provider Including Discount Brands, Nationwide³⁸²

Service Provider	1H2015		
	Mean LTE Download Speed (Mbps)	Median LTE Download Speed (Mbps)	Number of tests
Verizon Wireless	16.63	11.66	47,114
AT&T (including Cricket)	10.07	6.84	25,009
Sprint (including Boost, Virgin Mobile)	7.86	4.99	18,280
T-Mobile (including Metro PCS)	17.82	13.27	30,114
Total	14.14	9.07	126,096

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data includes discount brands, as did the *Seventeenth Report*. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers. Data are for January 2015 – May 2015.

³⁸⁰ We intend to release in the near future data with respect to the speeds of the four nationwide service providers' major discount brands.

³⁸¹ Estimated download speed data excludes any discount brands offered by a service provider.

³⁸² We recognize that some discount brands may have capped LTE download speeds, or employ different network management practices. See, e.g., CricketWireless website, "Mobile Broadband Information," available at <https://www.cricketwireless.com/legal-info/mobile-broadband-information.html>; Virgin Mobile website, available at <http://coverage.sprint.com/coverageDescVMU.html>.

3. RootMetrics

131. RootMetrics runs a test program that measures mobile data, call, and text performance in all 50 states across the United States.³⁸³ According to RootMetrics, tests are performed during all hours of the day, every day of the week, and nearly every week of the year, but the testing schedule is weighted more heavily toward typical consumer usage hours. Performance is measured indoors and outdoors at the same randomly chosen locations, and drive testing takes place during travel between locations. The RootMetrics Speed Index takes into account speed measurements of both data and texts.³⁸⁴ Results are reported at the national, state, and metro levels, and are then combined and converted into scores using a proprietary algorithm. RootScores are meant to reflect a consumer's experience of network performance and are scaled from 0 – 100,³⁸⁵ with the lower limit representing network performance that would result in a poor consumer experience and the upper limit reflecting extraordinary performance.³⁸⁶ In addition, Root Metrics has provided the Commission with underlying speed numbers that allow us to calculate nationwide LTE download speeds, as presented in Table VI.C.5 below.³⁸⁷

**Table VI.C.5
Root Metrics Speed Test – Estimated LTE Download Speeds
by Service Provider, Nationwide³⁸⁸**

Service Provider	1H2015		
	Mean Down load Speed (Mbps)	Median Download Speed (Mbps)	Number of tests
Verizon Wireless	15.87	15.68	266,147
AT&T	9.77	9.93	266,120
Sprint	4.80	5.06	265,968
T-Mobile	9.65	9.49	265,789
Total	10.02	10.04	1,064,024

Source: RootMetrics Data, 2015, © Rootmetrics. All rights reserved. In 1H15, there were 6,091,631 total tests, including 7,323 indoor locations. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers.

³⁸³ Tests are conducted in the 125 most populous metropolitan markets and within the 50 busiest U.S. airports. Each location is tested twice a year, once in the first half of the year and once in the second half of the year. Tests are conducted on the latest Android smartphone available from each service provider. All tests, which are conducted solely on the networks of the four nationwide service providers, are performed identically across all operators' devices. See RootMetrics website, "Testing Methodology," available at <http://www.rootmetrics.com/us/methodology>. In addition to the performance scores at each location, an Online Coverage Map is available (<http://webcoveragemap.rootmetrics.com/us>). This map incorporates the sample data described above, along with crowdsourced data that are available through consumer use of the free CoverageMap app, available on Android and iOS.

³⁸⁴ See RootMetrics website, "Testing Methodology," available at <http://www.rootmetrics.com/us/methodology>.

³⁸⁵ Prior to January 2014, Data RootScores in Metro and Airport RootScore Reports could exceed 100 if performance was extraordinary. See "Testing Methodology," available at <http://www.rootmetrics.com/us/methodology>.

³⁸⁶ See RootMetrics website, "Testing Standard," available at <http://www.rootmetrics.com/us/standards>.

³⁸⁷ We present additional results in Appendix Tables VI.C.xxi – VI.C.xxvi.

³⁸⁸ Rootmetrics speed data, © Rootmetrics. All rights reserved. Published with permission of Rootmetrics. In addition to the current table, this is applicable to Table VI.C.7 and Appendix Tables VI.C.xxiii-VI.C.xxvi.

4. CalSPEED

132. CalSPEED is an open source, non-proprietary, network performance measurement tool and methodology created for the CPUC with the assistance of a grant from the National Telecommunications and Information Administration (“NTIA”).³⁸⁹ The CalSPEED data presented in this *Report* are the result of a structured sampling program of nearly 2,000 locations scattered throughout California.³⁹⁰ In our presentation of CalSPEED data, we have dropped any observation that was not in the provider’s coverage area, or any observation that was terminated by the tester. Any other errors are counted as zero throughput.³⁹¹ Median LTE download speed measurements for the state of California, estimated using CalSPEED data collected during the first half of 2015, are presented in Chart VI.C.6 below.³⁹² A comparison of median California LTE download speeds estimated using Ookla, FCC, RootMetrics, and CalSPEED data are presented in Table VI.C.7 below.

Table VI.C.6
CalSPEED - Estimated LTE Download Speeds, by Service Provider, California Only

Service Provider	Spring 2015		
	Mean LTE Download Speed (Mbps)	Median LTE Download Speed (Mbps)	Number of Tests
Verizon Wireless	11.93	11.75	1,387
AT&T	9.06	7.56	1,298
Sprint	5.30	3.36	746
T-Mobile	9.84	9.57	688
Total	9.48	8.34	4,119

Source: The estimated speeds are based on the CalSPEED data. The top 1% of speed values were dropped, by service provider and time period. Spring 2015 tests were taken between the dates of May 1, 2015 through June 15, 2015.

³⁸⁹ We present additional CalSPEED results in Appendix VI., Tables VI.C.xxvii – VI.C.xxx, and also in Charts VI.C.i – VI.C.iii. *See also Seventeenth Report*, 29 FCC Rcd at 15410 ¶ 201, 15469-71, Appendix VI.C.iv.

³⁹⁰ *See* CPUC website, “Mobile Broadband Testing,” available at http://www.cpuc.ca.gov/PUC/Telco/bb_drivetest.htm.

³⁹¹ Upload and download speeds estimated using all technologies are presented in Appendix VI. The rankings are similar to those for LTE speeds. Data can be downloaded from the CPUC website, available at http://www.cpuc.ca.gov/PUC/Telco/bb_drivetest.htm (“Mobile Broadband Testing”).

³⁹² These sites are visited every six months and tests are run on both the latest Android phones and a USB network device on a Windows based netbook, for each of the four nationwide service providers. CalSPEED has now had seven rounds of sampling in California. Data can be downloaded from the CPUC website, available at http://www.cpuc.ca.gov/PUC/Telco/bb_drivetest.htm (“Mobile Broadband Testing”).

Table VI.C.7
LTE Download Speeds by Speed Test and Service Provider, California Only

Service Provider	Ookla: 1H2015		FCC: 1H2015 ³⁹³ Flagship Brands Only		FCC: 1H2015 ³⁹⁴ Includes Discount Brands		Root Metrics: 1H2015		CalSPEED: Spring 2015	
	Median LTE Down-load speed (Mbps)	# of tests ('000s)	Median LTE Down-load speed (Mbps)	#of tests	Median LTE Down-load speed (Mbps)	# of tests	Median LTE Down-load speed (Mbps)	# of tests	Median LTE Down-load speed (Mbps)	#of Tests
Verizon Wireless	15.27	442	10.52	6,740	10.52	6,740	21.44	37,331	11.75	1,387
AT&T	9.57	579	6.51	2,894	6.09	3,238	12.56	37,288	7.56	1,298
Sprint	6.78	295	4.53	1,813	4.46	1,853	6.56	37,347	3.36	746
T-Mobile	12.86	1,101	12.92	5,573	11.8	6,324	13.15	37,210	9.57	688
Total	9.36	2,448	8.64	18,465	8.64	18,466	13.43	149,176	8.34	4,119

* FCC Speed Estimates: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. The FCC data column that includes the discount brands for the four nationwide service providers include the following: T-Mobile includes MetroPCS, AT&T includes Cricket Wireless, and Sprint includes Virgin and Boost. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers.

** Ookla Speed Data: Ookla Internet performance data, © 2015 Ookla, LLC. All rights reserved. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers.

***Root Metrics Data: © Rootmetrics. All rights reserved. In 1H15, there were 844,004 total tests, including 993 indoor locations. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers.

**** CalSPEED: The top 1% of speed values were dropped, by service provider and time period. Spring 2015 tests were taken between the dates of May 1, 2015 to June 15, 2015.

5. Latency

133. Latency refers to several types of delays typically incurred during network data processing, and is typically measured in milliseconds (“ms”). One common measure is round-trip latency, which measures the amount of time it takes a data packet to travel from a source to a destination and back.³⁹⁵ Latency is often affected

³⁹³ Estimated download speed data excludes any discount brands offered by a service provider.

³⁹⁴ Consistent with the methodology used in previous reports, estimated download speed data includes any discount brands offered by a service provider. We recognize that some discount brands may have capped LTE download speeds, or employ different network management practices. See, e.g., CricketWireless website, “Mobile Broadband Information,” available at <https://www.cricketwireless.com/legal-info/mobile-broadband-information.html>; Virgin Mobile Website, available at <http://coverage.sprint.com/coverageDescVMU.html>

³⁹⁵ More precisely, it is measured as the sum of time from the start of packet transmission by a source to the start of packet reception by a destination plus the time that it takes for the packet to travel back from the receiving destination to the source. This excludes the amount of time that a destination system spends processing the packet.

by factors such as the specifics of the cellular network architecture or processing delays that may occur when the packets need to pass through proxy servers.³⁹⁶

134. *FCC Data.* Similar to Ookla, the FCC test selects the server with the lowest latency, chosen from an initial set of possible test servers, which may bias subsequent tests towards higher performance. It is possible that consecutive tests in the same place, on the same service provider, and at about the same time may test to different servers. If a packet is not received back within three seconds of sending, it is treated as lost.³⁹⁷ Based on FCC Speed Test App data for 2H2014 and 1H2015, Verizon Wireless had the lowest reported mean latency, followed closely by AT&T and T-Mobile. Sprint had the highest mean latency during the reporting period.

135. *CalSPEED Data.* CalSPEED tests the complete network path, from the client device, through the local access network, through the Internet backbone, to two ultimate server destinations, one in Northern California and the other in Northern Virginia. Based on the CalSPEED data, latency continues to improve. Verizon Wireless and Sprint have seen dramatic improvements in their latency over the last several reporting periods, and are closing in on AT&T for the lowest latency measurements. While T-Mobile has the highest mean latency,³⁹⁸ they have also demonstrated dramatic improvements during the last several test periods.

D. Differentiation in Mobile Wireless Devices and Advertising/Marketing

1. Differentiation in Mobile Wireless Devices

136. In addition to competing on price and network quality, service providers have also competed by offering consumers a variety of different mobile wireless devices with innovative features. Today, service providers offer a range of data-centric smartphones³⁹⁹ and tablets made by different manufacturers with different operating systems, and increasingly offer wearable devices, such as smartwatches.⁴⁰⁰ In many cases, customers may be able to find the same devices from several different service providers, but the promotion and marketing of specific devices may vary across providers. The first significant differentiation in mobile device offerings occurred with the introduction of Apple's iPhone in June 2007 pursuant to an exclusive arrangement with AT&T. Following that introduction, many handset manufacturers introduced competing products with similar features such as touch screens, mobile web browsing capabilities, and current-generation operating systems.

137. Today, smartphone operating systems such as the Android and the Apple iOS are available from multiple service providers, permitting consumers to pair their preferred operating systems with various service providers. While certain specific smartphones may be introduced by a single provider, the wide variety of similar models has made it more difficult for service providers to differentiate their services based upon differences in device offerings alone. We also note that all four nationwide service providers, as well as many regional and

³⁹⁶ See FCC website, International Broadband Data Report, DA 12-1334, at 14, available at <http://www.fcc.gov/document/international-broadband-data-report>.

³⁹⁷ See FCC website, "Measuring Mobile Broadband Methodology," available at <http://www.fcc.gov/measuring-broadband-america/mobile/technical-summary>.

³⁹⁸ See "CALSpeed – California's Mobile Broadband Assessment" (Spring 2015).

³⁹⁹ While there is no industry standard definition of a smartphone, for purposes of this *Report* we continue to consider the distinguishing features of a smartphone to be: an HTML browser that allows easy access to the full, open Internet; an operating system that provides a standardized interface and platform for application developers; and a larger screen size than a traditional, voice-centric handset. Many smartphones also have touch screens and/or a QWERTY keypad, and run an operating system that offers a standard platform for application developers to create and sell device software through an application store. See *Sixteenth Report*, 28 FCC Rcd at 3844 ¶ 220. By contrast, the basic handset category includes voice-centric handsets that do not allow or are not designed for easy web browsing. In addition to smartphones and basic handsets, a third category of devices consists of data-centric devices that have no inherent voice capability, such as USB wireless modem laptop cards, mobile Wi-Fi devices, e-readers, and laptops and netbooks with embedded mobile wireless modems.

⁴⁰⁰ See "The Trick for Wearables' Success is all in the Wristware," Mar. 30, 2015, available at <http://www.cnet.com/news/wearables-set-to-soar-on-the-back-of-wristwear-new-data-shows/>.

smaller service providers, currently offer the current iPhone models. Although all service providers continue to offer the highest end devices only on postpaid plans, providers are increasingly targeting prepaid customers by offering more devices with prepaid plans than before. Beginning in 2015, Walmart also began offering Sprint's Virgin prepaid shared data plans with purchase of the HTC Desire 510, the LG Tribute, the LG Volt, and the Samsung Galaxy Core Prime smartphones.⁴⁰¹ This offering was the first prepaid plan to allow for shared data.⁴⁰²

138. In addition to offering more devices on prepaid plans, service providers have been promoting cheaper tablets,⁴⁰³ in part to generate growth in data traffic and generate a market for future video offerings.⁴⁰⁴ Internet device net adds (including tablets) were 1.97 million in the second quarter of 2015, down from 2.27 million in the second quarter of 2014, and this marks the first decline in three years.⁴⁰⁵ AT&T increased its net internet device adds from 449,000 in the first quarter of 2014 to 711,000 in the first quarter of 2015, and saw a decline in the second quarter of 2015, to 600,000.⁴⁰⁶ Verizon Wireless increased its net internet device adds from 621,000 in the first quarter of 2014 to 667,000 in the first quarter of 2015, and to 803,000 in the second quarter of 2015.⁴⁰⁷ Sprint saw a decrease in its net internet device adds from 414,000 in the first quarter of 2014 to 379,000 in the first quarter of 2015 to 322,000 in the second quarter of 2015.⁴⁰⁸ T-Mobile had the fewest internet device net adds (134,000 in the first quarter of 2015, and 248,000 in the second quarter of 2015) as it entered the tablet market later than the other service providers.⁴⁰⁹

139. Although the use of data-only devices with mobile network connectivity has grown in recent years, "phablets," a class of mobile device combining the form and technical capabilities of smartphones and tablets, are replacing the use of tablets in some cases.⁴¹⁰ Phablet sales have been substantial and it has been predicted that phablets will account for more than 20 percent of mobile devices shipped by 2019.⁴¹¹ In part, due to the popularity of phablets, Apple launched the iPhone 6 Plus last year to reclaim customers lost to Android

⁴⁰¹ See "Sprint's Virgin Prepaid Service to Offer Shared Data Plans at Walmart," Jan. 16, 2015, available at <http://www.cnet.com/news/sprints-virgin-prepaid-service-to-offer-shared-data-plans-at-walmart/>.

⁴⁰² See *id.*

⁴⁰³ According to Cisco VNI Mobile, in 2014, a 4G smartphone, on average, used approximately 2 GB per month, as compared to 2.9 GB for a 4G tablet. Cisco predicts that by 2019, this is expected to grow to approximately 4 GB per month for a 4G smartphone, as compared to approximately 12 GB per month for a 4G tablet. See Cisco VNI Mobile, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update 2014-2019 White Paper," at 19, available at http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html.

⁴⁰⁴ See UBS, US Wireless 411: Version 56, May 14, 2015, at p. 11.

⁴⁰⁵ See UBS, US Wireless 411: Version 57, Aug. 17, 2015, at p. 20.

⁴⁰⁶ See UBS, US Wireless 411: Version 56, May 14, 2015, at p. 11; US Wireless 411: Version 57, Aug. 17, 2015, at p. 20.

⁴⁰⁷ See *id.*

⁴⁰⁸ See *id.*

⁴⁰⁹ See *id.*; see also "T-Mobile Revolutionizes how Customers Buy and Use Tablets with Free Data for Life," available at <https://newsroom.t-mobile.com/news/t-mobile-revolutionizes-how-customers-buy-and-use-tablets-with-free-data-for-life.htm>.

⁴¹⁰ The phablet has been defined as a handset with a screen size of 5.5 to 6.9 inches that can be held while making phone calls, but not necessarily for an extended period of time. See "Phablets to Flood Smartphone Market in Coming Years," Jan. 28, 2015, available at <http://www.cnet.com/news/phablets-to-flood-smartphone-market-in-coming-years-report/>.

⁴¹¹ See *id.*

vendors.⁴¹² In the first quarter of 2015, 44 percent of all U.S. phablet sales were the iPhone 6 Plus.⁴¹³ In addition to offering a variety of smartphones, traditional handsets, and phablets, mobile wireless service providers also sell or provide connectivity for other data-only devices such as tablets, e-readers, wireless data cards, mobile Wi-Fi hotspots,⁴¹⁴ netbook computers with embedded modems, and wearable gadgets such as smartwatches. Smartwatches such as Android watches have been available for several years, but they have become more popular since Apple introduced its Apple Watch in April 2015. Mobile wireless service providers also offer wireless data cards and mobile Wi-Fi hotspots to consumers seeking mobile Internet connections for laptop computers and other Wi-Fi enabled devices and may offer products for the interconnected home, such as security systems.

140. As service providers have become more able recently to compete with one another by offering many devices with similar characteristics from multiple equipment manufacturers, providers have sought to compete more along other dimensions, such as network speed and coverage. That being said, service providers may emphasize and promote different smartphone brands, although other brands may be available in their stores. According to a JD Power report on consumer satisfaction with smartphones, the primary reasons for purchasing a smartphone device differ by service provider. For example, Verizon Wireless customers are more likely to buy their device based on the smartphone's features (approximately 34 percent), while T-Mobile customers are more likely to buy based on price (approximately 30 percent).⁴¹⁵

2. Advertising and Marketing

141. Mobile wireless service providers also compete for customers through advertising and marketing, including by establishing retail and distribution networks. Several service providers stated that the goal of their advertising and marketing efforts is to increase and maintain brand awareness and to support distribution.⁴¹⁶ Service providers may also engage in advertising and marketing either to inform consumers about available products or services or to try to increase sales by influencing consumer preferences.⁴¹⁷ Service providers may advertise through traditional media, internet and mobile applications, social media, sponsorships and co-branding, and at events.⁴¹⁸ During the time period covered by this *Report*, the four nationwide service providers all increased their advertising expenditures, some quite substantially,⁴¹⁹ and telecom companies overall spent more on advertising than all but two industries in the first quarter of 2015.⁴²⁰ According to Nielsen, wireless telephone

⁴¹² *See id.*

⁴¹³ *See* "iPhone 6 Plus Leads Phablet Sales in U.S.," May 6, 2015, available at, <http://www.cnet.com/news/iphone-6-plus-leads-phablet-sales-in-us/>.

⁴¹⁴ Mobile Wi-Fi, or "Mi-Fi," devices are credit card-sized, mobile Wi-Fi routers with mobile broadband wide-area connections that allow a certain number of Wi-Fi-enabled devices in short range to connect to the Internet via a Wi-Fi connection. Many smartphones are now sold with built-in Wi-Fi hotspot capabilities, allowing them to serve as mobile Wi-Fi hotspots for an additional charge.

⁴¹⁵ *See* "Smartphone Device Launches Propel High Satisfaction with Apple, HTC, and Samsung," Apr. 23, 2015, available at <http://www.jdpower.com/press-releases/2015-us-wireless-smartphone-satisfaction-study%E2%80%94volume-1#>.

⁴¹⁶ *See, e.g.*, 2014 SEC Form 10-K for Sprint at 3, 2014 SEC Form 10-K for US Cellular at 2-3, 2014 SEC Form 10-K for Verizon Wireless at 6.

⁴¹⁷ *See Seventeenth Report*, 29 FCC Rcd at 15140 ¶ 212.

⁴¹⁸ *See, e.g.*, 2014 SEC Form 10-K for Sprint, 2014 SEC Form 10-K for US Cellular, and 2014 SEC Form 10-K for Verizon Wireless.

⁴¹⁹ CTIA Comments at 47-48 (citing Kantar Media Reports). AT&T reported advertising costs in 2014 as \$3.3 billion; Sprint reported sales and marketing expense was \$5.3 billion for the year ended Mar. 31, 2015 representing an increase of \$2.7 billion, or 102%; T-Mobile reported advertising expense included in selling, general and administrative expenses as \$1.4 billion for 2014; and Verizon Wireless reported advertising expenses at \$2.5 billion in 2014.

⁴²⁰ CTIA Comments at 47 (citing Kantar Media Reports).

services was the sixth largest category of U.S. advertising spending (\$2.2 billion from Jan. 1, 2014 to Sept. 30, 2015). In Kantar Media's Q3 2014 rankings of advertising spending, AT&T and Verizon Communications were the second and eighth largest U.S. advertisers, respectively,⁴²¹ although T-Mobile outspent the other wireless providers (including AT&T and Verizon Wireless) in July 2015.⁴²²

142. Some service providers' marketing campaigns continued to focus on the quality and size of their mobile broadband networks. Many service providers sought to highlight their network speed, coverage, reliability, and the data capabilities of devices available on these networks.⁴²³ Some service providers promoted the advantages of their particular service plans relative to those of rivals, including phone upgrade options and loyalty rewards programs. For example, in 2015, AT&T partnered with American Express and some other major brands to offer a loyalty program for customers called Plenti, which enabled consumers to shop at any of the stores in the program to earn points toward rewards.⁴²⁴ In 2015, Verizon Wireless used as an advertising slogan, the "never settle" tag line, implying that customers who choose other providers are settling for inferior network quality.⁴²⁵ In response, in May 2015, T-Mobile used the tag line #NeverSettleForVerizon and offered Verizon Wireless customers the chance to port their number to a new T-Mobile smartphone on a trial basis.⁴²⁶ In June 2015, T-Mobile announced its "Jump on Demand" marketing slogan which advertised that customers would be allowed to upgrade to new phones up to three times per year.⁴²⁷ In the summer of 2015, Verizon Wireless aired an ad that featured a flock of geese who are "flying back home to Verizon" after having "suffered" after leaving Verizon Wireless because of other wireless service providers' "unreliable cell phone networks and videos that kept buffering."⁴²⁸ T-Mobile aired its own ad featuring geese, informing the audience that it has expanded LTE coverage, and that it now has improved coverage and in-building penetration.⁴²⁹

VII. CONSUMERS AND TRENDS IN THE MOBILE WIRELESS ECOSYSTEM

143. In today's connected world, consumers are faced with a wide variety of choices in mobile service plans, devices and applications.⁴³⁰ In this section, we first report on trends in handsets and smartphone

⁴²¹ See "Kantar Media Reports U.S. Advertising Expenditures Increased 0.3 Percent in Q3 2014, Helped by the World Cup and Political Spend," Dec. 22, 2014, available at <http://kantarmedia.us/kantar-media-reports-us-adex-increase-q3-2014>.

⁴²² See "The Top 5 Wireless Adds: T-Mobile Outspent AT&T, Verizon, and Sprint in TV Advertisements in July," Aug. 12, 2015, available at <http://www.fiercewireless.com/special-reports/top-5-wireless-ads-t-mobile-outspent-att-verizon-and-sprint-tv-advertisemen?confirmation=123>.

⁴²³ See Verizon Wireless Comments at 13.

⁴²⁴ See "AT&T and Friends Form Rewards Program," Mar. 18, 2015, available at [http://www.lightreading.com/spit-\(service-provider-it\)/customer-experience-management-\(cem\)/atandt-and-friends-form-rewards-program/d/d-id/714502](http://www.lightreading.com/spit-(service-provider-it)/customer-experience-management-(cem)/atandt-and-friends-form-rewards-program/d/d-id/714502).

⁴²⁵ See "T-Mobile Targets Verizon Customers with Free Two Week Trial," May 5, 2015, available at <http://www.fiercewireless.com/story/t-mobile-targets-verizon-customers-free-two-week-trial/2015-05-05>.

⁴²⁶ See *id.*

⁴²⁷ See "T-Mobile Will Let You Upgrade Your Smartphone Any Time You Want," June 25, 2015, available at <http://www.cnet.com/news/t-mobile-will-let-you-upgrade-your-smartphone-anytime-you-want/>.

⁴²⁸ See "Verizon TV Spot, 'Magnificent Geese,'" available at <http://www.ispot.tv/ad/7PpP/verizon-magnificent-geese>.

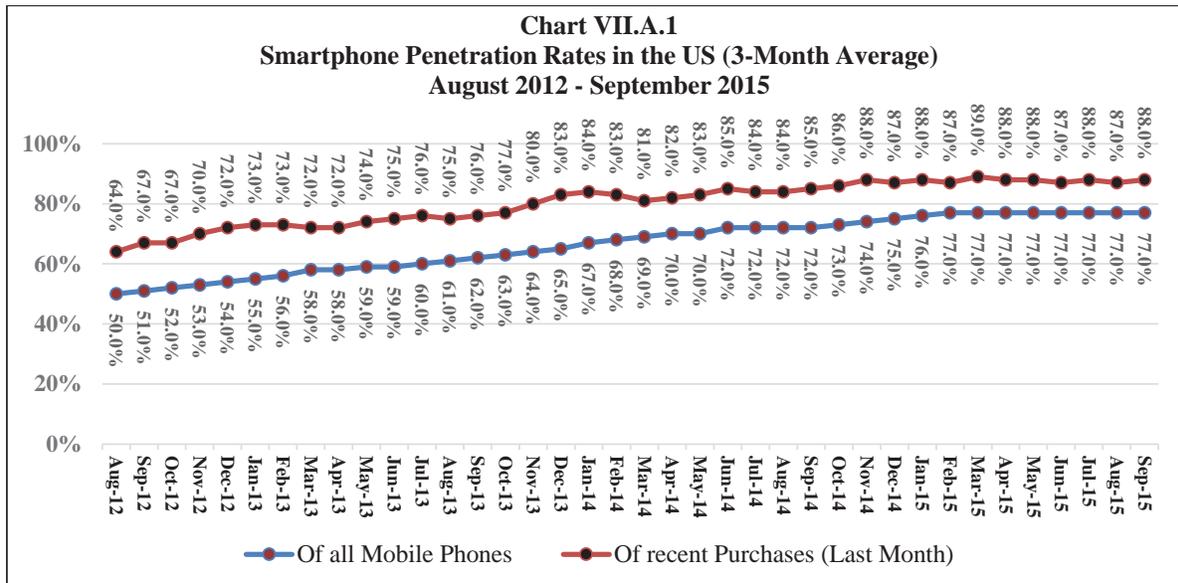
⁴²⁹ See "T-Mobile jabs at Verizon in new ad that highlights its 700 MHz LTE coverage expansion," available at <http://www.fiercewireless.com/story/t-mobile-jabs-verizon-new-ad-highlights-its-700-mhz-lte-coverage-expansion/2015-09-22>.

⁴³⁰ Consumers choose a service provider or switch between providers for varying reasons, including price, availability of family plans, network quality, free/unlimited in-network calling, billing/payment options/credit, reputation/recommendation, previous experience with the service provider, customer service, mobile data services, specific phone offerings, bundling mobile phone services with other services or other unspecified reasons. In the past, contract length, handset exclusivity, and lack of interoperability were some factors that were highlighted as barriers to switching. Consumers may incur some

penetration, considering the handset operating system, and application (“apps”) dimensions of the mobile wireless ecosystem. Next, we consider trends in consumers’ use of mobile wireless services. The handsets offered by, or compatible with a particular service provider, as well as the available apps, will affect consumers’ decisions since each greatly affects the user experience, as discussed below. This section then discusses consumers’ access to information, and lastly, we report on trends in consumers’ use of mobile versus non-mobile services.

A. Handsets and Downstream Mobile Applications

144. *Smartphone Penetration.* Smartphone use has continued to increase over the last three years, as Chart VII.A.1 shows, although smartphone use flattened out in 2015. According to ComScore, approximately 77 percent of all mobile subscribers had a smartphone in the third quarter of 2015, compared to approximately 51 percent in the third quarter of 2012.⁴³¹ The smartphone penetration rate among new phone purchases over the same period stood at approximately 88 percent in the third quarter of 2015 (again flattening out in 2015), up from approximately 67 percent in the third quarter of 2012. Among the top four mobile wireless service providers, the penetration rates for postpaid smartphone subscribers are approximately 94 percent, 89 percent, 83 percent, and 80 percent for T-Mobile, Sprint, AT&T, and Verizon Wireless, respectively.⁴³²



Note: ComScore, MobiLens Audience Profile, 3-month averages from Q3 2012 to Q3 2015.

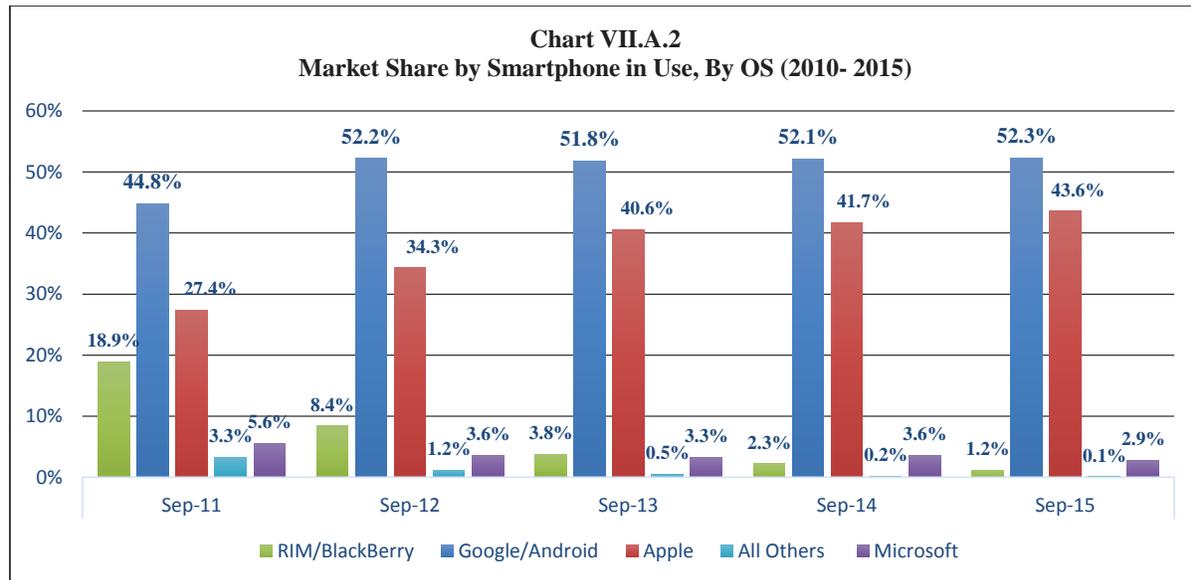
145. *Share of Smartphones by Operating System.* The operating system (“OS”) of a smartphone is a major determining factor of the smartphone’s ability to support mobile applications and Internet-based services. As seen in Chart VII.A.2, Apple’s iOS and Google’s Android continued to lead the market for mobile operating systems. In the third quarter of 2015, Android’s operating system accounted for approximately 52 percent of the smartphone OS market, while Apple’s iOS accounted for approximately 44 percent. While Android’s market share has been fairly constant since the third quarter of 2012, Apple’s market share has grown from approximately 34 percent to approximately 44 percent over the same time period. RIM (Research in

switching costs, even in today’s mobile wireless marketplace, including search costs, handset purchases, and implicit costs such as brand loyalty. See *Seventeenth Report*, FCC Rcd at 15347 ¶ 69.

⁴³¹ See ComScore, MobiLens Trend, 3-month averages from August 2012 to September 2015.

⁴³² See UBS, US Wireless 411, Version 57, Aug. 2015, at p. 26, Figure 37.

Motion)/Blackberry (approximately one percent), Microsoft (approximately three percent), and other firms (less than one percent) comprised the remainder of the market in the third quarter of 2015.



Note: Based on ComScore MobiLens 3-month survey data averages.

146. *Smartphones and Consumer Satisfaction.* According to an April 2015 JD Power study, consumer satisfaction with smartphone brands differs by wireless service provider.⁴³³ In addition, the primary reasons that customers cite for purchasing a smartphone differ by wireless service provider. For example, Verizon Wireless customers are more likely to cite phone features as the primary factor in their purchasing decision, while T-Mobile customers value price most highly. Apple and Samsung smartphones rank highest in satisfaction among customers of T-Mobile, Verizon Wireless, and AT&T, while HTC, Apple, and Samsung rank highest among customers of Sprint.⁴³⁴ Overall satisfaction with smart phone devices is highest among AT&T customers, according to the survey, followed by Sprint, Verizon Wireless, and T-Mobile customers.⁴³⁵

147. *Downstream Mobile Applications.* Smartphone users generally interact with their devices through specific apps and the increasing use of smartphones has spawned a large and growing mobile app ecosystem. Two app stores dominate the United States market – Google Play and Apple App Store. Google Play had approximately 1.5 million apps as of the first week of May 2015,⁴³⁶ and Apple App Store offered more than 1.4 million apps at the end of 2014.⁴³⁷ Other application stores include the Windows Phone Store, the Amazon

⁴³³ See “Smartphone Device Launches Propel High Satisfaction with Apple, HTC, and Samsung,” Apr. 23, 2015, available at <http://www.jdpower.com/press-releases/2015-us-wireless-smartphone-satisfaction-study%E2%80%941#>.

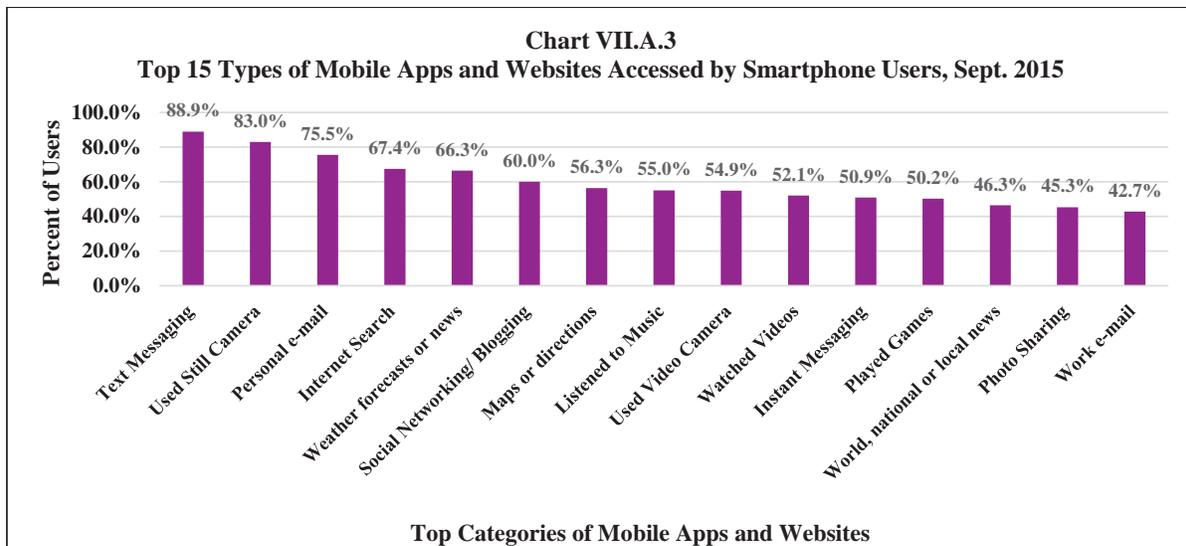
⁴³⁴ See *id.*

⁴³⁵ See *id.*

⁴³⁶ See “Android Statistics,” available at <http://www.appbrain.com/stats/number-of-android-apps>.

⁴³⁷ See “App Store Rings in 2015 with New Records,” Apple press release, Jan. 8, 2015.

App Store, and BlackBerry World.⁴³⁸ Mobile applications generate revenue through contracts for application developers, e-commerce sales, in-application advertising, and application store sales.⁴³⁹ Apple App Store generated approximately \$10 billion in revenue to developers in 2014, while Google Play has paid out \$7 billion to app developers over the same period.⁴⁴⁰ It is anticipated that app revenue from the Google Play marketplace and Apple App Store is likely to double by 2018.⁴⁴¹ Chart VII.A.3 shows the Top 15 types of mobile apps and websites accessed by smartphone users as of September 2015.



Note: Based on ComScore MobiLens 3-month survey data averages.

B. Usage

148. According to CTIA, reported annual minutes of use (“MOUs”) in 2014 reached over 2.45 trillion, a decrease of 6.2 percent, while average billable minutes of use, as shown in Chart VII.B.1, decreased by approximately 10 percent compared to year-end 2013.⁴⁴² This may be due in part to changes in how service providers report, service provider participation, and possible reported volume increases/decreases in usage. In addition, as service providers have continued to introduce new all-inclusive calling and data plans, as well as modifications on legacy plans, the reporting of specific breakout data has become more complicated and difficult to report.⁴⁴³ Further, the Internet of Things such as connected cars, telematics and M2M are likely to be harder to

⁴³⁸ For example, Microsoft has more than 585K apps in the Windows and Windows Phone store combined (<http://news.microsoft.com/bythenumbers/index.html>). As of January 2015, more than 293K mobile apps were available in the Amazon Appstore (<http://www.statista.com/statistics/307330/number-of-available-apps-in-the-amazon-appstore/>).

⁴³⁹ See Vision Mobile, “Business and Productivity Apps,” March 2014.

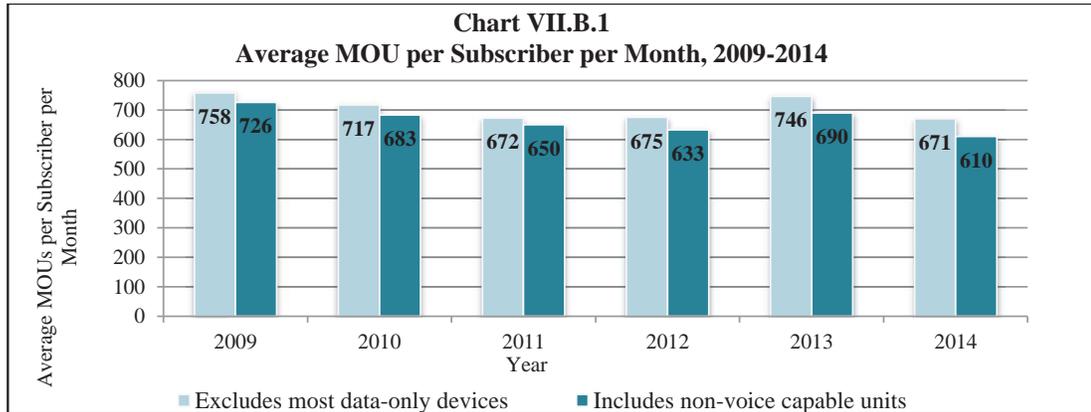
⁴⁴⁰ See Ina Fried, “Sales from Apple and Google App Stores Seen Doubling by 2018, In-App Advertising to Triple,” Mar. 30, 2015, available at <http://recode.net/2015/03/30/sales-from-apple-and-google-app-stores-seen-doubling-by-2018-in-app-advertising-to-triple/>.

⁴⁴¹ See *id.*

⁴⁴² See CTIA Wireless Industry Indices Year-End 2014, at p. 125, Table 44: Calendar Year Annualized MOU Data.

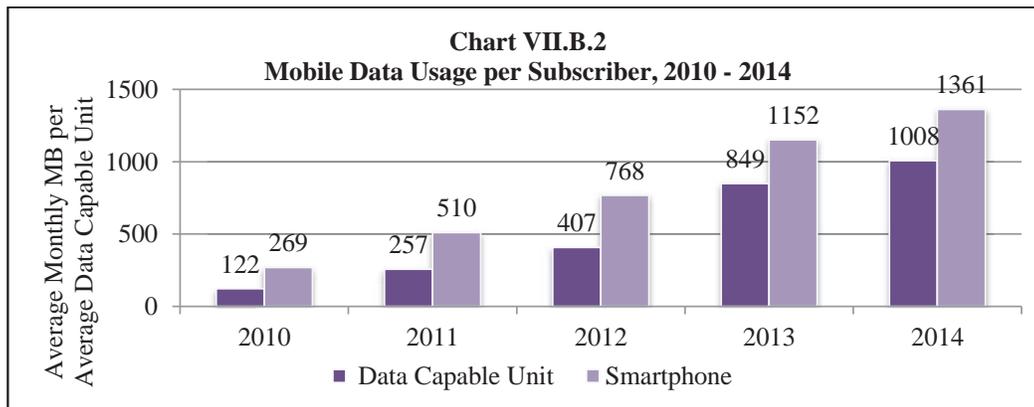
⁴⁴³ See *id.*, at pp.131-32 (describing understatement of MOUs).

report consistently across all service providers as many of the providers may not be able to segregate traditional voice usage since it may be included within their total data usage metrics.⁴⁴⁴



Source: CTIA Wireless Industry Indices Year-End 2014.

149. Although MOUs for voice may have decreased, data use has grown significantly. CTIA reported that SMS and text messaging traffic amounted to over 169.3 billion messages for the December 2014 period, an increase of 10 percent from the prior year, and monthly data usage per smartphone subscriber in 2014 averaged 1.4 GB per month, increasing 18 percent over 2013.⁴⁴⁵ Total wireless data traffic reported by the service providers to CTIA amounted to 4.06 trillion MB for 2014 up 25.7 percent from 3.23 trillion MB in 2013.⁴⁴⁶ Chart VII.B.2 provides average data usage per subscriber for 2010 to 2014 comparing the amount of data usage between data-capable devices and smartphones.



Source: CTIA Wireless Industry Indices Year-End 2014, Chart 32 Indices. Latest available data.

⁴⁴⁴ See section II.B.1 *supra*.

⁴⁴⁵ See CTIA Wireless Industry Indices Year-End 2014, at p. 136.

⁴⁴⁶ See *id.*, at p. 11.

150. Further, Cisco's Visual Networking Index reported that in 2014 the average usage per connection in North America was approximately 1.5 GB.⁴⁴⁷ Cisco estimated that in North America, mobile data grew 63 percent for 2014.⁴⁴⁸ Ericsson, in its latest June 2015 North American Mobility report indicated that data traffic per active smartphone user equaled approximately 2.4 GB per month,⁴⁴⁹ while Chetan Sharma Consulting indicated that the average usage was approximately 2.5 GB per month.⁴⁵⁰ According to GSMA, in 2014, globally LTE users used twice as much data as non-LTE users, which translated to about 1.5 GB of data per month on average.⁴⁵¹ This trend in increasing data use is due to multiple factors, including the increased adoption of smartphones and tablets, growth in streaming video, and the development of faster networks. According to the Pew Research Internet Project, 97 percent of cellphone users use their cellphone to send or receive text messages; 89 percent access the Internet; 88 percent send or receive email; 67 percent get directions, recommendations, or other location-based information; 64 percent of younger smartphone users listen to music; and 91 percent of users between 18 and 29 years of age used social networking compared to 55 percent of those age 50 and older.⁴⁵²

C. Consumer Access to Information

151. Through the "Consumer Code for Wireless Service," CTIA and the service providers voluntarily commit to providing consumers with information to assist them in the selection of a mobile wireless service provider.⁴⁵³ Signatories to CTIA's Consumer Code commit to disclose rates, additional taxes, fees, surcharges, and terms of service; provide coverage maps; and make customer service readily accessible. Since its creation, the code has been updated to require providers to ensure disclosure of data allowances offered in a service plan, whether there are any prohibitions on data service usage, and whether there are network management practices that will have a material impact on the customer's wireless data experience.

152. In December 2013, CTIA added a section enhancing transparency and disclosure of mobile wireless providers' device unlocking policies.⁴⁵⁴ The ability to unlock a handset in order to activate it on another service providers network enables consumers to exercise greater choice in choosing or switching providers and lowers switching costs. These requirements include notifying customers when their postpaid device is eligible for unlocking if the device is not automatically unlocked. In addition, participating service providers are required to

⁴⁴⁷ Cisco's Visual Networking Index, reported that in 2014 the average usage per connection in North America was 1,477 megabytes. See Cisco Visual Networking Index: Forecast and Methodology, 2014-2019 (Feb. 3, 2015): average mobile connections in 2019 will generate 7,648 megabytes of mobile data traffic per month.

⁴⁴⁸ See *id.* Global mobile data traffic is predicted to increase nearly tenfold between 2014 and 2019. Mobile data traffic will grow at a compound annual growth rate ("CAGR") of 57% from 2014 to 2019, reaching 24.3 exabytes per month by 2019.

⁴⁴⁹ See Ovum: "Smartphone & tablet usage trends & insights: 4G LTE and Wi-Fi powering data consumption" (2015). Ericsson – a network infrastructure service provider – projects mobile data growth of 35% per year between 2014 and 2020. See Ericsson Mobility Appendix (June 2015).

⁴⁵⁰ See "Industry Research: Technology & Strategy Consulting," available at <http://www.chetansharma.com/research.htm>. See also "Report: U.S. Consumers Swallowed 2.5 GB/month of Cellular Data in Q1 on Average," available at <http://www.fiercewireless.com/story/report-us-consumers-swallowed-25-gbmonth-cellular-data-q1-average/2015-05-19>.

⁴⁵¹ See GSMA Report, "The Mobile Economy 2014," available at http://www.gsmamobileeconomy.com/GSMA_ME_Report_2014_R2_WEB.pdf.

⁴⁵² See "U.S. Smartphone Use in 2015" (Apr. 1, 2015), available at http://www.pewinternet.org/files/2015/03/PI_Smartphones_0401151.pdf.

⁴⁵³ See "Consumer Code for Wireless Service," available at <http://www.ctia.org/policy-initiatives/voluntary-guidelines/consumer-code-for-wireless-service>.

⁴⁵⁴ See *id.*

post on their websites a clear, concise, and easily found policy on mobile device unlocking.⁴⁵⁵ The member service providers were required to implement all of the unlocking disclosure policies by February 11, 2015, and all of the major service providers have fulfilled this commitment.⁴⁵⁶ The member service providers agreeing to CTIA's Consumer Code account for service to 97 percent of U.S. wireless customers.⁴⁵⁷ All of these customers must be sent alerts regarding data, voice, text, international roaming, and device unlocking eligibility, unless they decide to opt out. In order to further facilitate the adoption of such alerts, the Commission has established a web site where consumers can determine which providers are implementing the voluntary commitments.⁴⁵⁸

153. *Open Internet Rules.* The rules on Internet openness adopted by the Commission in February 2015, require both fixed and mobile broadband Internet service providers to “publicly disclose accurate information regarding the network management practices, performance, and commercial terms of its broadband Internet access services sufficient for consumers to make informed choices regarding use of such services.”⁴⁵⁹ The 2015 *Open Internet Order* reaffirms and enhances transparency rules that were originally adopted in 2010.⁴⁶⁰ In 2014, the D.C. Circuit Court rejected a challenge by Verizon to the 2010 transparency rule, although it did invalidate anti-blocking and anti-discrimination rules.⁴⁶¹ Subsequently, in 2015, the Commission adopted new rules against blocking, throttling, and paid prioritization for fixed and mobile service providers.⁴⁶²

154. In providing guidance regarding effective disclosure models in the 2010 and 2015 Orders, the Commission indicated that among the types of information that might be included in an effective disclosure are pricing terms such as monthly prices, usage-based fees, and fees for early termination or additional network services.⁴⁶³ The 2015 Order enhanced the transparency rules adopted in 2010 by adopting a requirement that broadband service providers always must disclose promotional rates, all fees and/or surcharges, and all data caps or data allowances.⁴⁶⁴ In addition, the 2015 Order requires that packet loss as a measure of network performance

⁴⁵⁵ See FCC website, Official FCC Blog, “Wireless Providers Fulfill Commitment to Let Consumers Unlock Mobile Phones,” available at <https://www.fcc.gov/blog/wireless-providers-fulfill-commitment-let-consumers-unlock-mobile-phones>.

⁴⁵⁶ See “Consumer Code for Wireless Service,” available at <http://www.ctia.org/policy-initiatives/voluntary-guidelines/consumer-code-for-wireless-service>.

⁴⁵⁷ See *id.*

⁴⁵⁸ See FCC website, “Helping Consumers Avoid Bill Shock,” available at <https://www.fcc.gov/bill-shock-alerts>.

⁴⁵⁹ Protecting and Promoting the Open Internet, GN Docket No. 14-28, *Report and Order on Remand, Declaratory Ruling, and Order*, 30 FCC Rcd 5601, 5609 ¶ 23 (2015) (“2015 *Open Internet Order*”).

⁴⁶⁰ See *id.* See also Preserving the Open Internet, GN Docket No. 09-191, WC Docket No. 07-52, *Report and Order*, 25 FCC Rcd 17905, 17938-39 ¶ 56 (2010) (“2010 *Open Internet Order*”).

⁴⁶¹ See *Verizon v. Federal Communications Commission*, 740 F.3d 623 (D.C. Cir. 2014).

⁴⁶² See 2015 *Open Internet Order*, 30 FCC Rcd at 5607-8 ¶¶ 15-19.

⁴⁶³ See 2015 *Open Internet Order*, 30 FCC Rcd at 5609 ¶ 23; 2010 *Open Internet Order*, 25 FCC Rcd at 17938-39 ¶ 56. On July 23, 2014, the Enforcement Bureau of the FCC announced that, “Providers of broadband Internet access services must disclose accurate information about their service offerings and make this information accessible to the public.” (See DA 14-39, Enforcement Advisory No. 2014-03, July 23, 2014, (https://transition.fcc.gov/eb/Public_Notices/DA-14-1039A1.html)). The Commission charged its Consumer Advisory Committee with making recommendations regarding proposed consumer facing disclosure format, based on input from a broad range of stakeholders, accessible to persons with disabilities, and to consider whether different formats should be used for fixed and mobile service providers. See 2015 *Open Internet Order*, 30 FCC Rcd at 5680-81 ¶ 180. The recommendations were submitted on October 26, 2015, and are available on the FCC website, “Consumer Advisory Committee Recommendations 2014 thru 2016,” <https://www.fcc.gov/consumer-advisory-committee-recommendations-2014-thru-2016>.

⁴⁶⁴ See 2015 *Open Internet Order*, 30 FCC Rcd at 5609 ¶ 23.

must be disclosed and requires specific notification to consumers that a “network practice” is likely to significantly affect their use of the service.⁴⁶⁵

D. Intermodal Developments

155. Advances in technologies and functionalities have made mobile broadband services more versatile and useful to consumers. However, while fixed and mobile broadband services may provide overlapping capabilities, mobile and fixed services are not co-extensive in their capabilities; there are unique capabilities for each of fixed and mobile services. It is also sometimes the case that mobile services and fixed services enhance the quality of one another. In fact, residential and business consumers alike often use mobile and fixed services in concert to, for example, off load reliance from cellular networks to Wi-Fi systems that are connected to the internet via a fixed service.⁴⁶⁶ In addition, the increasingly dynamic nature of residential and business communication requires a mix of fixed and mobile broadband access to provide sufficient functionality for families and businesses whose members often simultaneously rely on data-capacity intensive applications at fixed locations and mobile applications on the go.

156. For voice services, we here provide the latest information from the Centers for Disease Control and Prevention’s (“CDC”) National Health Interview Survey on wireless substitution, which we emphasize only pertains to voice services and therefore no inferences regarding broadband services can, or should, be drawn based upon it. The survey includes information about household telephones and whether anyone in the household has a wireless telephone. Preliminary results from CDC’s January to June 2015 National Health Interview Survey indicate that the number of American homes with only wireless telephones continues to grow. As shown in Chart VII.D.1 and Chart VII.D.2, the percentage of U.S. adults and children living in households with landlines, with or without wireless, has fallen steadily over the past several years.⁴⁶⁷ The percentage of wireless-only households has continued to increase for both groups, and the percentage of households without phones has increased slightly.⁴⁶⁸ A significant percentage of homes with both landline and wireless phone access received all or almost all calls on wireless telephones despite also having a landline telephone.⁴⁶⁹

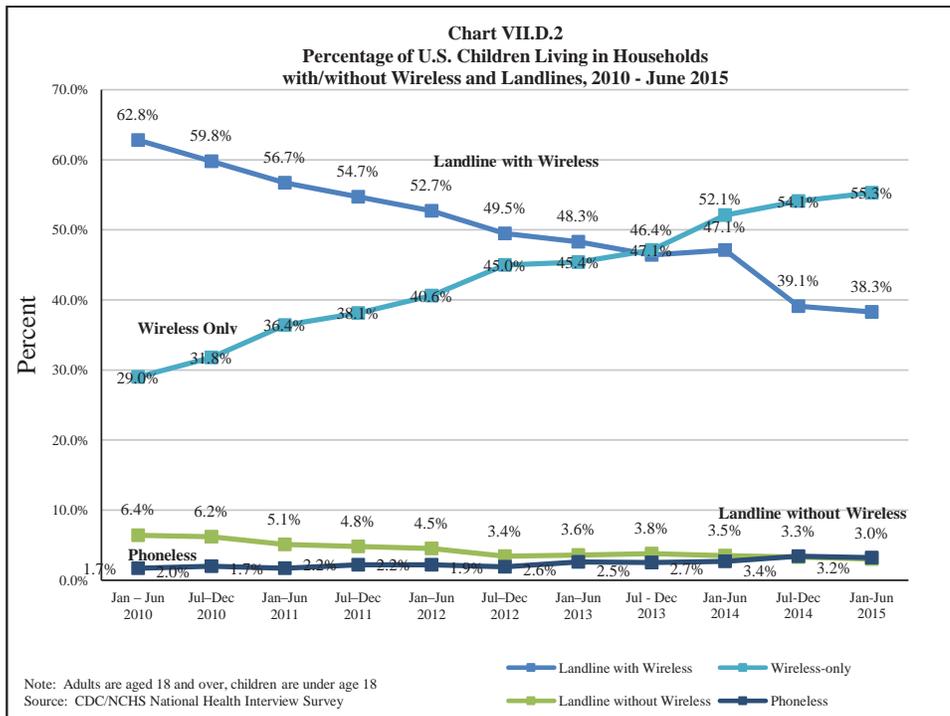
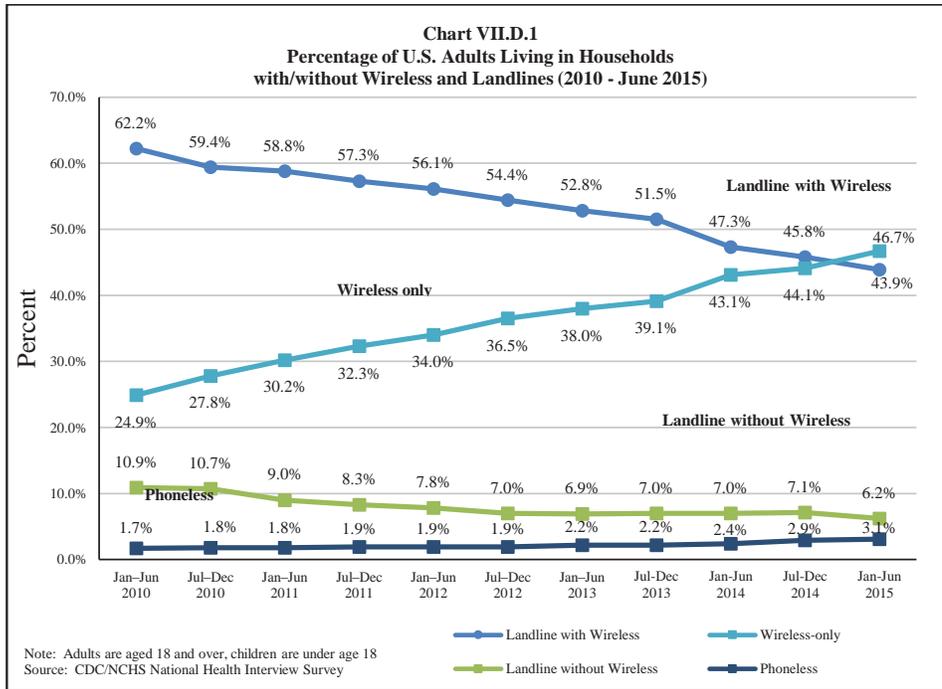
⁴⁶⁵ See *id.*

⁴⁶⁶ According to Cisco VNI Mobile, “By 2016, more than half of all traffic from mobile-connected devices will be offloaded to the fixed network by means of Wi-Fi devices and femtocells each month.” See Cisco VNI Mobile, “Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update 2014-2019 White Paper,” at 4, available at http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html. As of 2014, 45% of total mobile data traffic from all mobile-connected devices was offloaded. See *id.*, at 22.

⁴⁶⁷ See Appendix Tables VII.C.i and VII.C.ii.

⁴⁶⁸ See Stephen J. Blumberg and Julian V. Luke, “Wireless Substitution: Early Release of Estimates from the National Health Interview Survey,” January to June 2015, National Center for Health Statistics, Centers for Disease Control (December 2015), available at <http://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless201512.pdf>.

⁴⁶⁹ See *id.*



VIII. CONCLUSION

157. Promoting competition is a fundamental goal of the Commission's policymaking. Competition has played and must continue to play an essential role in the mobile wireless industry – leading to lower prices and higher quality for American consumers, and producing innovation and investment in wireless networks, devices, and services. This *Report* analyzes competition in the mobile wireless industry pursuant to section 332(c)(1)(C) of the Communications Act and highlights several key trends. As with past reports, this *Report* examines various facets of the mobile wireless industry including market concentration, the conduct and rivalry of service providers, and competition in other segments of the mobile wireless ecosystem, including spectrum, backhaul, and handsets/devices, as well as consumer behavior.

IX. PROCEDURAL MATTERS

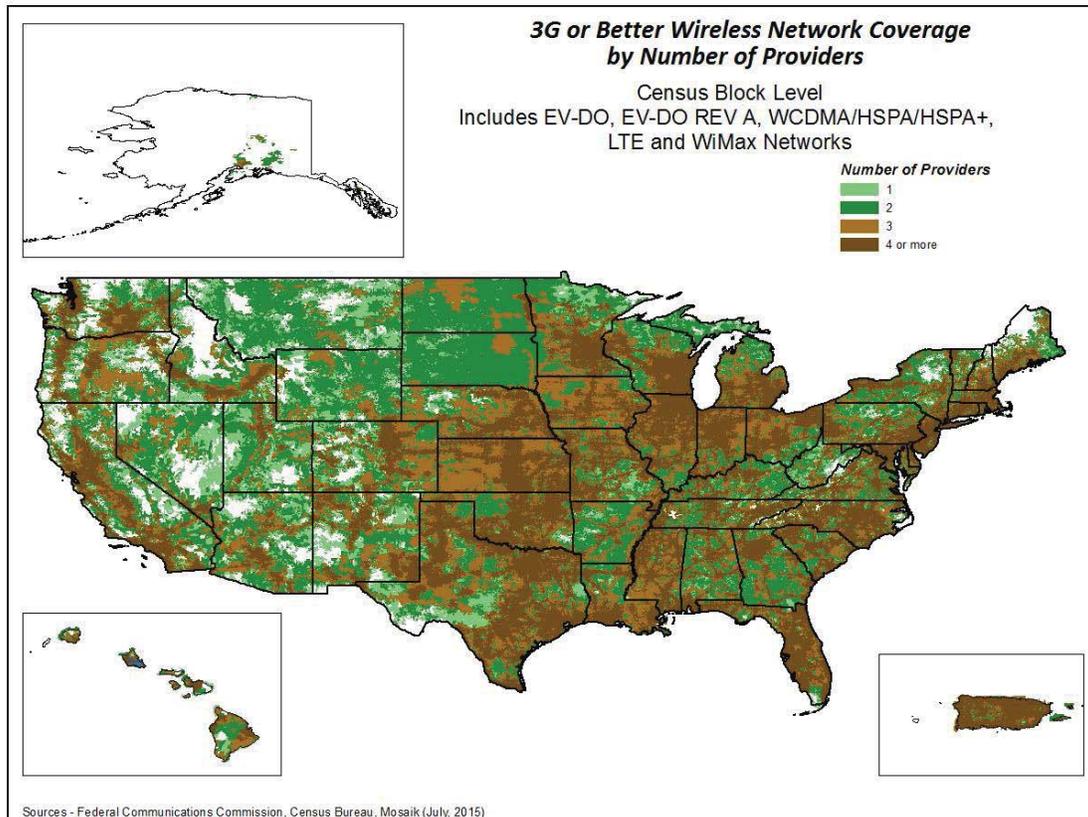
158. This *Eighteenth Report* is issued pursuant to authority contained in Section 332(c)(1)(C) of the Communications Act of 1934, as amended, 47 U.S.C. § 332(c)(1)(C), and authority delegated to the Wireless Telecommunications Bureau under section 0.331 of the Commission's rules, 47 C.F.R. § 0.331.

159. It is ORDERED that copies of this *Eighteenth Report* be sent to the appropriate committees and subcommittees of the United States House of Representatives and the United States Senate.

FEDERAL COMMUNICATIONS COMMISSION

Roger C. Sherman
Chief, Wireless Telecommunications Bureau

APPENDIX I:
MOBILE WIRELESS 3G OR BETTER COVERAGE BY NUMBER OF PROVIDERS⁴⁷⁰



Note: The percentages of population located in census blocks with a certain number of mobile service providers represent network coverage, which does not necessarily mean that they offered service to residents in the census block. In addition, we emphasize that a service provider reporting mobile wireless coverage in a particular census block may not provide coverage everywhere in the census block. For both these reasons, the number of service providers in a census block does not necessarily reflect the number of choices available to a particular individual or household, and does not purport to measure competition. In addition, calculations based on Mosaik data on coverage, while useful for measuring developments in mobile wireless coverage, have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

⁴⁷⁰ We note that additional coverage maps showing mobile wireless digital coverage (CDMA, GSM/TDMA, and iDEN), nationwide mobile wireless coverage, and nationwide mobile LTE coverage are provided in (web) Appendix 1, available at https://www.fcc.gov/reports-research/reports?og_group_ref_target_id=1638&field_report_series_tid=1733&shs_term_node_tid_depth=All&=Apply.

APPENDIX II: COMPETITIVE DYNAMICS WITHIN THE INDUSTRY

Connections, Net Adds, and Churn

Table II.B.i
Estimated Total Mobile Wireless Connections: 2002 – 2014

Year	NRUF			CTIA
	Connections (millions)	Increase from previous year (millions)	Connections Per 100 People	Estimated Connections (millions)
2002	141.8	13.3	49	140.8
2003	160.6	18.8	54	158.7
2004	184.7	24.1	62	182.1
2005	213.0	28.3	71	207.9
2006	241.8	28.8	80	233.0
2007	263.0	21.2	86	255.4
2008	279.6	16.6	91	270.3
2009	290.7	11.1	94	285.6
2010	301.8	11.1	97	296.3
2011	317.3	15.5	101	316.0
2012	329.2	11.9	105	326.5
2013	339.2	10.0	108	335.7
2014	357.1	17.2	114	355.4

Source: Based on CTIA Wireless Industry Indices Year-End 2014, Table 6. NRUF 2002 – 2014. 2010 Census data (2010 nationwide population including the territories is 312,846,492).

Table II.B.ii
Quarterly Total Mobile Wireless Connections by Service Segment
2012 – 2nd Quarter 2015

Quarter Year	Postpaid	Prepaid	Wholesale	Connected Devices	Total Connections
1Q12	215,466	69,133	13,955	24,502	323,056
2Q12	215,633	70,649	13,423	24,982	324,687
3Q12	216,129	71,112	13,567	25,836	326,644
4Q12	218,246	71,728	13,416	26,889	330,279
1Q13	217,887	73,007	16,847	28,233	335,974
2Q13	218,473	71,687	17,445	29,551	337,156
3Q13	221,142	71,906	17,881	30,932	341,862
4Q13	223,759	72,978	18,683	31,958	347,378
1Q14	225,580	74,827	17,738	33,661	351,807
2Q14	228,348	73,875	18,713	35,234	356,170
3Q14	231,572	73,774	20,210	38,462	364,017
4Q14	235,349	74,484	21,148	40,490	371,471
1Q15	237,409	74,606	22,236	41,961	376,213
2Q15	240,108	74,653	23,575	43,970	382,307

Source: UBS Investment Research. US Wireless 411, Version 51. US Wireless 411, Version 57.

Table II.B.iii
Quarterly Net Adds in Mobile Wireless Connections by Service Segment (in thousands)
2010 – 2nd Quarter 2015

Quarter Year	Postpaid	Prepaid	Wholesale	Connected Devices	Total Net Adds
1Q10	(6)	2,464	671	1,237	4,366
2Q10	813	749	483	1,421	3,466
3Q10	823	1,565	607	1,634	4,629
4Q10	895	2,633	39	1,831	5,398
1Q11	196	2,661	1,210	1,725	5,791
2Q11	787	1,093	1,017	1,452	4,349
3Q11	583	1,730	1,119	1,446	4,878
4Q11	1,304	1,998	1,506	76	4,884
1Q12	(147)	1,891	1,296	493	3,533
2Q12	784	414	568	480	2,246
3Q12	(405)	462	1,244	854	2,156
4Q12	2,177	603	(151)	1,053	3,682
1Q13	(3,872)	1,278	3,431	1,344	2,181
2Q13	263	(1,391)	598	1,318	788
3Q13	1,132	280	436	1,381	3,229
4Q13	2,492	1,069	802	1,026	5,389
1Q14	3,147	472	-945	1,703	4,378
2Q14	2,899	(1,029)	975	1,574	4,418
3Q14	3,064	686	1,497	1,967	7,214
4Q14	3,787	712	938	2,028	7,465
1Q15	2,003	187	1,088	1,471	4,748
2Q15	2,809	(21)	1,339	2,009	6,136

Source: 2010 data from the *Sixteenth Competition Report*, 28 FCC Rcd at 3836; UBS US Wireless 411 4Q11, at p. 10. 1Q12 - 2Q14 data from UBS US Wireless 411: Version 54; UBS US Wireless 411: Version 57.

Financial Indicators**Table II.D.i
Annualized Average Revenue Per Reported Subscriber Unit (ARPU): 1993 – 2014**

Year	Total Annual Service Revenue	Percentage Change	Average Reported Subscribers	Average Monthly Revenue per Active Subscriber Unit
1993	\$10,895,174,566		11,861,362	\$76.55
1994	\$14,229,921,264	30.6%	18,299,487	\$64.80
1995	\$19,081,239,000	34.1%	26,757,320	\$59.43
1996	\$23,634,971,000	23.9%	35,554,818	\$55.40
1997	\$27,485,632,936	16.3%	46,375,849	\$49.39
1998	\$33,133,174,978	20.6%	58,455,471	\$47.23
1999	\$40,018,489,104	20.8%	71,885,076	\$46.39
2000	\$52,466,019,720	31.1%	90,048,320	\$48.55
2001	\$65,316,235,000	24.5%	109,318,848	\$49.79
2002	\$76,508,187,000	17.1%	125,002,023	\$51.00
2003	\$87,624,093,000	14.5%	141,658,059	\$51.55
2004	\$102,121,210,043	16.5%	161,980,026	\$52.54
2005	\$113,538,220,438	11.2%	186,801,940	\$50.65
2006	\$125,456,824,884	10.5%	213,077,033	\$49.07
2007	\$138,869,303,958	10.7%	234,921,960	\$49.26
2008	\$148,084,169,893	6.6%	252,539,475	\$48.87
2009	\$152,551,853,953	3.0%	265,038,212	\$47.97
2010	\$159,929,646,977	4.9%	280,392,201	\$47.53
2011	\$169,767,314,353	6.2%	306,840,648	\$46.11
2012	\$185,013,934,995	9.0%	314,685,754	\$48.99
2013	\$189,192,811,836	2.3%	323,133,932	\$48.79
2014	\$187,848,477,106	(0.7%)	335,606,098	\$46.64

Source: Based on CTIA Year-End 2014 Wireless Indices Report, Table 27.

Table II.D.ii
Change in CPI, 1997 - 2014

Year	CPI		Wireless Telephone Services CPI		Telephone Services CPI		Land-line Telephone Services CPI	
	Index Value	Annual Change	Index Value	Annual Change	Index Value	Annual Change	Index Value	Annual Change
1997	100		100		100		-	-
1998	101.6		95.1		100.7		-	-
1999	103.8	2.2%	84.9	-10.7%	100.1	-0.6%	-	-
2000	107.3	3.4%	76.0	-10.5%	98.5	-1.6%	-	-
2001	110.3	2.8%	68.1	-10.4%	99.3	0.8%	-	-
2002	112.1	1.6%	67.4	-1.0%	99.7	0.4%	-	-
2003	114.6	2.3%	66.8	-0.9%	98.3	-1.4%	-	-
2004	117.7	2.7%	66.2	-0.9%	95.8	-2.5%	-	-
2005	121.7	3.4%	65.0	-1.8%	94.9	-0.9%	-	-
2006	125.6	3.2%	64.6	-0.6%	95.8	0.9%	-	-
2007	129.2	2.8%	64.4	-0.3%	98.2	2.6%	-	-
2008	134.1	3.8%	64.2	-0.2%	100.5	2.2%	-	-
2009	133.7	-0.4%	64.3	0.0%	102.4	1.9%	-	-
2010	135.9	1.6%	62.4	-2.9%	102.4	0.0%	101.6	-
2011	140.1	3.2%	60.1	-3.6%	101.2	-1.1%	103.3	1.7%
2012	143.0	2.1%	59.4	-1.2%	101.7	0.04%	106.1	2.7%
2013	145.2	1.5%	58.2	-1.6%	101.6	0.0%	109.3	3.0%
2014	147.4	1.6%	57.4	-2.1%	101.1	-0.4%	111.1	2.7%
1997 to 2014		35.6%		-44.8%		0.8%		10.1%

Source: Data from Bureau of Labor Statistics. All CPI figures were taken from BLS databases found on the BLS Internet site, available at <http://www.bls.gov>. Beginning in January 2010, the CPIs for local telephone service and long-distance telephone service were discontinued and replaced by a new CPI for land-line telephone services.

APPENDIX III: OVERALL WIRELESS INDUSTRY METRICS

The tables and charts below are based on Commission estimates derived from census block analysis of Mosaik CoverageRight coverage maps, July 2015.⁴⁷¹ We note that the percentage of the population located in census blocks with a certain number of service providers represents network coverage, which does not necessarily mean service is offered to residents in the census block. In addition, we emphasize that a service provider reporting coverage in a particular census block may not provide coverage everywhere in the census block. For both these reasons, the number of service providers in a census block does not necessarily reflect the number of choices available to a particular individual or household, and does not purport to measure competition. In addition, calculations based on Mosaik coverage data, while useful for measuring developments in mobile wireless coverage, have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

Table III.A.i
Estimated Mobile Wireless Coverage by Census Block Incl. Federal Land, July 2015

Number of Providers with Coverage in a Block	Number of Blocks	POPs Contained in Those Blocks	% of Total U.S. POPs	Square Miles Contained in Those Blocks	% of Total U.S. Square Miles	Road Miles Contained in Those Blocks	% of Total U.S. Road Miles
<i>U.S. Total</i>	<i>11,155,486</i>	<i>312,471,327</i>	<i>100.0</i>	<i>3,802,067</i>	<i>100.0</i>	<i>6,821,187</i>	<i>100.0</i>
1 or more	11,016,076	312,294,374	99.9	2,963,795	78.0	6,624,159	97.1
2 or more	10,746,142	311,349,672	99.6	2,611,973	68.7	6,253,679	91.7
3 or more	9,708,349	303,672,063	97.2	1,883,971	49.6	5,131,820	75.2
4 or more	8,150,122	286,467,076	91.7	1,161,936	30.6	3,773,219	55.3
5 or more	2,321,216	60,650,171	19.4	362,650	9.5	1,150,323	16.9

Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage.

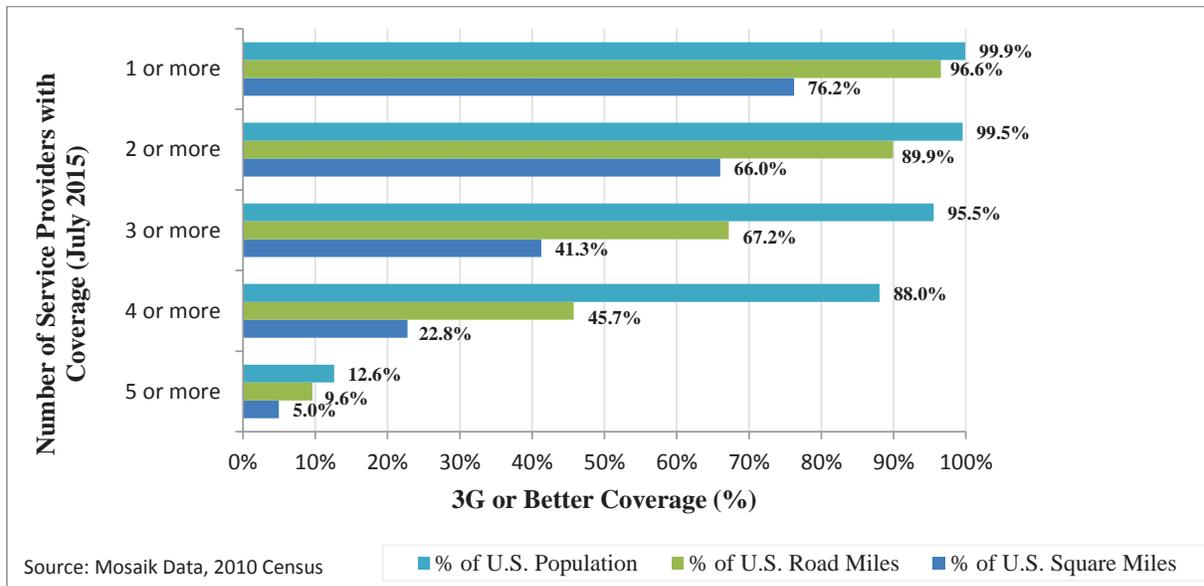
⁴⁷¹ Population data are from the 2010 Census, and include the United States and Puerto Rico. Square miles also include the United States and Puerto Rico.

Table III.A.ii
Estimated Mobile Wireless Coverage by Census Block Excl. Federal Land, July 2015

Number of Providers with Coverage in a Block	Number of Blocks	POPs Contained in Those Blocks	% of Total U.S. POPs	Square Miles Contained in Those Blocks	% of Total U.S. Square Miles	Road Miles Contained in Those Blocks	% of Total U.S. Road Miles
<i>U.S. Total</i>	10,449,282	307,208,959	100.0	2,664,706	100.0	5,893,270	100.0
1 or more	10,382,225	307,098,118	100.0	2,308,042	86.6	5,818,134	98.7
2 or more	10,201,965	306,332,361	99.7	2,139,846	80.3	5,608,895	95.2
3 or more	9,312,135	299,203,374	97.4	1,632,153	61.3	4,742,335	80.5
4 or more	7,890,214	282,721,581	92.0	1,058,820	39.7	3,579,215	60.7
5 or more	2,243,484	59,683,913	19.4	339,889	12.8	1,100,971	18.7

Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage.

Chart III.A.i
Estimated Mobile Wireless 3G or Better Coverage by Census Block, July 2015



Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage. The 3G and 4G technologies included are the following: EVDO, EVDO Rev A, WCDMA/HSPA, HSPA+, LTE, and mobile WiMAX.

Table III.A.iii
Estimated Mobile Wireless 3G or Better Coverage by Census Block
Incl. Federal Land, July 2015

Number of Providers with Coverage in a Block	Number of Blocks	POPs Contained in Those Blocks	% of Total U.S. POPs	Square Miles Contained in Those Blocks	% of Total U.S. Square Miles	Road Miles Contained in Those Blocks	% of Total U.S. Road Miles
<i>U.S. Total</i>	<i>11,155,486</i>	<i>312,471,327</i>	<i>100.0</i>	<i>3,802,067</i>	<i>100.0</i>	<i>6,821,187</i>	<i>100.0</i>
1 or more	10,989,916	312,202,031	99.9	2,898,617	76.2	6,585,914	96.6
2 or more	10,662,014	311,014,320	99.5	2,510,098	66.0	6,133,402	89.9
3 or more	9,156,885	298,502,327	95.5	1,569,270	41.3	4,584,799	67.2
4 or more	7,269,188	275,130,421	88.0	865,111	22.8	3,120,038	45.7
5 or more	1,426,253	39,389,479	12.6	189,175	5.0	655,795	9.6

Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage. The 3G and 4G technologies included are the following: EVDO, EVDO Rev A, WCDMA/HSPA, HSPA+, LTE, and mobile WiMAX.

Table III.A.iv
Estimated Mobile Wireless 3G or Better Coverage by Census Block
Excl. Federal Land, July 2015

Number of Providers with Coverage in a Block	Number of Blocks	POPs Contained in Those Blocks	% of Total U.S. POPs	Square Miles Contained in Those Blocks	% of Total U.S. Square Miles	Road Miles Contained in Those Blocks	% of Total U.S. Road Miles
<i>U.S. Total</i>	<i>10,449,282</i>	<i>307,208,959</i>	<i>100.0</i>	<i>2,664,706</i>	<i>100.0</i>	<i>5,893,270</i>	<i>100.0</i>
1 or more	10,366,375	307,042,064	99.9	2,280,745	85.6	5,799,540	98.4
2 or more	10,139,497	306,055,154	99.6	2,084,969	78.2	5,533,794	93.9
3 or more	8,824,450	294,291,060	95.8	1,401,983	52.6	4,298,999	72.9
4 or more	7,063,962	271,690,765	88.4	808,420	30.3	2,994,361	50.8
5 or more	1,380,956	38,743,888	12.6	179,259	6.7	630,889	10.7

Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage. The 3G and 4G technologies included are the following: EVDO, EVDO Rev A, WCDMA/HSPA, HSPA+, LTE, and mobile WiMAX.

Table III.A.v
Estimated Mobile Wireless Network Coverage by Technology by Census Block, Mosaik, July 2015⁴⁷²

Technology	POPs in Covered Blocks	% of Total POPs	Square Miles Contained in Those Blocks	% of Total Square Miles	Road Miles Contained in Those Blocks	% of Total U.S. Road Miles
CDMA 1xRTT	310,903,292	99.5	2,590,683	68.1	6,208,441	91.0
GPRS/EDGE	310,031,545	99.2	2,508,242	66.0	6,045,466	88.6
WCDMA/HSPA/HSPA+	311,299,550	99.6	2,716,645	71.5	6,354,398	93.2
EV-DO/EV-DO Rev. A	310,594,906	99.4	2,487,400	65.4	6,093,222	89.3
Mobile WiMAX	105,546,452	33.8	43,978	1.2	419,921	6.2
LTE	311,115,606	99.6	2,573,689	67.7	6,185,589	90.7

Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage.

Table III.A.vi
Estimated Mobile Voice Coverage in Rural Areas by Census Block, July 2015

# of Providers with Coverage in a Block	Number of Rural Census Blocks	POPs Contained in Rural Census Blocks	% of Total U.S. POPs	Square Miles Contained in Those Blocks	% of Total U.S. Square Miles	Road Miles Contained in Those Blocks	% of Total U.S. Road Miles
<i>Total for Rural U.S.</i>	5,387,335	59,151,859	18.9	3,213,692	84.5	4,591,032	67.3
			Total Rural U.S. POPs (%)		Total Rural U.S. Square Miles (%)		Total Rural U.S. Road Miles (%)
1 or more	5,174,914	58,775,012	99.4	2,288,106	71.2	4,277,960	93.2
2 or more	4,822,529	57,347,877	97.0	1,865,528	58.0	3,780,261	82.3
3 or more	3,798,592	49,682,553	84.0	1,212,368	37.7	2,704,800	58.9
4 or more	2,486,882	37,017,213	62.6	623,726	19.4	1,566,324	34.1
5 or more	910,191	14,345,261	24.3	190,415	5.9	517,884	11.3

Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage.

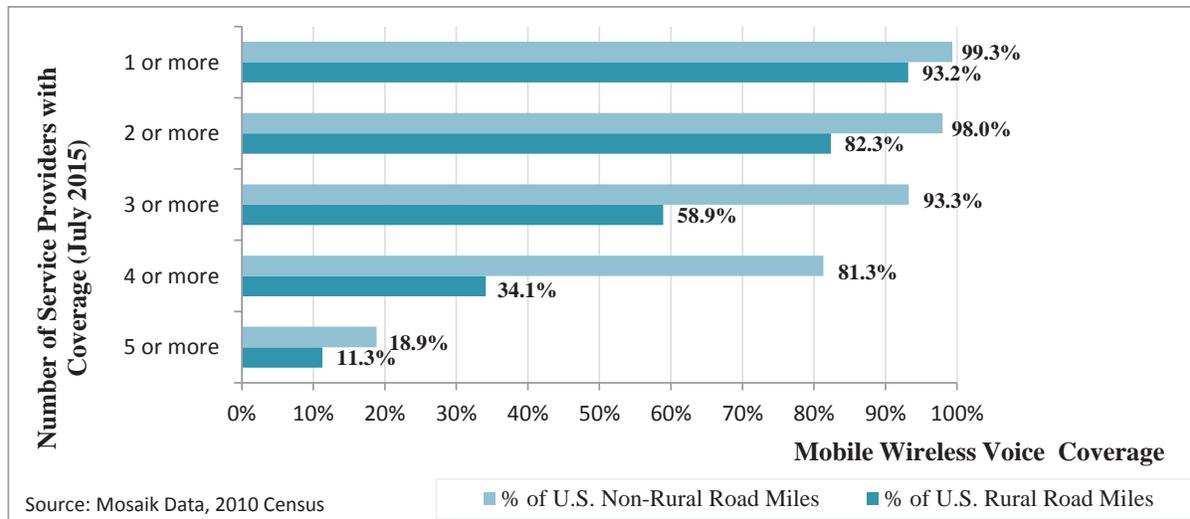
⁴⁷² The Commission has adopted flexible licensing policies and does not mandate any particular technology or network standard for mobile wireless licensees. Service providers choose their own network technologies and services and abide by certain technical parameters designed to avoid radiofrequency interference with adjacent licensees.

Table III.A.vii
Estimated Mobile Voice Coverage in Non-Rural Areas by Census Block, July 2015

Number of Providers with Coverage in a Block	Number of Non-Rural Census Blocks	POPs Contained in Non-Rural Census Blocks	% of Total U.S. POPs	Square Miles in Those Blocks	% of Total U.S. Square Miles	Road Miles in Those Blocks	% of Total U.S. Road Miles
<i>Total for Non-Rural U.S.</i>	<i>5,768,151</i>	<i>253,319,468</i>	<i>81.8</i>	<i>588,375</i>	<i>15.5</i>	<i>2,230,155</i>	<i>32.7</i>
			Total Non-Rural U.S. POPs (%)		Total Non-Rural U.S. Square Miles (%)		Total Non-Rural U.S. Road Miles (%)
1 or more	5,752,400	253,269,831	100.0	548,426	93.2	2,215,348	99.3
2 or more	5,721,720	253,040,079	99.9	525,354	89.3	2,184,864	98.0
3 or more	5,588,728	251,115,541	99.1	465,900	79.2	2,079,791	93.3
4 or more	5,176,461	242,007,399	95.5	356,433	60.6	1,813,178	81.3
5 or more	1,116,038	41,546,985	16.4	88,355	15.0	420,408	18.9

Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage.

Chart III.A.ii
Estimated Mobile Wireless Voice Coverage by Road Miles by Census Block in Rural vs. Non-Rural Areas, July 2015



Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage.

Table III.A.viii
Estimated Mobile Wireless 3G or Better Coverage in Rural Areas
by Census Block, July 2015

Total Number of Providers with Coverage in a Block	Number of Rural Census Blocks	POPs Contained in Rural Census Blocks	% of Total Rural U.S. POPs	Square Miles Contained in Those Blocks	% of Total Rural U.S. Square Miles	Road Miles Contained in Those Blocks	% of Total Rural U.S. Road Miles
1 or more	5,231,510	58,903,268	99.6	2,345,458	73.0	4,366,137	95.1
2 or more	4,929,198	57,862,216	97.8	1,979,675	61.6	3,938,223	85.8
3 or more	3,588,316	47,515,484	80.3	1,113,264	34.6	2,525,449	55.0
4 or more	2,144,623	33,098,991	56.0	513,134	16.0	1,325,305	28.9
5 or more	654,006	10,392,502	17.6	127,143	4.0	361,759	7.9

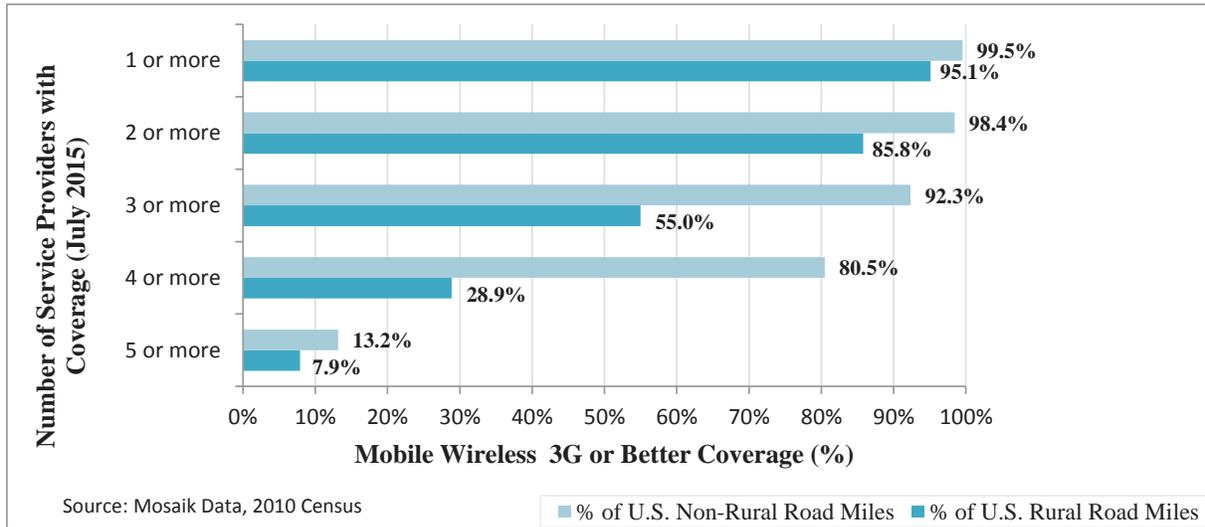
Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage. The 3G and 4G technologies included are the following: EVDO, EVDO Rev A, WCDMA/HSPA, HSPA+, LTE, and mobile WiMAX.

Table III.A.xix
Estimated Mobile Wireless 3G or Better Coverage in Non-Rural Areas
by Census Block, July 2015

Total Number of Providers with Coverage in a Block	Number of Non-Rural Census Blocks	POPs Contained in Non-Rural Census Blocks	% of Total Non-Rural U.S. POPs	Square Miles Contained in Those Blocks	% of Total Non-Rural U.S. Square Miles	Road Miles Contained in Those Blocks	% of Total Non-Rural U.S. Road Miles
1 or more	5,758,406	253,298,763	100.0	553,159	94.0	2,219,778	99.5
2 or more	5,732,816	253,152,104	99.9	530,423	90.2	2,195,179	98.4
3 or more	5,568,569	250,986,843	99.1	456,006	77.5	2,059,350	92.3
4 or more	5,124,565	242,031,430	95.5	351,977	59.8	1,794,734	80.5
5 or more	772,247	28,996,977	11.4	62,032	10.5	294,037	13.2

Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage. The 3G and 4G technologies included are the following: EVDO, EVDO Rev A, WCDMA/HSPA, HSPA+, LTE, and mobile WiMAX.

Chart III.A.iii
Estimated Mobile Wireless 3G or Better Coverage by Road Miles
by Census Block, in Rural vs. Non-Rural Areas, July 2015



Source: Based on July 2015 Mosaik and 2010 Census data. It is important to note that the number of service providers in a census block represent network coverage only. Network coverage does not necessarily reflect the number of service providers from which any particular individual or household in a given area may choose. Coverage calculations based on Mosaik data, while useful for measuring developments in mobile coverage, have certain limitations that likely result in an overstatement of the extent of mobile coverage. The 3G and 4G technologies included are the following: EVDO, EVDO Rev A, WCDMA/HSPA, HSPA+, LTE, and mobile WiMAX.

APPENDIX IV: INPUT MARKET

Table IV.B.i
Year End Cell Site Counts by Service Provider, 2012 – 2014⁴⁷³

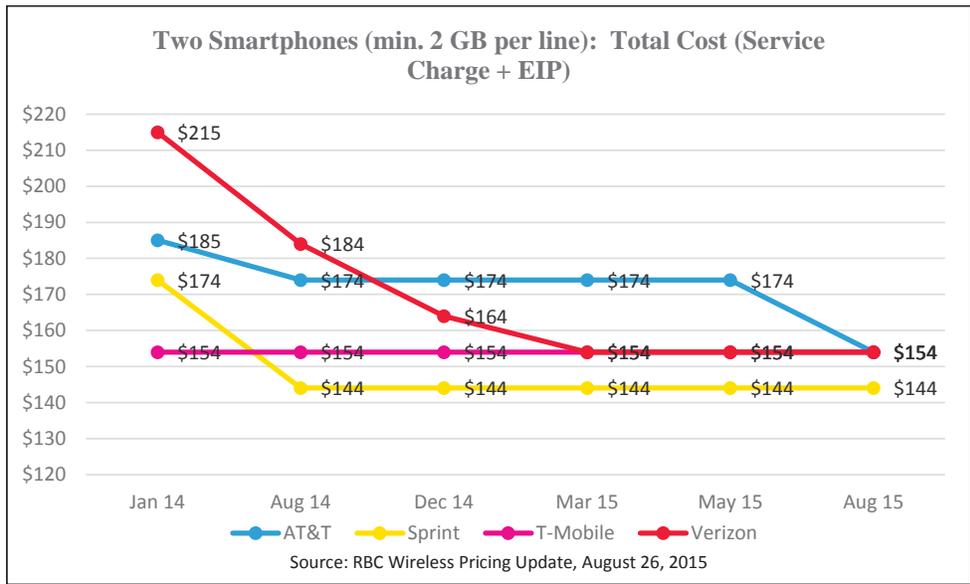
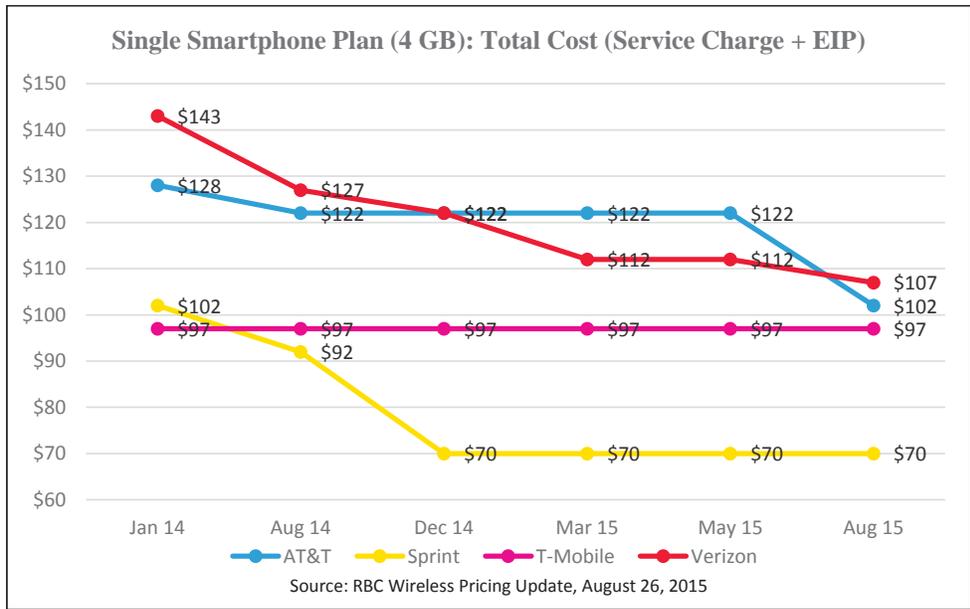
Cell Sites	2012	2013	2014	1 st Half 2015
Verizon Wireless	44,590	46,655	50,065	51,500
AT&T	56,900	61,800	71,768	67,383
Sprint	57,900	55,000	55,000	55,000
T-Mobile	51,104	63,879	61,079	58,651
NTELOS	1,429	1,444	1,453	1,443
US Cellular	8,028	6,975	6,220	6,223
Total by Top Seven Reported Service Providers	228,951	244,753	245,585	240,200
CTIA Reported Total Industry-wide Cell Sites	301,779	304,360	298,055	

Source: Cell site counts for service providers are from UBS US Wireless 411: Version 57, Figure 63. The total industry-wide cell count is from CTIA Wireless Industry Indices Year-End 2014, at p. 103, Sept. 2015.

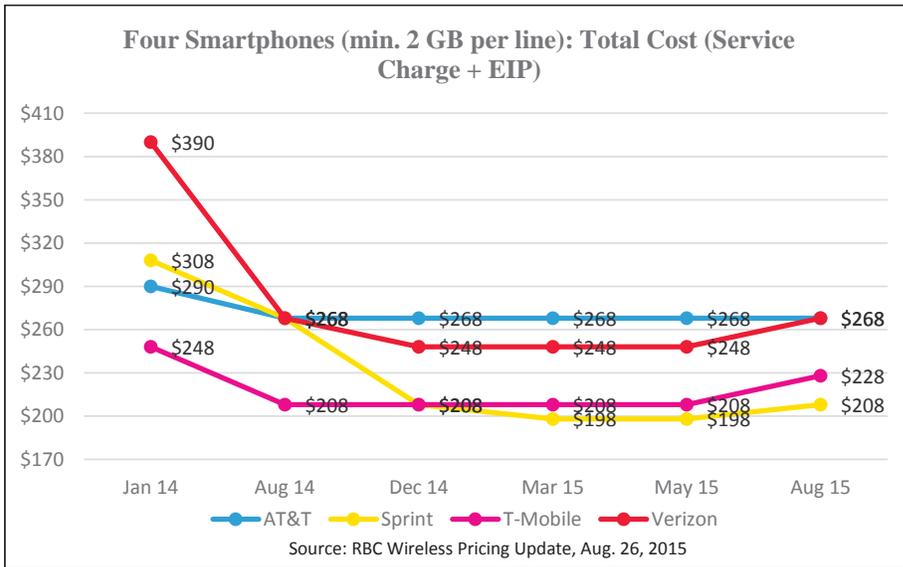
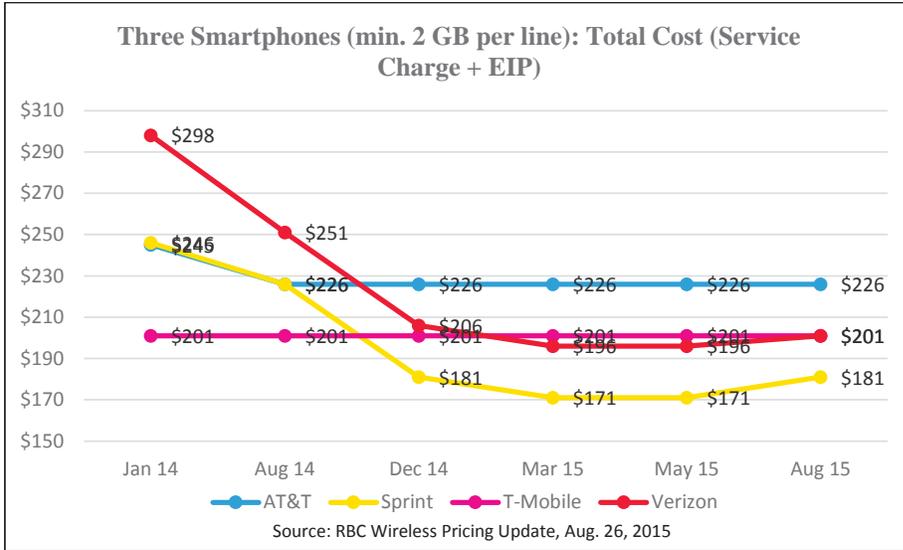
⁴⁷³ See CTIA Wireless Industry Indices Year-End 2014, at p. 101. Because multiple cell sites can be co-located in the same “tower” site, the reported cell sites should not be equated with “towers.” The reported cell sites include repeaters and other cell-extending devices (e.g., femtocells, or distributed antenna systems). See CTIA Wireless Industry Indices Year-End 2014, at pp. 101-2.

APPENDIX V: PRICING

The charts below show pricing changes for various plans across the four nationwide service providers, sourced from RBC Capital Markets, for the time period January 2014 through August 2015.⁴⁷⁴



⁴⁷⁴ See RBC Capital Markets, “Wireless Pricing Update, Wireless Telecommunications Service,” Jonathan Atkin and Brian Hyun (Aug. 26, 2015).



APPENDIX VI: NON-PRICE RIVALRY

Network Coverage

The tables below are based on Commission estimates derived from census block analysis of Mosaik CoverageRight coverage maps, July 2015.⁴⁷⁵ We note that the percentage of the population located in census blocks with a certain number of service providers represents network coverage, which does not necessarily mean service is offered to residents in the census block. In addition, we emphasize that a service provider reporting coverage in a particular census block may not provide coverage everywhere in the census block. For both these reasons, the number of service providers in a census block does not necessarily reflect the number of choices available to a particular individual or household, and does not purport to measure competition. In addition, calculations based on Mosaik coverage data, while useful for measuring developments in mobile wireless coverage, have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

Table VI.B.i
Estimated Mobile Wireless Coverage in the U.S. by Service Provider, July 2015

Service Provider	Number of Blocks	POPS Contained in Those Blocks	% of Total U.S. POPs	% of Total U.S. Square Miles	% of Total U.S. Road Miles
Total for U.S.	11,155,486	312,471,327	100.0	100.0	100.0
AT&T	10,646,897	310,278,040	99.3	68.4	90.5
Verizon Wireless	10,300,641	304,170,059	97.3	63.7	87.0
Sprint	7,526,872	280,152,856	89.7	24.0	47.3
T-Mobile	8,183,337	286,265,928	91.6	34.0	58.0

Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

Table VI.B.ii
Estimated Mobile Wireless 3G or Better Coverage in the U.S. by Service Provider, July 2015

Service Provider	Number of Blocks	POPS Contained in Those Blocks	% of Total U.S. POPs	% of Total U.S. Square Miles	% of Total U.S. Road Miles
Total for U.S.	11,155,486	312,471,327	100.0	100.0	100.0
AT&T	10,616,327	310,136,594	99.3	67.5	90.0
Verizon Wireless	10,287,446	304,107,377	97.3	63.1	86.7
Sprint	7,526,872	280,152,856	89.7	24.0	47.3
T-Mobile	7,077,781	272,483,385	87.2	23.8	45.7

Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage. The 3G and 4G technologies included are the following: EVDO, EVDO Rev A, WCDMA/HSPA, HSPA+, LTE, and mobile WiMAX.

⁴⁷⁵ Population data are from the 2010 Census, and include the United States and Puerto Rico. Square miles also include the United States and Puerto Rico.

Table VI.B.iii
Estimated LTE Broadband Coverage in the U.S. by Service Provider, July 2015

Service Provider	Number of Blocks	POPS Contained in Those Blocks	% of Total U.S. POPs	% of Total U.S. Square Miles	% of Total U.S. Road Miles
Total for U.S.	11,155,486	312,471,327	100.0	100.0	100.0
AT&T	9,515,982	302,070,044	96.7	46.4	72.2
Verizon Wireless	10,159,559	303,212,253	97.0	60.9	84.6
Sprint	6,637,924	265,642,199	85.0	17.7	38.6
T-Mobile	6,672,986	266,234,619	85.2	20.1	41.0

Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

Table VI.B.iv
Estimated Mobile Wireless Voice Coverage in Rural Areas by Service Provider, July 2015

	Number of Rural Census Blocks	POPS Contained in Rural Census Blocks	% of Total U.S. POPs	% of Total U.S. Square Miles	% of Total U.S. Road Miles
Total for U.S.	5,387,335	59,151,859	18.9	84.5	67.3
Provider	Number of Rural Census Blocks	POPS Contained in Rural Census Blocks	% of Total Rural U.S. POPs	% of Total Rural U.S. Square Miles	% of Total Rural U.S. Road Miles
AT&T	4,398,674	54,048,800	91.4	51.2	73.3
Verizon Wireless	4,501,096	53,715,705	90.8	55.7	78.3
Sprint	2,096,363	33,581,916	56.8	14.6	26.9
T-Mobile	2,651,166	37,784,502	63.9	24.6	40.1

Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

Table VI.B.v
Estimated Mobile Wireless Voice Coverage in Non-Rural Areas by Service Provider, July 2015

	Number of Non-Rural Census Blocks	POPS Contained in Non-Rural Census Blocks	% of Total U.S. POPs	% of Total U.S. Square Miles	% of Total U.S. Road Miles
Total for U.S.	5,768,151	253,319,468	81.8	15.5	32.7
Provider	Number of Non-Rural Census Blocks	POPS Contained in Non-Rural Census Blocks	% of Total Non-Rural U.S. POPs	% of Total Non-Rural U.S. Square Miles	% of Total Non-Rural U.S. Road Miles
AT&T	5,719,061	252,918,393	99.8	89.8	97.9
Verizon Wireless	5,603,401	248,298,419	98.0	86.6	95.8
Sprint	5,112,435	239,696,324	94.6	59.2	78.9
T-Mobile	5,374,070	246,561,147	97.3	73.7	88.8

Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

Table VI.B.vi
Estimated Mobile 3G or Better Coverage in Rural Areas by Service Provider, July 2015

	Number of Rural Census Blocks	POPS Contained in Rural Census Blocks	% of Total U.S. POPs	% of Total U.S. Square Miles	% of Total U.S. Road Miles
Total for U.S.	5,387,335	59,151,859	18.9	84.5	67.3
Provider	Number of Rural Census Blocks	POPS Contained in Rural Census Blocks	% of Total Rural U.S. POPs	% of Total Rural U.S. Square Miles	% of Total Rural U.S. Road Miles
AT&T	4,869,669	56,940,755	96.3	63.1	85.7
Verizon Wireless	4,651,740	55,050,346	93.1	58.6	81.7
Sprint	2,246,358	35,567,035	60.1	16.2	29.5
T-Mobile	1,948,906	30,772,737	52.0	16.3	27.9

Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage. The 3G and 4G technologies included are the following: EVDO, EVDO Rev A, WCDMA/HSPA, HSPA+, LTE, and mobile WiMAX.

Table VI.B.vii
Estimated Mobile 3G or Better Coverage in Non-Rural Areas by Service Provider, July 2015

	Number of Non-Rural Census Blocks	POPS Contained in Non-Rural Census Blocks	% of Total U.S. POPs	% of Total U.S. Square Miles	% of Total U.S. Road Miles
Total for U.S.	5,768,151	253,319,468	81.8	15.5	32.7
Provider	Number of Non-Rural Census Blocks	POPS Contained in Non-Rural Census Blocks	% of Total Non-Rural U.S. POPs	% of Total Non-Rural U.S. Square Miles	% of Total Non-Rural U.S. Road Miles
AT&T	5,746,658	253,195,839	100.0	91.4	98.9
Verizon Wireless	5,635,706	249,057,031	98.3	88.2	96.8
Sprint	5,280,514	244,585,821	96.6	66.4	83.9
T-Mobile	5,128,875	241,710,648	95.4	64.7	82.3

Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage. The 3G and 4G technologies included are the following: EVDO, EVDO Rev A, WCDMA/HSPA, HSPA+, LTE, and mobile WiMAX.

Table VI.B.viii
Estimated LTE Broadband Coverage in Rural Areas by Service Provider, July 2015

	Number of Rural Census Blocks	POPS Contained in Rural Census Blocks	% of Total U.S. POPs	% of Total U.S. Square Miles	% of Total U.S. Road Miles
Total for U.S.	5,387,335	59,151,859	18.9	84.5	67.3
Provider	Number of Rural Census Blocks	POPS Contained in Rural Census Blocks	% of Total Rural U.S. POPs	% of Total Rural U.S. Square Miles	% of Total Rural U.S. Road Miles
AT&T	3,887,034	50,348,879	85.1	39.8	61.4
Verizon Wireless	4,546,276	54,451,645	92.1	56.2	79.0
Sprint	1,660,665	28,469,487	48.1	10.4	20.2
T-Mobile	1,677,041	28,004,770	47.3	12.7	22.6

Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

Table VI.B.ix
Estimated LTE Broadband Coverage in Non-Rural Areas by Service Provider, July 2015

	Number of Non-Rural Census Blocks	POPS Contained in Non-Rural Census Blocks	% of Total U.S. POPs	% of Total U.S. Square Miles	% of Total U.S. Road Miles
Total for U.S.	5,768,151	253,319,468	81.8	15.5	32.7
Service Provider	Number of Non-Rural Census Blocks with LTE Coverage	POPS Contained in Non-Rural Census Blocks with LTE Coverage	% of Total Non-Rural U.S. POPs with LTE Coverage	% of Total Non-Rural U.S. Square Miles with LTE Coverage	% of Total Non-Rural U.S. Road Miles with LTE Coverage
AT&T	5,628,948	251,721,165	99.4	82.1	94.5
Verizon Wireless	5,613,283	248,760,608	98.2	86.6	96.0
Sprint	4,977,259	237,172,712	93.6	57.4	76.6
T-Mobile	4,995,945	238,229,849	94.0	60.4	78.9

Source: July 2015 Mosaik and 2010 Census. It is important to note that the data underlying these estimates measure mobile network coverage only. Network coverage does not necessarily reflect whether a service provider is indeed affirmatively offering service to residents in all these geographical areas. In addition, the Mosaik data as well as the coverage calculation methodology have certain limitations that likely result in an overstatement of the extent of mobile wireless coverage.

Quality of Service

Ookla: An in-depth discussion of the Ookla speed test is available in the *Seventeenth Report*.⁴⁷⁶ In this *Report*, we present mobile wireless upload and download speeds within the United States for the second half of 2014 through the first half of 2015.⁴⁷⁷ Commission staff estimated the total value of each parameter for all service providers using the specific technology combination in the applicable geographic region. For each geographic and technological subgroup, the total mean value is calculated to be the mean of all the state means, and the total median is the median of all the state medians.

Table VI.C.i
Ookla Speed Test - Estimated Download Speeds by Service Provider, Nationwide

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests ('000s)	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests ('000s)	Mean Down load Speed (Mbps)	Median Download Speed (Mbps)	Number of tests ('000s)
Verizon Wireless	15.26	11.86	4,115	15.62	12.18	7,082	16.11	12.65	2,968
AT&T	10.66	7.29	5,465	10.97	7.52	9,191	11.44	7.86	3,726
Sprint	6.83	4.68	3,627	7.24	4.93	6,044	7.89	5.35	2,417
T-Mobile	12.90	10.23	6,207	13.50	10.66	11,302	14.19	11.04	5,093
Total	6.29	5.00	19,926	6.65	5.43	34,487	7.38	5.94	14,558

Source: Ookla Internet performance data, © 2015 Ookla, LLC. All rights reserved. Total mean and median download speeds are calculated using data for the four nationwide service providers, as well as any other wireless service providers that appear in the Ookla dataset.

Table VI.C.ii
Ookla Speed Test - Estimated LTE Download Speeds by Service Provider, Nationwide

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests ('000s)	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests ('000s)	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests ('000s)
Verizon Wireless	16.18	12.77	3,880	16.39	12.95	6,747	16.67	13.23	2,867
AT&T	13.33	10.38	4,122	13.29	10.18	7,223	13.27	9.93	3,101
Sprint	9.26	7.47	2,893	9.55	7.46	5,024	10.00	7.73	2,130
T-Mobile	18.45	16.79	4,368	17.54	15.23	8,518	17.31	14.39	4,150
Total	11.63	10.20	15,563	11.48	10.01	28,060	11.20	9.51	12,495

Source: Ookla Internet performance data, © 2015 Ookla, LLC. All rights reserved. Total mean and median download speeds are calculated using data for the four nationwide service providers, as well as any other wireless service providers that appear in the Ookla dataset.

⁴⁷⁶ See *Seventeenth Report*, 29 FCC Rcd at 15465-66, Appendix VI. ¶¶ 1-6.

⁴⁷⁷ The provider specific mean, median, and count values shown below were provided to the Commission by Ookla, who estimated these parameters by service provider, at the state and nationwide level, for all technologies and for LTE only.

Table VI.C.iii
Ookla Speed Test - Estimated Upload Speeds by Service Provider, Nationwide

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)
Verizon Wireless	6.00	4.57	4,115	6.10	4.56	7,082	6.25	4.58	2,968
AT&T	4.18	2.75	5,465	4.31	2.96	9,191	4.51	3.27	3,726
Sprint	2.93	2.11	3,627	3.08	2.23	6,044	3.31	2.45	2,417
T-Mobile	5.45	4.00	6,207	5.88	4.58	11,302	6.38	5.27	5,093
Total	2.68	2.07	19,926	2.88	2.32	34,487	3.25	2.63	14,558

Source: Ookla Internet performance data, © 2015 Ookla, LLC. All rights reserved. Total mean and median upload speeds are calculated using data for the four nationwide service providers, as well as any other wireless service providers that appear in the Ookla dataset.

Table VI.C.iv
Ookla Speed Test - Estimated LTE Upload Speeds by Service Provider, Nationwide

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)
Verizon Wireless	6.34	5.00	3,880	6.39	4.91	6,747	6.46	4.83	2,867
AT&T	5.38	4.50	4,122	5.37	4.48	7,223	5.36	4.45	3,101
Sprint	3.97	3.60	2,893	4.02	3.55	5,024	4.21	3.64	2,130
T-Mobile	8.13	7.68	4,368	8.02	7.45	8,518	8.04	7.34	4,150
Total	5.15	4.60	15,563	5.27	4.72	28,060	5.18	4.56	12,495

Source: Ookla Internet performance data, © 2015 Ookla, LLC. All rights reserved. Total mean and median upload speeds are calculated using data for the four nationwide service providers, as well as any other wireless service providers that appear in the Ookla dataset.

Table VI.C.v
Ookla Speed Test - Estimated Download Speeds by Service Provider, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load speed (Mbps)	Median Down load speed (Mbps)	Number of tests ('000s)	Mean Down load speed (Mbps)	Median Down load speed (Mbps)	Number of tests ('000s)	Mean Down load speed (Mbps)	Median Download speed (Mbps)	Number of tests ('000s)
Verizon Wireless	16.85	11.45	696	18.34	12.64	1,151	20.51	14.65	456
AT&T	11.89	7.56	966	12.24	7.78	1,650	12.70	8.07	684
Sprint	6.65	4.12	578	7.34	4.53	923	8.50	5.26	344
T-Mobile	14.77	11.27	1,596	14.77	10.70	2,930	14.77	9.98	1,334
Total	9.11	8.01	3,912	8.50	7.53	6,774	7.42	6.15	2,861

Source: Ookla Internet performance data, © 2015 Ookla, LLC. All rights reserved. Total mean and median download speeds are calculated using data for the four nationwide service providers, as well as any other wireless service providers that appear in the Ookla dataset.

Table VI.C.vi
Ookla Speed Test - Estimated LTE Download Speeds by Service Provider, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load speed (Mbps)	Median Down load speed (Mbps)	Number of tests ('000s)	Mean Down load speed (Mbps)	Median Down load speed (Mbps)	Number of tests ('000s)	Mean Down load speed (Mbps)	Median Download speed (Mbps)	Number of tests ('000s)
Verizon Wireless	17.48	12.12	664	18.94	13.31	1,107	21.03	15.27	442
AT&T	13.95	9.87	754	14.05	9.74	1,332	14.17	9.57	579
Sprint	8.69	6.32	440	9.19	6.49	736	9.93	6.78	295
T-Mobile	18.50	15.96	1,146	17.81	14.60	2,247	17.06	12.86	1,101
Total	13.86	12.60	3,052	14.48	13.18	5,500	11.09	9.36	2,448

Source: Ookla Internet performance data, © 2015 Ookla, LLC. All rights reserved. Total mean and median download speeds are calculated using data for the four nationwide service providers, as well as any other wireless service providers that appear in the Ookla dataset.

Table VI.C.vii
Ookla Speed Test - Estimated Upload Speeds by Top 4 Nationwide Service Provider, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)
Verizon Wireless	7.12	4.70	696	7.62	4.88	1,151	8.36	5.17	456
AT&T	5.00	2.81	966	5.12	3.07	1,650	5.28	3.40	684
Sprint	2.58	1.14	578	2.81	1.32	923	3.20	1.60	344
T-Mobile	7.85	5.69	1,596	8.16	6.21	2,930	8.52	6.80	1,334
Total	4.38	3.79	3,912	3.90	3.35	6,774	3.22	2.57	2,861

Source: Ookla Internet performance data, © 2015 Ookla, LLC. All rights reserved. Total mean and median upload speeds are calculated using data for the four nationwide service providers, as well as any other wireless service providers that appear in the Ookla dataset.

Table VI.C.viii
Ookla Speed Test - Estimated LTE Upload Speeds by Service Provider, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)	Mean Upload speed (Mbps)	Median Upload speed (Mbps)	Number of tests ('000s)
Verizon Wireless	7.38	4.99	664	7.87	5.15	1,107	8.57	5.42	442
AT&T	6.06	4.44	754	6.06	4.47	1,332	6.05	4.51	579
Sprint	3.28	2.32	440	3.44	2.32	736	3.68	2.32	295
T-Mobile	10.35	9.11	1,146	10.28	9.01	2,247	10.20	8.91	1,101
Total	6.95	6.44	3,052	6.94	6.37	5,500	5.11	4.43	2,448

Source: Ookla Internet performance data, © 2015 Ookla, LLC. All rights reserved. Total mean and median upload speeds are calculated using data for the four nationwide service providers, as well as any other wireless service providers that appear in the Ookla dataset.

FCC: An in-depth discussion of the FCC Speed test is available in the *Seventeenth Report*.⁴⁷⁸ In this *Report*, we present mobile wireless upload and download speeds within the United States for the second half of 2014 through the first half of 2015. These values are estimated using all technologies, and also for LTE only.⁴⁷⁹ We note that throughput is originally measured in bytes/sec, and the conversion to Mbps is [1 Mbps=8*(10⁻⁶) bytes/sec]. Roaming observations are included in the mean and median speed estimates, in order to mimic actual customer experience. Total mean and median download speeds are calculated using data for the four nationwide providers, as well as any other wireless service providers that appear in the FCC dataset.

The data collected by the Measuring Broadband America Program's FCC Speed Test App for Android and iOS Speed data were used in this *Report*. These data included the test results for download, upload, and latency as well as information about the handset and cellular environment such as the location of the test, operating system of the handset, the WiFi or 3G/4G cellular technology used for the test, the bearer channels, and certain other parameters helpful for the characterization of mobile performance. Data extracts for the appropriate time periods reviewed in this *Report* were culled from the main database collection selecting only observations that included valid GPS location data in the United States and were executed on the smartphone's cellular connection. So, for example, if a test was executed on a WiFi connection in any portion of a download test, that observation was not included. In addition, only observations with valid and consistent network operator names were included in the data. Duplicate measurements were dropped.

⁴⁷⁸ See *Seventeenth Report*, 29 FCC Rcd at 15467, Appendix VI. ¶¶ 7-9.

⁴⁷⁹ Throughput speeds were converted from bytes/sec to Mbps using a conversion of [1 Mbps=8*(10⁻⁶) bytes/sec]. The throughput speed for failed tests was replaced with a value of zero, and the top 1% of speed observations were trimmed from the dataset, by service provider and separately for each time period. Roaming observations were included in the calculations in order to replicate customer experience; however, these observations did not make up a significant portion of the data. Only observations within the United States were included in the analysis. All tests performed over Wi-Fi were dropped, and only mobile observations were included in the analysis.

Table VI.C.ix
FCC Speed Test - Estimated Download Speeds for All Technologies By Service Provider
Including Discount Brands, Nationwide⁴⁸⁰

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load speed (Mbps)	Median Down load speed (Mbps)	Number of tests	Mean Down load speed (Mbps)	Median Down load speed (Mbps)	Number of tests	Mean Down load speed (Mbps)	Median Down load speed (Mbps)	Number of tests
Verizon	14.08	8.69	76,377	14.52	9.23	148,551	14.97	9.83	72,174
AT&T (includes Cricket)	8.76	5.14	46,807	8.62	5.05	100,313	8.51	4.96	53,507
Sprint (includes Virgin, Boost)	3.88	1.32	49,221	4.45	1.59	89,853	5.16	1.93	40,632
T-Mobile (includes Metro PCS)	12.21	8.24	58,911	12.91	8.26	121,225	13.58	8.27	62,314
Total	9.88	5.06	251,943	10.35	5.37	501,105	10.83	5.69	249,163

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data includes discount brands as did the *Seventeenth Report*. Total speeds are evaluated using data for all service providers, not only the four nationwide service providers. July 2014 – June 2015.

⁴⁸⁰ Consistent with the methodology used in previous reports, estimated download speed data includes any discount brands offered by a service provider. We recognize that some discount brands may have capped LTE download speeds, or employ different network management practices. See, e.g., CricketWireless website, “Mobile Broadband Information,” available at <https://www.cricketwireless.com/legal-info/mobile-broadband-information.html>; Virgin Mobile website, available at <http://coverage.sprint.com/coverageDescVMU.html>.

Table VI.C.x

FCC Speed Test - Estimated LTE Download Speeds by Service Provider's Flagship Brand, Nationwide⁴⁸¹

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests
Verizon	16.13	10.97	63,436	16.34	11.24	110,549	16.63	11.66	47,114
AT&T	12.13	8.52	23,913	11.78	8.06	44,818	11.38	7.53	20,905
Sprint	7.13	5.00	23,701	7.47	5.02	41,430	7.94	5.05	17,729
T-Mobile	17.97	14.91	31,586	18.02	14.33	59,594	18.07	13.58	28,008
Total	13.98	9.44	154,279	14.05	9.29	280,373	14.13	9.07	126,096

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data excludes discount brands. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers. July 2014 – May 2015.

Table VI.C.xi

FCC Speed Test - Estimated LTE Download Speeds by Service Provider Including Discount Brands, Nationwide⁴⁸²

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests
Verizon	16.13	10.97	63,436	16.34	11.24	110,549	16.63	11.66	47,114
AT&T (includes Cricket)	11.26	7.69	26,596	10.69	7.31	51,604	10.07	6.84	25,009
Sprint (includes Virgin, Boost)	7.11	4.98	24,156	7.43	4.98	42,435	7.86	4.99	18,280
T-Mobile (includes MetroPCS)	17.65	14.57	33,195	17.73	13.99	63,309	17.82	13.27	30,114
Total	13.98	9.44	154,280	14.05	9.28	280,372	14.14	9.07	126,096

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data includes discount brands, as did the *Seventeenth Report*. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers. July 2014 – May 2015.

⁴⁸¹ Estimated download speed data excludes any discount brands offered by a service provider.

⁴⁸² See n.480 *supra*.

Table VI.C.xii
FCC Speed Test - Estimated Upload Speeds for All Technologies by Service Provider
Including Discount Brands, Nationwide⁴⁸³

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests
Verizon	4.05	2.68	72,013	4.97	2.96	140,996	5.94	3.28	68,984
AT&T (includes Cricket)	3.01	1.66	41,792	3.59	1.87	89,677	4.11	2.09	47,885
Sprint (includes Virgin, Boost)	1.58	0.73	45,926	1.88	0.80	83,495	2.27	0.88	37,570
T-Mobile (includes MetroPCS)	4.25	2.33	53,925	5.64	2.91	108,278	7.03	4.02	54,353
Total	3.22	1.53	232,962	4.05	1.79	460,855	4.91	2.16	227,895

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data includes discount brands, as did the *Seventeenth Report*. Total speeds are evaluated using data for all service providers, not only the four nationwide service providers. July 2014 – June 2015.

Table VI.C.xiii
FCC Speed Test - Estimated LTE Upload Speeds by Service Provider's Flagship Brand, Nationwide

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests
Verizon	4.63	3.54	60,286	5.59	3.82	105,888	6.86	4.31	45,603
AT&T	4.10	3.47	22,150	4.73	3.67	41,579	5.45	4.01	19,429
Sprint	2.75	2.22	21,725	3.08	2.36	38,129	3.55	2.58	16,405
T-Mobile	6.86	5.63	28,789	8.47	6.50	53,963	10.31	8.64	25,175
Total	4.67	3.68	143,477	5.66	4.05	261,224	6.87	4.71	117,750

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data excludes discount brands. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers. July 2014 – May 2015.

⁴⁸³ See n.480 *supra*.

Table VI.C.xiv
FCC Speed Test - Estimated LTE Upload Speeds by Service Provider
Including Discount Brands, Nationwide⁴⁸⁴

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests
Verizon	4.63	3.54	60,286	5.59	3.82	105,888	6.86	4.31	45,603
AT&T (includes Cricket)	4.07	3.36	24,453	4.84	3.73	47,613	5.67	4.28	23,161
Sprint (includes Virgin, Boost)	2.75	2.22	22,129	3.07	2.33	39,051	3.51	2.52	16,923
T-Mobile (includes MetroPCS)	6.80	5.58	30,179	8.44	6.46	56,993	10.29	8.63	26,815
Total	4.67	3.68	143,478	5.66	4.05	261,225	6.87	4.71	117,751

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data includes discount brands, as did the *Seventeenth Report*. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers. July 2014 – May 2015.

⁴⁸⁴ See *id.*

Table VI.C.xv
FCC Speed Test - Estimated Download Speeds for All Technologies by Service Provider
Including Discount Brands, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests
Verizon	13.51	7.31	10,116	14.66	8.12	20,293	15.80	9.08	10,177
AT&T (includes Cricket)	9.07	5.39	5,864	9.12	5.20	12,842	9.17	5.05	6,978
Sprint (includes Virgin, Boost)	3.05	1.00	6,312	3.61	1.16	11,068	4.40	1.47	4,756
T-Mobile (includes MetroPCS)	12.43	8.59	10,396	12.80	8.06	23,013	13.11	7.49	12,617
Total	9.97	4.96	34,477	10.81	5.29	70,339	11.62	5.65	35,862

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data includes discount brands, as did the *Seventeenth Report*. Total speeds are evaluated using data for all service providers, not only the four nationwide service providers. July 2014 – June 2015.

Table VI.C.xvi
FCC Speed Test - Estimated LTE Download Speeds by Service Provider's Flagship Brand, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests
Verizon	14.72	9.02	8,466	15.68	9.61	15,206	16.90	10.52	6,740
AT&T	11.63	7.59	2,963	11.23	6.98	5,856	10.84	6.51	2,894
Sprint	6.59	4.69	2,522	7.07	4.61	4,335	7.84	4.53	1,813
T-Mobile	17.80	14.90	5,511	17.60	13.92	11,084	17.41	12.92	5,573
Total	13.69	8.94	20,730	14.07	8.81	39,193	14.52	8.64	18,465

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data excludes discount brands. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers. July 2014 – May 2015.

Table VI.C.xvii
FCC Speed Test - Estimated LTE Download Speeds by Service Provider
Including Discount Brands, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of tests
Verizon	14.72	9.02	8,466	15.68	9.61	15,206	16.90	10.52	6,740
AT&T (includes Cricket)	11.42	7.37	3,051	10.70	6.64	6,288	10.04	6.09	3,238
Sprint (includes Virgin, Boost)	6.58	4.68	2,566	7.03	4.59	4,418	7.78	4.46	1,853
T-Mobile (includes MetroPCS)	16.80	13.67	6,175	16.62	12.84	12,498	16.45	11.80	6,324
Total	13.69	8.94	20,730	14.07	8.81	39,193	14.52	8.64	18,466

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data includes discount brands, as did the *Seventeenth Report*. Total speeds are evaluated using data for all LTE service providers, not only the four nationwide service providers. July 2014 – June 2015.

Table VI.C.xviii
FCC Speed Test - Estimated Upload Speeds for All Technologies by Service Provider
Including Discount Brands, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests
Verizon	4.03	2.48	9,348	5.25	2.67	18,968	6.44	2.91	9,620
AT&T (includes Cricket)	3.26	1.39	5,165	3.72	1.66	11,244	4.12	1.91	6,079
Sprint (includes Virgin, Boost)	1.29	0.65	5,858	1.44	0.67	9,999	1.67	0.72	4,142
T-Mobile (includes MetroPCS)	5.06	2.61	9,354	6.62	3.83	19,463	8.06	5.33	10,109
Total	3.55	1.40	31,339	4.62	1.75	62,487	5.71	2.26	31,149

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data includes discount brands, as did the *Seventeenth Report*. Total speeds are evaluated using data for all service providers, not only the four nationwide service providers. July 2014 – May 2015.

Table VI.C.xix
FCC Speed Test - Estimated Upload LTE Speeds by Service Provider's Flagship Brand, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests
Verizon	4.47	3.09	7,959	5.64	3.21	14,428	7.09	3.40	6,469
AT&T	4.47	3.43	2,771	4.98	3.55	5,484	5.52	3.67	2,714
Sprint	2.52	1.74	2,254	2.62	1.55	3,736	2.81	1.31	1,483
T-Mobile	8.05	6.52	4,918	9.88	7.45	9,760	11.75	10.13	4,843
Total	5.17	3.89	18,985	6.42	4.24	35,485	7.87	4.82	16,503

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data excludes discount brands. Total speeds are evaluated using data for all service providers, not only the four nationwide service providers. July 2014 – May 2015.

Table VI.C.xx
FCC Speed Test - Estimated Upload LTE Speeds by Service Provider Including Discount Brands, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of tests
Verizon	4.47	3.09	7,959	5.64	3.21	14,428	7.09	3.40	6,469
AT&T (includes Cricket)	4.46	3.42	2,841	5.00	3.54	5,788	5.52	3.66	2,948
Sprint (includes Virgin, Boost)	2.52	1.74	2,290	2.61	1.55	3,805	2.79	1.30	1,515
T-Mobile (includes MetroPCS)	7.77	6.34	5,506	9.66	7.24	10,823	11.62	9.90	5,318
Total	5.17	3.89	18,984	6.42	4.24	35,484	7.87	4.82	16,503

Source: Data from FCC Measuring Mobile Broadband America data. Observations include failed tests. Provider speed data includes discount brands, as did the *Seventeenth Report*. Total speeds are evaluated using data for all service providers, not only the four nationwide service providers. July 2014 – May 2015.

Rootmetrics. An in-depth discussion of the Root Metrics dataset is available in the *Seventeenth Report*.⁴⁸⁵ In this *Report*, we present mobile wireless upload and download speeds and indices within the United States for the second half of 2014 through the first half of 2015.⁴⁸⁶

Table VI.C.xxii
Root Metrics National Speed Index Data, 2nd Half 2014, 1st Half 2015

Service Provider	2nd Half 2014			1st Half 2015		
	Speed Index	Data Performance	Text Performance	Speed Index	Data Performance	Text Performance
Verizon Wireless	89.0	94.5	92.4	91.9	96.6	95.2
AT&T	85.5	91.5	93.2	88.5	94.1	95.5
Sprint	71.0	81.4	92.7	75.8	85.0	95.0
T-Mobile	79.1	81.9	89.7	85.1	87.0	90.5

Source: RootMetrics RootScore Report Data, 2nd half 2014, 1st half 2015.

Table VI.C.xxii
RootMetrics California Speed Index Data, 2nd Half 2014, 1st Half 2015

Service Provider	2nd Half 2014			1st Half 2015		
	Speed Index	Data Performance	Text Performance	Speed Index	Data Performance	Text Performance
Verizon Wireless	90.9	95.2	91.8	93.0	97.2	95.4
AT&T	89.1	93.5	92.2	90.9	95.2	96.6
Sprint	67.4	77.9	91.6	77.0	86.4	95.2
T-Mobile	86.5	88.5	90.6	89.6	93.4	94.9

Source: RootMetrics RootScore Report Data, 2nd half 2014, 1st half 2015.

⁴⁸⁵ See *Seventeenth Report*, 29 FCC Rcd at 15467, Appendix VI. ¶¶ 10-11.

⁴⁸⁶ The speed estimates are based on median download and upload speeds by state and by provider, which RootMetrics provided to the Commission. To estimate “mean” nationwide speeds, the mean of the median values across all states was calculated, by provider and overall. Nationwide median speeds represent the median speed across all states, by service provider and overall. This was done separately for each time period.

Table VI.C.xxiii
Root Metrics Speed Test - Estimated LTE Download Speeds by Service Provider, Nationwide

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load Speed (Mbps)	Median Down load speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load speed (Mbps)	Number of tests
Verizon Wireless	14.94	14.92	205,508	15.41	15.30	471,655	15.87	15.68	266,147
AT&T	9.98	9.74	206,082	9.88	9.83	472,202	9.77	9.93	266,120
Sprint	3.80	3.94	205,637	4.30	4.50	471,605	4.80	5.06	265,968
T-Mobile	9.29	9.37	205,397	9.47	9.43	471,186	9.65	9.49	265,789
Total	9.50	9.49	822,624	9.76	9.77	1,886,648	10.02	10.04	1,064,024

Source: RootMetrics Data, 2015. © Rootmetrics. All rights reserved. Total mean and median download speeds are calculated using data for the four nationwide service providers.

Table VI.C.xxiv
Root Metrics Speed Test - Estimated LTE Download Speeds by Service Provider, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Down load Speed (Mbps)	Median Down load speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Down load speed (Mbps)	Number of tests	Mean Down load Speed (Mbps)	Median Download speed (Mbps)	Number of tests
Verizon Wireless	16.91	16.91	19,197	19.17	19.17	56,528	21.44	21.44	37,331
AT&T	12.10	12.10	19,205	12.33	12.33	56,493	12.56	12.56	37,288
Sprint	3.05	3.05	19,180	4.80	4.80	56,527	6.56	6.56	37,347
T-Mobile	12.35	12.35	19,194	12.75	12.75	56,404	13.15	13.15	37,210
Total	11.10	11.10	76,776	12.27	12.27	225,952	13.43	13.43	149,176

Source: RootMetrics Data, 2015. © Rootmetrics. All rights reserved. Total mean and median download speeds are calculated using data for the four nationwide service providers.

Table VI.C.xxv
Root Metrics Speed Test - Estimated LTE Upload Speeds by Service Provider, Nationwide

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload Speed (Mbps)	Median Upload speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload speed (Mbps)	Number of tests
Verizon Wireless	8.16	7.91	205,153	8.56	8.09	471,740	8.97	8.27	266,587
AT&T	5.61	4.89	206,468	5.54	4.82	473,051	5.46	4.74	266,583
Sprint	2.13	2.32	206,023	2.35	2.43	472,437	2.58	2.54	266,414
T-Mobile	6.21	6.55	205,734	6.71	6.72	471,955	7.20	6.90	266,221
Total	5.52	5.42	823,378	5.79	5.51	1,889,183	6.05	5.61	1,065,805

Source: RootMetrics Data, 2015. © Rootmetrics. All rights reserved. Total mean and median upload speeds are calculated using data for the four nationwide service providers.

Table VI.C.xxvi
Root Metrics Speed Test - Estimated LTE Upload Speeds by Service Provider, California Only

Service Provider	2H2014			2H2014 - 1H2015			1H2015		
	Mean Upload Speed (Mbps)	Median Upload speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload speed (Mbps)	Number of tests	Mean Upload Speed (Mbps)	Median Upload speed (Mbps)	Number of tests
Verizon Wireless	10.05	10.05	19,209	12.68	12.68	56,579	15.31	15.31	37,370
AT&T	7.80	7.80	19,220	7.84	7.84	56,554	7.88	7.88	37,334
Sprint	1.34	1.34	19,194	2.35	2.35	56,592	3.37	3.37	37,398
T-Mobile	10.65	10.65	19,206	12.95	12.95	56,450	15.25	15.25	37,244
Total	7.46	7.46	76,829	8.96	8.96	226,175	10.45	10.45	149,346

Source: RootMetrics Data, 2015. © Rootmetrics. All rights reserved. Total mean and median upload speeds are calculated using data for the four nationwide service providers.

CalSPEED. An in-depth discussion of the CalSPEED dataset is available in the *Seventeenth Report*.⁴⁸⁷ In this *Report*, we present mobile wireless upload and download speeds within California for the fall of 2014 and the spring of 2015.⁴⁸⁸ We also present charts summarizing mobile wireless upload and download speeds and latency within the United States for the spring of 2012 through the spring of 2015.⁴⁸⁹

Table VI.C.xxvii
CalSPEED - Estimated Download Speeds by Service Provider, California Only

Service Provider	Fall 2014			Fall 2014 and Spring 2015			Spring 2015		
	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of Tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of Tests	Mean Down load Speed (Mbps)	Median Down load Speed (Mbps)	Number of Tests
Verizon Wireless	12.51	10.71	1,865	11.75	10.71	3,515	10.99	10.71	1,651
AT&T	9.72	7.11	1,647	8.91	6.69	3,358	8.19	6.30	1,711
Sprint	3.17	0.96	1,234	3.57	1.21	2,586	3.95	1.48	1,353
T-Mobile	8.43	6.22	1,344	8.50	7.03	2,354	8.67	7.89	1,010
Total	8.96	5.88	6,090	8.51	6.01	11,813	8.08	6.16	5,725

Source: The estimated speeds are based on the CalSPEED data. The top 1% of speed values were dropped, by provider and time period. Fall 2014 tests were taken between the dates of 10/1/2014 and 11/21/2014. Spring 2015 tests were taken between the dates of 5/1/2015 and 6/15/2015. Total mean and median download speeds are calculated using data for the four nationwide service providers.

⁴⁸⁷ See *Seventeenth Report*, 29 FCC Rcd at 15469-70, Appendix VI. ¶¶ 12-16.

⁴⁸⁸ These values are estimated using all technologies, and also for LTE only. The throughput speed was replaced with a value of zero for certain test errors, which correspond to the method used by CPUC. Tests were not included if they were quit by the user, if the test was outside of the service area, or if the testing device was not a smartphone. Finally, results from each site and for each provider were averaged across all east coast and west coast servers, and the top 1% of resulting speed observations were trimmed from the dataset, by provider and separately for each time period. This is a surveyed test and not crowdsourced, and therefore some of the cleaning criteria may be different from the other speed tests.

⁴⁸⁹ We note that while CPUC performed tests using both commercially available, Android-based smartphones as well as tablets, the charts in this Appendix reflect measurements taken using phones only.

Table VI.C.xxviii
CalSPEED - Estimated Upload Speeds by Service Provider, California Only

Service Provider	Fall 2014			Fall 2014 and Spring 2015			Spring 2015		
	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of Tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of Tests	Mean Upload Speed (Mbps)	Median Upload Speed (Mbps)	Number of Tests
Verizon Wireless	6.38	6.33	1,865	6.53	6.51	3,515	6.70	6.69	1,651
AT&T	5.63	5.17	1,647	5.50	5.02	3,358	5.38	4.76	1,711
Sprint	2.12	0.87	1,234	2.29	0.95	2,586	2.46	1.06	1,353
T-Mobile	5.10	4.42	1,344	5.52	5.45	2,354	6.07	6.97	1,010
Total	5.03	4.02	6,090	5.11	4.13	11,813	5.19	4.23	5,725

Source: The estimated speeds are based on the CalSPEED data. The top 1% of speed values were dropped, by provider and time period. Fall 2014 tests were taken between the dates of 10/1/2014 and 11/21/2014. Spring 2015 tests were taken between the dates of 5/1/2015 and 6/15/2015. Total mean and median upload speeds are calculated using data for the four nationwide service providers.

Table VI.C.xxix
CalSPEED - Estimated LTE Download Speeds by Service Provider, California Only

Service Provider	Fall 2014			Fall 2014 and Spring 2015			Spring 2015		
	Mean LTE Down load Speed (Mbps)	Median LTE Down load Speed (Mbps)	Number of Tests	Mean LTE Down load Speed (Mbps)	Median LTE Down load Speed (Mbps)	Number of Tests	Mean LTE Down load Speed (Mbps)	Median LTE Down load Speed (Mbps)	Number of Tests
Verizon Wireless	13.82	12.66	1,594	12.90	12.18	2,981	11.93	11.75	1,387
AT&T	10.94	8.98	1,245	9.95	8.23	2,543	9.06	7.56	1,298
Sprint	5.24	3.33	539	5.28	3.33	1,285	5.30	3.36	746
T-Mobile	10.66	9.54	883	10.25	9.55	1,570	9.84	9.57	688
Total	11.24	9.30	4,261	10.34	8.78	8,379	9.48	8.34	4,119

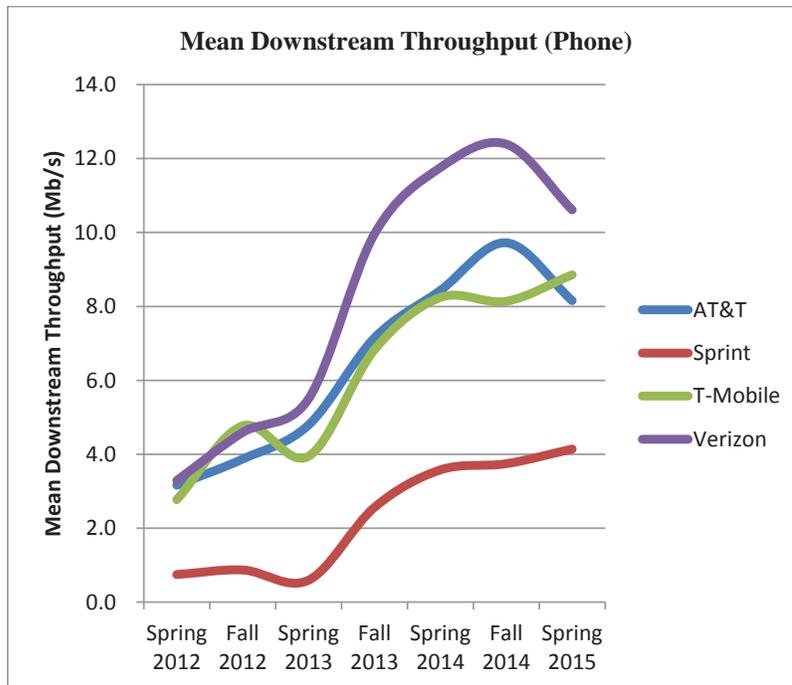
Source: The estimated speeds are based on the CalSPEED data. The top 1% of speed values were dropped, by provider and time period. Fall 2014 tests were taken between the dates of 10/1/2014 and 11/21/2014. Spring 2015 tests were taken between the dates of 5/1/2015 and 6/15/2015. Total mean and median download speeds are calculated using data for the four nationwide service providers.

Table VI.C.xxx
CalSPEED - Estimated LTE Upload Speeds by Service Provider, California Only

Service Provider	Fall 2014			Fall 2014 and Spring 2015			Spring 2015		
	Mean LTE Upload Speed (Mbps)	Median LTE Upload Speed (Mbps)	Number of Tests	Mean LTE Upload Speed (Mbps)	Median LTE Upload Speed (Mbps)	Number of Tests	Mean LTE Upload Speed (Mbps)	Median LTE Upload Speed (Mbps)	Number of Tests
Verizon Wireless	7.06	7.31	1,594	7.17	7.49	2,977	7.34	7.63	1,387
AT&T	6.44	6.63	1,245	6.23	6.36	2,540	6.06	6.14	1,298
Sprint	3.34	2.40	539	3.24	2.27	1,274	3.29	2.18	746
T-Mobile	6.49	7.23	883	6.70	7.58	1,567	7.01	7.98	688
Total	6.29	6.35	4,261	6.20	6.20	8,358	6.15	6.10	4,119

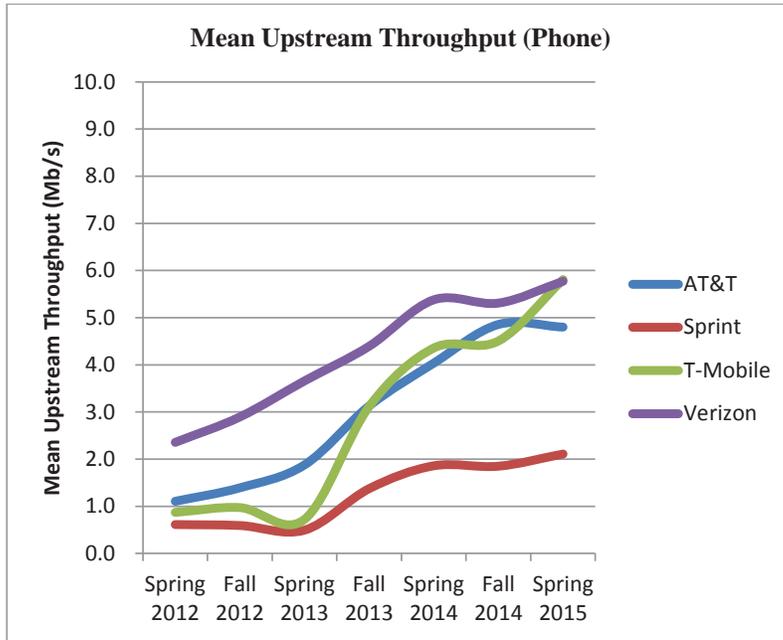
Source: The estimated speeds are based on the CalSPEED data. The top 1% of speed values were dropped, by provider and time period. Fall 2014 tests were taken between the dates of 10/1/2014 and 11/21/2014. Spring 2015 tests were taken between the dates of 5/1/2015 and 6/15/2015. Total mean and median upload speeds are calculated using data for the four nationwide service providers.

Chart VI.C.i
CalSPEED - Mean Downstream Throughput, 2012-Spring 2015



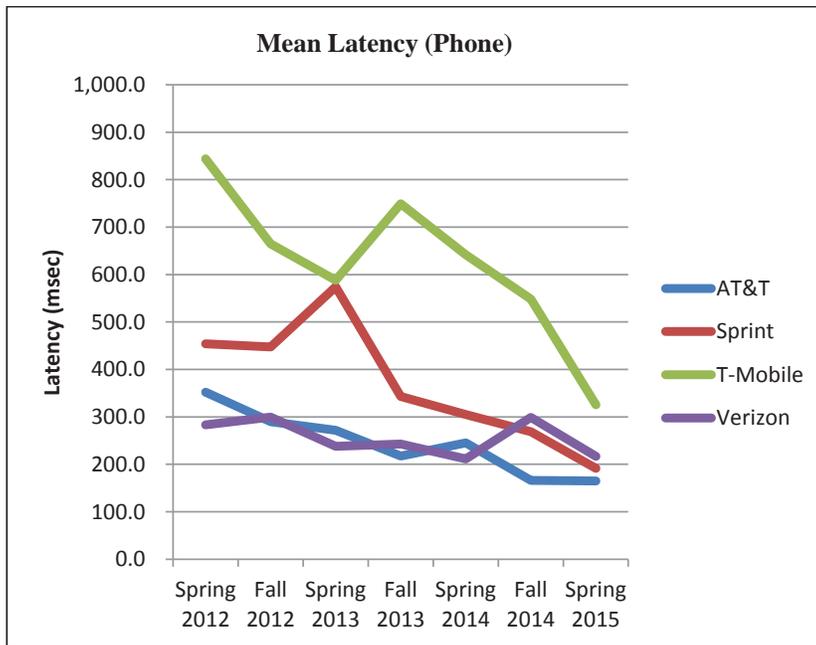
Source: "CALSPED - California's Mobile Broadband Assessment," Spring 2015.

Chart VI.C.ii
CalSPEED - Mean Upstream Throughput, California, 2012-Spring 2015



Source: “CalSPEED - California’s Mobile Broadband Assessment,” Spring 2015.

Chart VI.C.iii
CalSPEED - Mean Latency, California, 2012-Spring 2015



Source: “CalSPEED - California’s Mobile Broadband Assessment,” Spring 2015.

APPENDIX VII: CONSUMERS AND TRENDS IN THE MOBILE WIRELESS ECOSYSTEM

Table VII.C.i
Percentage of U.S. Adults Living in Households with/without
Wireless and Landlines (2010 - 2015)

Date of interview	Percent of Adults in Households with:			
	Landline with Wireless	Landline without Wireless	Wireless-only	Phoneless
Jan–Jun 2010	62.2%	10.9%	24.9%	1.7%
Jul–Dec 2010	59.4%	10.7%	27.8%	1.8%
Jan–Jun 2011	58.8%	9.0%	30.2%	1.8%
Jul–Dec 2011	57.3%	8.3%	32.3%	1.9%
Jan–Jun 2012	56.1%	7.8%	34.0%	1.9%
Jul–Dec 2012	54.4%	7.0%	36.5%	1.9%
Jan–Jun 2013	52.8%	6.9%	38.0%	2.2%
Jul–Dec 2013	51.5%	7.0%	39.1%	2.2%
Jan–Jun 2014	47.3%	7.0%	43.1%	2.4%
Jul–Dec 2014	45.8%	7.1%	44.1%	2.9%
Jan–Jun 2015	43.9%	6.2%	46.7%	3.1%

Note: Adults are aged 18 and over, children are under age 18. Source: CDC/NCHS National Health Interview Survey.

Table VII.C.ii
Percentage of U.S. Children Living in Households with/without
Wireless and Landlines (2010 - 2015)

Date of interview	Percent of Children in Households with:			
	Landline with Wireless	Landline without Wireless	Wireless-only	Phoneless
Jan–Jun 2010	62.8%	6.4%	29.0%	1.7%
Jul–Dec 2010	59.8%	6.2%	31.8%	2.0%
Jan–Jun 2011	56.7%	5.1%	36.4%	1.7%
Jul–Dec 2011	54.7%	4.8%	38.1%	2.2%
Jan–Jun 2012	52.7%	4.5%	40.6%	2.2%
Jul–Dec 2012	49.5%	3.4%	45.0%	1.9%
Jan–Jun 2013	48.3%	3.6%	45.4%	2.6%
Jul–Dec 2013	46.4%	3.8%	47.1%	2.5%
Jan–Jun 2014	47.1%	3.5%	52.1%	2.7%
Jul–Dec 2014	39.1%	3.3%	54.1%	3.4%
Jan–Jun 2015	38.3%	3.0%	55.3%	3.2%

Note: Adults are aged 18 and over, children are under age 18. Source: CDC/NCHS National Health Interview Survey.